

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The mission of CIT is to impart high quality education and training to its students to make them World - Class Engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

To empower the graduates with "Capabilities of Academic, Technical and Professional competence and to nurture them in the emerging fields of research, and innovative product development".

MISSION

The mission of the Electrical and Electronics Engineering program is to :

1. Make the students more active in using basic engineering and technology of the course by deep teaching learning method.
2. Train the students to create new product development procedures by agile based learning and master the operation of systems engineering.
3. Inculcate the ethics on realizing the importance of engineering, technology development and research on society and their future

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To offer thematic oriented teaching through practical engineering operation and make the students to learn from practice to be successful in their career.
2. To promote creative thinking to inspire the real world engineering design based on demand through research and development
3. To make the students to realize the importance of becoming entrepreneurs by promoting project design considering the product R&D, production, marketing, service aspects and product life cycle
4. To foster teamwork, communication, leadership and cultivate techno-commercial-socio-economic problem solving capabilities

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

(POs & PSOs)

At the end of the programme, Electrical and Electronics Engineering Graduates will be able to :

PO1 : Engineering knowledge : Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialisation for the solution of complex engineering problems.

Competency	Indicators
1.1 Demonstrate competence in mathematical modelling	1.1.1 Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems 1.1.2 Apply advanced mathematical techniques to model and solve electrical engineering problems
1.2 Demonstrate competence in basic sciences	1.2.1 Apply laws of natural science to an engineering problem
1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply fundamental engineering concepts to solve engineering problems
1.4 Demonstrate competence in specialized engineering knowledge to the program	1.4.1 Apply electrical engineering concepts to solve engineering problems.

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

Competency	Indicators
2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.1 Articulate problem statements and identify objectives 2.1.2 Identify engineering systems, variables, and parameters to solve the problems 2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1 Reframe complex problems into interconnected sub-problems

	<p>2.2.2 Identify, assemble and evaluate information and resources.</p> <p>2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions</p> <p>2.2.4 Compare and contrast alternative solution processes to select the best process.</p>
2.3 Demonstrate an ability to formulate and interpret a model	<p>2.3.1 Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.</p> <p>2.3.2 Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required</p>
2.4 Demonstrate an ability to execute a solution process and analyze results	<p>2.4.1 Apply engineering mathematics and computations to solve mathematical models</p> <p>2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models</p> <p>2.4.3 Identify sources of error in the solution process, and limitations of the solution.</p> <p>2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis</p>

PO3 : Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

Competency	Indicators
3.1 Demonstrate an ability to define a complex/open-ended problem in engineering terms	<p>3.1.1 Recognize that need analysis is key to good problem definition</p> <p>3.1.2 Elicit and document, engineering requirements from stakeholders</p> <p>3.1.3 Synthesize engineering requirements from a review of the state-of-the-art</p> <p>3.1.4 Extract engineering requirements from relevant engineering Codes and Standards such as ASME, ASTM, BIS, ISO and ASHRAE.</p>

	<p>3.1.5 Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues</p> <p>3.1.6 Determine design objectives, functional requirements and arrive at specifications</p>
3.2 Demonstrate an ability to generate a diverse set of alternative design solutions	<p>3.2.1 Apply formal idea generation tools to develop multiple engineering design solutions</p> <p>3.2.2 Build models/prototypes to develop a diverse set of design solutions</p> <p>3.2.3 Identify suitable criteria for the evaluation of alternate design solutions</p>
3.3 Demonstrate an ability to select an optimal design scheme for further development	<p>3.3.1 Apply formal decision-making tools to select optimal engineering design solutions for further development</p> <p>3.3.2 Consult with domain experts and stakeholders to select candidate engineering design solution for further development</p>
3.4 Demonstrate an ability to advance an engineering design to defined end state	<p>3.4.1 Refine a conceptual design into a detailed design within the existing constraints (of the resources)</p> <p>3.4.2 Generate information through appropriate tests to improve or revise the design</p>

PO4 : Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Competency	Indicators
4.1 Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	<p>4.1.1 Define a problem, its scope and importance for purposes of investigation</p> <p>4.1.2 Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation</p> <p>4.1.3 Apply appropriate instrumentation and/or software tools to make measurements of physical quantities</p> <p>4.1.4 Establish a relationship between measured data and underlying physical principles.</p>

<p>4.2 Demonstrate an ability to design experiments to solve open-ended problems</p>	<p>4.2.1 Design and develop an experimental approach, specify appropriate equipment and procedures</p> <p>4.2.2 Understand the importance of the statistical design of experiments and choose an appropriate experimental design plan based on the study objectives</p>
<p>4.3 Demonstrate an ability to analyze data and reach a valid conclusion</p>	<p>4.3.1 Use appropriate procedures, tools and techniques to conduct experiments and collect data</p> <p>4.3.2 Analyze data for trends and correlations, stating possible errors and limitations</p> <p>4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions</p> <p>4.3.4 Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions</p>

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

Competency	Indicators
<p>5.1 Demonstrate an ability to identify / create modern engineering tools, techniques and resources</p>	<p>5.1.1 Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources for engineering activities</p> <p>5.1.2 Create/adapt/modify/extend tools and techniques to solve engineering problems</p>
<p>5.2 Demonstrate an ability to select and apply discipline-specific tools, techniques and resources</p>	<p>5.2.1 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.</p> <p>5.2.2 Demonstrate proficiency in using discipline-specific tools</p>
<p>5.3 Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem</p>	<p>5.3.1 Discuss limitations and validate tools, techniques and resources</p> <p>5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.</p>

PO 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.

Competency		Indicators
6.1	Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

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

Competency		Indicators
7.1	Demonstrate an understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1 Identify risks/impacts in the life-cycle of an engineering product or activity 7.1.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1 Describe management techniques for sustainable development 7.2.2 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline

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

Competency		Indicators
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1 Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1 Identify tenets of the ASME professional code of ethics 8.2.2 Examine and apply moral & ethical principles to known case studies

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

Competency	Indicators
9.1 Demonstrate an ability to form a team and define a role for each member	9.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team 9.1.2 Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2 Demonstrate effective individual and team operations-- communication, problem solving, conflict resolution and leadership skills	9.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills 9.2.2 Treat other team members respectfully 9.2.3 Listen to other members 9.2.4 Maintain composure in difficult situations
9.3 Demonstrate success in a team-based project	9.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

PO 10 : Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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

Competency	Indicators
10.1 Demonstrate an ability to comprehend technical literature and document project work	10.1.1 Read, understand and interpret technical and non-technical information 10.1.2 Produce clear, well-constructed, and well-supported written engineering documents 10.1.3 Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
10.2 Demonstrate competence in listening, speaking, and presentation	10.2.1 Listen to and comprehend information, instructions, and viewpoints of others 10.2.2 Deliver effective oral presentations to technical and non-technical audiences
10.3 Demonstrate the ability to integrate different modes of communication	10.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations 10.3.2 Use a variety of media effectively to convey a message in a document or a presentation

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

Competency	Indicators
11.1 Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1 Describe various economic and financial costs/benefits of an engineering activity 11.1.2 Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2 Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1 Analyze and select the most appropriate proposal based on economic and financial considerations.
11.3 Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks. 11.3.2 Use project management tools to schedule an engineering project, so it is completed on time and on budget.

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

Competency	Indicators
12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1 Describe the rationale for the requirement for continuing professional development 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
12.3 Demonstrate an ability to identify and access sources for new information	12.3.1 Source and comprehend technical literature and other credible sources of information 12.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

PSO1 : MODELING AND ANALYSIS : An ability to mathematically model and analyze the performance of Electrical machines, Control systems, Instrumentation systems, Power systems and Power electronic systems.

PSO2 : DESIGN AND DEVELOPMENT : An ability to design the hardware and software requirements for the development of Electric drives, Automation systems and Embedded systems.

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING (FULL TIME)

CHOICE BASED CREDIT SYSTEM

Curriculum from the Academic Year 2019 - 2020 and onwards

SUBJECTS OF STUDY

Semester III

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEM31	Transforms, Probability and Random Variables	3	0	0	3	BS
2	19EE31	Electric Circuit Analysis	2	1	0	3	PCC
3	19EE32	Electromagnetic Fields	2	1	0	3	PCC
4	19EE33	DC Machines and Transformers	3	0	0	3	PCC
5	19EE34	Analog Electronics	3	0	0	3	PCC
6	19EE35	Digital Electronics	3	0	0	3	PCC
7	19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HS
8	19EEL36	DC Machines and Transformers Laboratory	0	0	2	1	PCC
9	19EEL37	Analog and Digital Electronics Laboratory	0	0	2	1	PCC
10		One Credit Course 1				1	OCC
11	19HOC31	Communication Skills For Engineers I*	0	0	2	1	EEC
(BS - 3, HS - 1, PCC - 17, OCC - 1, EEC - 1) TOTAL CREDITS						23	
* Not to be counted for GPA. Pass is required							

Semester IV

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE41	AC Rotating Machines	3	0	0	3	PCC
2	19EE42	Networks and Systems	3	0	0	3	PCC
3	19EE43	Measurements and Instrumentation	3	0	0	3	PCC
4	19EE44	Linear Integrated Circuits	3	0	0	3	PCC
5	19EE45	Transmission and Distribution	3	0	0	3	PCC
6	19EE46	OOPS and C++ for Electrical Engineers	3	0	0	3	PCC
7	19EEL47	AC Rotating Machines Laboratory	0	0	2	1	PCC
8	19EEL48	Linear Integrated Circuits Laboratory	0	0	2	1	PCC
9		One Credit Course 2				1	OCC
10	19HOC41	Communication Skills For Engineers II*	0	0	2	1	EEC
(PCC - 20, OCC - 1, EEC - 1) TOTAL CREDITS						22	
* Not to be counted for GPA. Pass is required							

Semester V

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE51	Control Systems	3	0	0	3	PCC
2	19EE52	Power System Analysis	3	0	0	3	PCC
3	19EE53	Data Structures and Algorithms	3	0	0	3	PCC
4	19EE54	Embedded System Design	3	0	0	3	PCC
5		Elective Course 1	3	0	0	3	EC
6		Elective Course 2	3	0	0	3	EC
7	19EEL55	Control systems Laboratory	0	0	2	1	PCC
8	19EEL56	Embedded System Design Laboratory	0	0	2	1	PCC
9		One Credit Course 3				1	OCC
10	19EEL66	Mini Project	-	-	2	-	EEC
11	19INT51	Internship - I	-	-	-	1	EEC
12	19HOC51	Employability and Personality Development Skills - I *	0	0	2	1	EEC
(PCC - 14, EC - 6, OCC - 1, EEC - 2) TOTAL CREDITS						23	
* Not to be counted for GPA. Pass is required							

Semester VI

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE61	Power Electronics	3	0	0	3	PCC
2	19EE62	Digital Protection of Power Systems	3	0	0	3	PCC
3	19EE63	Digital Signal Processing	3	1	0	4	PCC
4		Elective Course 3	3	0	0	3	EC
5		Elective Course 4	3	0	0	3	EC
6	19EEL64	Power Electronics Laboratory	0	0	2	1	PCC
7	19EEL65	Power Systems Laboratory	0	0	2	1	PCC
8		One Credit Course 4				1	OCC
9	19EEL66	Mini Project	0	0	6	3	EEC
10	19INT61	Internship - II	-	-	-	1	EEC
11	19HOC61	Employability and Personality Development Skills - II*	0	0	2	1	EEC
(PCC - 12, EC - 6, OCC - 1, EEC - 5) TOTAL CREDITS						24	
* Not to be counted for GPA. Pass is required							

Semester VII

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE71	Solid State Drives and Control	3	0	0	3	PCC
2	19EE72	Generation of Electrical Energy	3	1	0	4	PCC
3	19EE73	Smart Grid	3	0	0	3	PCC
4		Elective Course 5	3	0	0	3	EC
5		Elective Course 6	3	0	0	3	EC
6	19EEL74	Electrical Drives Laboratory	0	0	2	1	PCC
7	19EEL75	Professional Competency	0	0	4	2	PCC
8	19EE76	Project Work Phase - I	0	0	6	3	EEC
(PCC - 13, EC - 6, EEC - 3)			TOTAL CREDITS			22	

Semester VIII

S. No.	Course Code	Course Name	L	T	P	C	Category
1		Elective Course 7	3	0	0	3	EC
2		Elective Course 8	3	0	0	3	EC
3	19EE81	Project Work Phase - II	0	0	10	5	EEC
(EC - 6, EEC - 5)			TOTAL CREDITS			11	

TOTAL CREDITS : 164 *

* Including First Year Credits

Category : **BS** - Basic Sciences, **HS** - Humanities and Social Sciences, **ES** - Engineering Sciences, **PCC** - Professional Core Course, **EC** - Elective Course, **EEC** - Employability Enhancement Course, **OCC** - One Credit Course.

ELECTIVE COURSES**PROFESSIONAL ELECTIVE COURSE : STREAM****I. ELECTRICAL MACHINES AND CONTROL (EMC)**

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEE01	Design of Electrical Machines	3	0	0	3	EC
2	19EEE02	Special Electrical Machines	3	0	0	3	EC
3	19EEE03	Modeling and Analysis of Electrical Machines	3	0	0	3	EC
4	19EEE04	Digital Control Systems	3	0	0	3	EC
5	19EEE05	Systems Theory	3	0	0	3	EC
6	19EEE06	Embedded control of electric drives	3	0	0	3	EC
7	19EEE07	Robust Control	3	0	0	3	EC

II. POWER AND ENERGY (PE)

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEE08	Power Quality	3	0	0	3	EC
2	19EEE09	Advanced Power Electronics	3	0	0	3	EC
3	19EEE10	Power and Energy Management	3	0	0	3	EC
4	19EEE11	Energy Storage Technology	3	0	0	3	EC
5	19EEE12	Utilization and Conservation of Electrical Energy	3	0	0	3	EC
6	19EEE13	Electrical Safety	3	0	0	3	EC
7	19EEE14	Energy Efficient Lighting Systems	3	0	0	3	EC
8	19EEE15	Power System Design	3	0	0	3	EC
9	19EEE16	High Voltage Transmission Systems	3	0	0	3	EC
10	19EEE17	Deregulated Power System	3	0	0	3	EC
11	19EEE18	Electric Vehicles	3	0	0	3	EC
12	19EEE19	Energy Audit in Thermal & Electrical Utilities	3	0	0	3	EC
13	19EEE41	Switched Mode Power Conversion	3	0	0	3	EC
14	19EEE42	Utilization of Solar Energy	3	0	0	3	EC

III. ELECTRONIC DESIGN (ED)

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEE20	Real Time Embedded Systems	3	0	0	3	EC
2	19EEE21	VLSI Design	3	0	0	3	EC
3	19EEE22	FPGA based System Design	3	0	0	3	EC
4	19EEE23	Robotics and Control	3	0	0	3	EC
5	19EEE24	Digital Consumer technology	3	0	0	3	EC
6	19EEE25	Electronic Product Design	3	0	0	3	EC
7	19EEE26	Medical Electronics	3	0	0	3	EC
8	19EEE27	Analog and Digital Communication	3	0	0	3	EC
9	19EEE28	Multimedia system	3	0	0	3	EC
10	19EEE29	Automation, Renewable Energy & FPGA Laboratory	0	0	6	3	EC
11	19EEE43	Wearable Sensors	3	0	0	3	EC

IV. COMPUTER AND COMMUNICATION (CC)

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EEE30	Computer Architecture and Parallel Processing	3	0	0	3	EC
2	19EEE31	Multi Core Architecture	3	0	0	3	EC
3	19EEE32	Data Communication Networks	3	0	0	3	EC
4	19EEE33	Fog Computing	3	0	0	3	EC
5	19EEE34	Internet of Things	3	0	0	3	EC
6	19EEE35	Data Analytics	3	0	0	3	EC
7	19EEE36	Virtual Instrumentation	3	0	0	3	EC
8	19EEE37	Cyber Physical Systems	3	0	0	3	EC
9	19EEE38	Intelligent Techniques for Electrical Engineers	3	0	0	3	EC
10	19EEE39	Industrial Automation	3	0	0	3	EC
11	19EEE40	Deep Learning	3	0	0	3	EC

BS - BASIC SCIENCES

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19FYM12	Calculus and Numerical Methods	3	1	0	4	BS
2	19FYP13	Engineering Physics	3	0	0	3	BS
3	19FYC11	Engineering Chemistry	3	0	0	3	BS
4	19PL11	Physics Laboratory-I	0	0	1	0.5	BS
5	19CL11	Chemistry Laboratory-I	0	0	1	0.5	BS
6	19FYM22	Vector Calculus, Linear Algebra and Partial Differential Equations	3	1	0	4	BS
7	19PL21	Physics Laboratory-II	0	0	1	0.5	BS
8	19CL21	Chemistry Laboratory-II	0	0	1	0.5	BS
9	19MEL12	Engineering Practices Laboratory	0	0	2	1	BS
10	19EEM31	Transforms, Probability and Random Variables	3	0	0	3	BS
TOTAL CREDITS						20	

HS - HUMANITIES AND SOCIAL SCIENCES

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19FYE11	Technical English	1	0	2	2	HS
2	19FYE21	Language Elective	1	0	2	2	HS
3	19FYC21	Environmental Science and Engineering	1	0	0	1	HS
4	19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HS
TOTAL CREDITS						6	

ES - ENGINEERING SCIENCES

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19CM11	Basic Civil and Mechanical Engineering	3	0	0	3	ES
2	19MEL11	Engineering Graphics	1	0	4	3	ES
3	19FYP23	Electron Devices	3	0	0	3	ES
4	19EE22	Electric and Magnetic Circuits	3	0	0	3	ES
5	19CSL21	C Programming and Data Bases	0	0	4	2	ES
TOTAL CREDITS						14	

PCC - PROFESSIONAL CORE COURSE

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19EE31	Electric Circuit Analysis	2	1	0	3	PCC
2	19EE32	Electromagnetic Fields	2	1	0	3	PCC
3	19EE33	DC Machines and Transformers	3	0	0	3	PCC
4	19EE34	Analog Electronics	3	0	0	3	PCC
5	19EE35	Digital Electronics	3	0	0	3	PCC
6	19EEL36	DC Machines and Transformers Laboratory	0	0	2	1	PCC
7	19EEL37	Analog and Digital Electronics Laboratory	0	0	2	1	PCC
8	19EE41	AC Rotating Machines	3	0	0	3	PCC
9	19EE42	Networks and Systems	3	0	0	3	PCC
10	19EE43	Measurements and Instrumentation	3	0	0	3	PCC
11	19EE44	Linear Integrated Circuits	3	0	0	3	PCC
12	19EE45	Transmission and Distribution	3	0	0	3	PCC
13	19EE46	OOPS and C++ for Electrical Engineers	3	0	0	3	PCC
14	19EEL47	AC Rotating Machines Laboratory	0	0	2	1	PCC
15	19EEL48	Linear Integrated Circuits Laboratory	0	0	2	1	PCC
16	19EE51	Control Systems	3	0	0	3	PCC
17	19EE52	Power System Analysis	3	0	0	3	PCC
18	19EE53	Data Structures and Algorithms	3	0	0	3	PCC
19	19EE54	Embedded System Design	3	0	0	3	PCC
20	19EEL55	Control systems Laboratory	0	0	2	1	PCC
21	19EEL56	Embedded System Design Laboratory	0	0	2	1	PCC
22	19EE61	Power Electronics	3	0	0	3	PCC
23	19EE62	Digital Protection of Power Systems	3	0	0	3	PCC
24	19EE63	Digital Signal Processing	3	1	0	4	PCC
25	19EEL64	Power Electronics Laboratory	0	0	2	1	PCC
26	19EEL65	Power Systems Laboratory	0	0	2	1	PCC
27	19EE71	Solid State Drives and Control	3	0	0	3	PCC
28	19EE72	Generation of Electrical Energy	3	1	0	4	PCC
29	19EE73	Smart Grid	3	0	0	3	PCC
30	19EEL74	Electrical Drives Laboratory	0	0	2	1	PCC
31	19EEL75	Professional Competency	0	0	4	2	PCC
TOTAL CREDITS						76	

EEC - EMPLOYABILITY ENHANCEMENT COURSE

S. No.	Course Code	Course Name	L	T	P	C	Category
1	19FYEL11	Employability Skills	0	0	2	1	EEC
2	19FYEL21	English for Employability	0	0	2	1	EEC
3	19HOC31	Communication Skills For Engineers I*	0	0	2	1	EEC
4	19HOC41	Communication Skills For Engineers II*	0	0	2	1	EEC
5	19HOC51	Employability and Personality Development Skills - I *	0	0	2	1	EEC
6	19HOC61	Employability and Personality Development Skills - II *	0	0	2	1	EEC
7	19INT51	Internship - I	-	-	-	1	EEC
8	19EEL66	Mini Project	0	0	6	3	EEC
9	19INT61	Internship - II	-	-	-	1	EEC
10	19EE76	Project Work Phase - I	0	0	6	3	EEC
11	19EE81	Project Work Phase - II	0	0	10	5	EEC
TOTAL CREDITS						19	

LIST OF ONE CREDIT COURSES ***1. DEPARTMENT BASED ONE CREDIT COURSES**

S. No.	Course Code	Course Name	Credit	Category
1	19EEOC06	Electrical Safety Standards and Practices	1	OCC
2	19EEOC07	Scilab Programming	1	OCC

2. INDUSTRY BASED ONE CREDIT COURSES

S. No.	Course Code	Course Name	Credit	Category
1	19EEOC08	Machine Vision	1	OCC
2	19EEOC09	Cyber Security in Manufacturing and Smart Grid	1	OCC
3	19EEOC10	Robotics and Automation	1	OCC
4	19EEOC12	AWS Cloud Practitioner Essentials	1	OCC
5	19EEOC13	Introduction to IoT	1	OCC
6	19EEOC14	TCS ION Career Edge Young Professional	1	OCC

* One credit courses could be opted from Department/Industry/NPTEL

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CEOE01	Town Planning and Architecture	3	0	0	3	All Branches
19CEOE02	Climate Change and Adaptation	3	0	0	3	All Branches
19CEOE03	Metro Systems and Engineering	3	0	0	3	All Branches
19CEOE04	Renewable Energy Sources	3	0	0	3	All Branches
19CEOE05	Principles of Sustainable Development	3	0	0	3	All Branches
19CEOE06	Disaster Management	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19MEOE01	Design of Experiments	3	0	0	3	All branches
19MEOE02	Engineering Optimization	3	0	0	3	All branches
19MEOE03	Engineering Polymers, Composites and Allied Manufacturing Processes	3	0	0	3	Mechanical Chemical & Civil
19MEOE04	Industrial Robotics	3	0	0	3	Mechanical EEE and ECE
19MEOE05	Business Process Re-engineering	3	0	0	3	All branches
19MEOE06	Engineering Economics and Financial Management	3	0	0	3	All branches

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
19EEOE02	Solar and Wind Energy Systems	3	0	0	3	ECE, Mech, Chemical
19EEOE03	Electrical Safety Procedures and Management	3	0	0	3	All Branches
19EEOE04	Energy Efficient Illumination Systems	3	0	0	3	All Branches
19EEOE05	Electric Vehicle Technology	3	0	0	3	All Branches except Civil & Chemical
19EEOE06	Energy Efficiency in Thermal and Electrical Utilities	3	0	0	3	EEE & Mechanical

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19ECEOE01	Signal Processing and its Applications	3	0	0	3	Chemical, Mechanical & Civil
19ECEOE02	Smart Sensors and IoT	3	0	0	3	All Branches
19ECEOE03	Consumer Electronics	3	0	0	3	Mechanical & Civil
19ECEOE04	Robotics	3	0	0	3	Mechanical, CSE & IT
19ECEOE05	Information Theory and Coding Techniques	3	0	0	3	All Branches
19ECEOE06	Wireless Sensor Networks	3	0	0	3	All Branches
19ECEOE07	Automotive Embedded Systems	3	0	0	3	All Branches
19ECEOE08	5G Technologies and Applications	3	0	0	3	All Branches
19ECEOE09	Vehicular Communication	3	0	0	3	All Branches
19ECEOE010	Sensing for Automotive Systems	3	0	0	3	All Branches

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CSOE01	Customer Relationship Management	3	0	0	3	All Branches
19CSOE02	Fundamentals of Software Engineering	3	0	0	3	All Branches
19CSOE03	Internet Programming	3	0	0	3	All Branches
19CSOE04	Introduction to Data Warehousing and Data Mining	3	0	0	3	All Branches
19CSOE05	Introduction to Embedded Systems	3	0	0	3	All Branches

DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code	Course Name	L	T	P	C	Eligible Branches
19ITOE01	Digital Computer Basics	3	0	0	3	Civil, Mech, Chem
19ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE06	Introduction to Human Computer Interaction	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE07	Enterprise Resource planning Concepts	3	0	0	3	EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
19CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
19CHOE03	Green Technology	3	0	0	3	All Branches
19CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
19CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches
19CHOE06	Nanomaterial Synthesis and Characterization Laboratory	0	0	6	3	All Branches
19CHOE07	Multivariate Statistics Laboratory	0	0	6	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19MOE01	Graph Theory & its Applications	3	0	0	3	All Branches
19MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
19MOE03	Linear and Non - Linear Programming	3	0	0	3	All Branches
19MOE04	Probability and Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	All Branches except IT
19POE02	Physics and Technology of Thin Films	3	0	0	3	Mechanical, EEE, Chemical & ECE
19POE03	Solar Cell Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
19POE04	Advanced Material Processing Technologies	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
19COE01	Medical Nanotechnology	3	0	0	3	Chemical
19COE02	Advanced Drug Delivery Systems	3	0	0	3	Chemical
19COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
19COE04	Nanocomposites	3	0	0	3	Mechanical, Chemical & Civil
19COE05	Biorefinery	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
19HOE01	Principles of Management	3	0	0	3	Common to all branches
19HOE02	Current Trends in Indian Economy	3	0	0	3	Common to all branches
19HOE03	Monetary Economics	3	0	0	3	Common to all branches
19HOE04	English for Academic Purposes	3	0	0	3	Common to all branches
19HOE05	English for Competitive Exams	3	0	0	3	Common to all branches
19HOE06	Life and Literature	3	0	0	3	Common to all branches

19EEM31 - TRANSFORMS, PROBABILITY AND RANDOM VARIABLES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon successfully completing of this course the students will be able to demonstrate ability to

- CO1** : Analyze the Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.
- CO2** : Use the effective mathematical tools for the solutions of difference equations by using Z transform techniques for discrete time systems.
- CO3** : Solve the physical problems of engineering by using the mathematical principles on transforms.
- CO4** : Apply the basics of probability and random variables to solve engineering problems
- CO5** : Apply moments, probability density functions, correlation & regression to analyze and solve problems.

LAPLACE TRANSFORM

Existence conditions - Transforms of elementary functions - Transform of unit step function and unit impulse function - Basic properties - Shifting theorems - Transforms of derivatives and integrals - Initial and final value theorems - Inverse transforms - Convolution theorem - Transform of periodic functions - Application to solution of linear second order ordinary differential equations with constant coefficients. **9**

Z TRANSFORMS AND DIFFERENCE EQUATIONS

Z-transforms - Elementary properties - Inverse Z-transform - Convolution theorem - Solution of difference equations using Z-transform. **9**

FOURIER SERIES AND FOURIER TRANSFORMS

Introduction to Fourier Series-Dirichlet's conditions-Trigonometric Fourier Series-Exponential form of Fourier Series-Fourier integral theorem (without proof)-Infinite Fourier transform-Infinite Fourier sine and cosine transforms properties and problems-Convolution theorem-Parseval's identity. **9**

PROBABILITY AND RANDOM VARIABLES

Probability-Axioms of Probability-Conditional Probability-Bayes's theorem -Discrete and continuous random variables - Moments - Moment generating functions - Binomial, Poisson, Geometric, Normal, Uniform and Exponential distributions. **9**

TWO DIMENSIONAL RANDOM VARIABLES

Probability mass function - Probability distribution function - Cumulative distribution function-Marginal probability functions - Conditional distribution - Expectation of two dimensional random variables - Covariance - Correlation. **9**

TOTAL: 45

TEXTBOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, New Delhi, 2017.

REFERENCE BOOKS

1. B.V.Ramana, "Higher Engineering Mathematics", 6th Edition (2014), Tata MC Graw-Hill Publishing Company Limited, New Delhi.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. William W Hines, Douglas C Montgomery, David M Goldsman and Connie M Borrer, "Probability and Statistics in Engineering", John Wiley, 2008.

19EE31- ELECTRIC CIRCUIT ANALYSIS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : *Apprehend the fundamentals of sinusoids, phasor and apply & analyse the sinusoidal excitation of R, L, C under steady state and associated power relations*
- CO2** : *Realize the concept of linearity and apply the circuit theorems to solve complex electric circuits.*
- CO3** : *Comprehend the frequency response of a resonant circuit and analyse the impact of quality factor, bandwidth on the frequency response.*
- CO4** : *Recognize and interpret the dot convention of mutually coupled coils in a circuit and solve complex electromagnetic circuits. Also understand nature of the waveform and its impact on the electrical systems*
- CO5** : *Describe the significance of three phase systems with star & delta connected circuits to solve the three phase circuits for both domestics and industrial applications*

SINUSOIDAL STEADY STATE ANALYSIS

Sinusoidal voltage and current -Peak, Average and RMS values - Peak (Crest) and Form factors for sinusoidal and non - sinusoidal periodic waveforms - R, L and C elements and their voltage - current relationships - concept of phasor - transforming a circuit into a phasor equivalent circuit- complex impedance and admittance - phasor diagrams - analysis of simple, single phase ac series and parallel circuits - apparent power, active power, reactive power, power factor - concept of complex power - impedance and power triangle **9**

CIRCUIT THEOREMS

Mesh and Nodal analysis in AC circuits - Linearity of a circuit and Superposition theorem - Thevenin's theorem - Norton's theorem - Maximum power transfer theorem - Reciprocity theorem - Tellegen's theorem - Millman's theorem-Concept of duality and dual networks. **9**

RESONANCE

Series and Parallel Resonance - resonant frequency for a tank circuit -impedance and phase angle of a resonant circuit - bandwidth and quality factor - voltage and current in a resonant circuit - variation of impedance with frequency **9**

COUPLED CIRCUITS AND WAVEFORM ANALYSIS (FOURIER METHOD)

Analysis of coupled circuits - conductively coupled circuits - single tuned and double tuned coupled circuit. Periodic waveforms in circuit analysis- exponential Fourier series -Trigonometric Fourier series- - waveform symmetry-line spectrum- RMS values-average power and power cube- true power factor - circuit applications. **9**

THREE PHASE CIRCUITS

Advantages of three phase system - generation of three - phase voltages - phase sequence - inter connection of three - phase sources and loads - star and delta connections and their transformation - line and phase quantities - analysis of three phase circuits with star and delta connected balanced and unbalanced loads - symmetrical components- phasor diagram representation - power measurement in three - phase circuits. **9**

Note: 1. A term paper on "Computer Simulation of Electric Circuits" to be submitted during the course work for internal assessment using MATLAB/PSIM/pSpice/Multisim.

2. Design Problems and Practical Applications to be discussed for all the units and team activity may be given on the specific design tasks for internal assessment.

TEXT BOOKS

1. Charles K. Alexander and Matthew N.O.Sadiku, "Fundamentals of Electric Circuits" McGraw Hill Education (India) Private Limited, 6th Edition, 2019.
2. Joseph A. Edminister and Mahmood Nahvi, "Electric Circuits", Schaum's Series, McGraw Hill Education (India) Private Limited, 6th Edition, 2013.

REFERENCES

1. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis - Theory and Practice" Cengage Learning, 5th Edition, 2013.
2. William H. Hayt Jr, Jack E. Kemmerly, and Steven M.Durbin, "Engineering Circuit Analysis", McGraw Hill Education (India) Private Limited, 8th Edition, 2013.
3. K.S.Suresh Kumar, "Electric Circuits and Networks" Pearson, Dorling Kindersley (India) Private Limited, 2014.
4. James W.Nilsson,Susan A.Riedel, "Electric Circuits" Pearson, 11th edition, 2018.
5. Richard Dorf, James A.Svoboda, "Introduction to Electric Circuits" Wiley-India, John Wiley & Sons, 6th Edition 2004.
6. Robert.L.Boylestad, "Introductory Circuit Analysis" Pearson, Dorling Kindersley (India) Private Limited, 12th Edition, 2014.
7. Sudhakar A. and Shyammohan S.P., "Circuits and Networks: Analysis and Synthesis", McGraw Hill Education (India) Private Limited, 2015.

19EE32 - ELECTROMAGNETIC FIELDS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Solve electromagnetic field problems by using vector calculus concepts.
- CO2** : Illustrate Coulomb's law, Gauss law, Poisson and Laplace equation concepts to solve electrostatic problems.
- CO3** : Apply ampere's circuital law and Biot - Savart's law to determine magnetic field intensity and magnetic flux density in magneto static problems..
- CO4** : Determine the capacitance and inductance for various configurations in electrostatic and magnetostatic fields.
- CO5** : Analyze Maxwell's equations in different forms (differential and integral) and apply them to diverse engineering problems.

VECTOR ANALYSIS

Vector algebra - Co - ordinate systems - Vector calculus: Dot product of vectors, Cross product of vectors, Transformation of vectors - Types of integral related to electromagnetic theory - Gradient, Divergence and Curl - Divergence theorem - Stoke's theorem. **9**

ELECTROSTATIC FIELDS

Coulomb's law - Electric field intensity of point, line and sheet of charges - Electric flux density - Gauss's law and its applications - Poisson's and Laplace equations - Electric potential - Potential gradient. **9**

ELECTRIC FIELD IN MATERIALS AND CAPACITANCE

Properties of Conductors and dielectric materials - Polarization in dielectrics - Boundary conditions for perfect dielectric materials - Electric dipole - Potential and field due to an electric dipole - Capacitance of parallel plate capacitor, spherical capacitor and cables with single dielectric - Electrostatic energy storage and Energy density. **9**

MAGNETOSTATICS AND INDUCTANCE

Applications of Biot - Savart's law - Applications of Ampere's circuital law - Scalar and Vector magnetic potentials - Magnetization - Magnetic boundary conditions - Inductance of Transmission lines - Magneto static energy and energy density - Lifting force of a magnet. **9**

ELECTRODYNAMIC FIELDS AND ELECTROMAGNETIC WAVES

Conduction and displacement current densities - Maxwell's equations in differential and integral forms - Maxwell's equation for harmonically varying fields - Electromagnetic waves: Electromagnetic wave equations - Intrinsic impedance and Skin depth - Electromagnetic waves in good conductors, lossy and lossless dielectrics - Poynting vector and Poynting's theorem. **9**

TOTAL : 45

TEXT BOOKS

1. *Matthew N.O.Sadiku, "Elements of Electromagnetics", Oxford University Press, 6th edition, 2015.*
2. *Gangadhar K.A. and Ramanathan P.M, "Electromagnetic Field Theory", Khanna Publishers, Delhi, 2011.*

REFERENCES

1. *W.H.Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill, New Delhi, 6th edition, 2011.*
2. *John D. Kraus and Daniel A. Fleisch, "Electromagnetics with Applications", Tata McGraw Hill, 4th Edition, 2010.*
3. *Ophelia burgess, "Principles of Electromagnetism", Larsen & Keller Education, 2019.*
4. *Steven W. Ellingson, "Electromagnetics", Volume 2, Virginia tech publishing, 2019*

19EE33 - DC MACHINES AND TRANSFORMERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Elucidate the constructional details and analyze the operation of DC machines
- CO2** : Illustrate the speed control methods, braking and testing of DC machines for industrial application
- CO3** : Explain the construction of transformer and to compute the equivalent circuit parameters to evaluate its performance under various conditions.
- CO4** : Erudite the basic concept of three phase connections, principle of autotransformers and special purpose transformers.
- CO5** : Design of overall transformers and inductors for specific application.

DC MOTOR AND GENERATOR

D.C. Machines - Construction - Principle of operation - Methods of excitation- Armature Windings- Armature reaction - DC motor: Torque equation and characteristics - DC Generator: characteristics - EMF equation - commutation. **10**

SPEED CONTROL AND TESTING OF DC MOTORS

Speed control methods - Electric braking - Losses and Efficiency- Testing: Direct, Indirect and Regenerative methods to test the DC machines. **8**

TRANSFORMERS

Construction and operation of single phase transformers - EMF equation- Phasor diagram-equivalent circuit - voltage regulation- losses and efficiency - All day efficiency- Parallel operation. Predetermination of performance from open circuit and short circuit tests. **9**

THREE PHASE TRANSFORMERS AND AUTOTRANSFORMERS

Three-phase transformer: types of connection and their comparative features-Autotransformers: Construction- Principle- saving in copper - Applications -Special Purpose Transformers: Pulse, welding, rectifier, high frequency transformers. **8**

DESIGN OF TRANSFORMERS

Output equation - Design of core - Optimum Design for weight, volume, cost and losses - Overall Dimensions - Design of windings - No load current and losses calculations - Temperature rise and Regulation from design data - Design of inductors: Requirements - Fundamental Consideration with examples - Design of Tank and Cooling tubes (qualitative treatment only) - **10**

TOTAL: 45

TEXT BOOKS

1. Kothari D.P., Nagrath, I.J. "Electrical Machines", McGraw Hill Publishing Company Ltd., Fourth Edition, New Delhi .2017.
2. Smarajit Ghosh., "Electrical Machines I," Pearson Education, First Edition 2011.

REFERENCE BOOKS

1. *Bhattacharya, S.K., "Electrical Machines", Tata McGraw Hill, 2017.*
2. *A. E. Fitzgerald, Kingsley, Stephen D, "Electric Machinery", International Edition, Sixth Edition, the McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, 2003. ISBN 0-07- 112193-5*
3. *Colonel Wm. T. Mclyman, "Inductor Design Handbook", Third Edition, Marcel Dekker, Inc. 270 Madison Avenue, New York, NY 10016, U.S.A, 2004. ISBN: 0-8247-5393-3*
4. *M.G. Say, "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors, New Delhi, 2002.*

19EE34 - ANALOG ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Illustrate the rectifiers, filters and regulators of a DC power supply.

CO2 : Analyze BJT and FET amplifiers using small signal models and to plot the frequency response of the amplifiers.

CO3 : Design and evaluate different classes of power amplifiers used for audio and radio applications.

CO4 : Utilize the concepts of negative feedback amplifiers to improve the stability of the amplifiers..

CO5 : Apply the concepts of positive feedback amplifiers to generate sustained oscillations and to design clippers and clampers.

DC POWER SUPPLIES

Single Phase Rectifiers : Half wave, Full wave and Bridge rectifiers - Ripple factor - Rectification efficiency - TUF - PIV - Regulation - Filters: Inductor, Capacitor, L section and Π section filters - Ripple factor - Regulators: Series and Shunt type - Protection circuits. **9**

BJT AND FET SMALL SIGNAL AMPLIFIERS

BJT Amplifier : Small signal low frequency parameters and equivalent circuit - Small signal analysis of CE, CB and CC amplifiers with voltage divider bias using h - parameters. Multistage amplifier: RC Coupled - Transformer coupled amplifiers - Frequency response. FET Amplifier: Small signal model and analysis of CS, CD and CG amplifier. **12**

LARGE SIGNAL AMPLIFIERS

Classification : Class A power amplifier - Harmonic distortion - Class B amplifier - Push - pull amplifier - Complementary symmetry operation - Class AB amplifier, Class C amplifier and Class D amplifier. **6**

FEEDBACK AMPLIFIERS

Feedback concepts - Ideal feedback topologies - Advantages and Disadvantages of negative feedback - Analysis of voltage and current: Series and Shunt feedback amplifier circuits. **9**

WAVE SHAPING CIRCUITS AND OSCILLATORS

Clippers - Clampers. Oscillators: Barkhausen criterion - RC phase shift oscillator - Hartley Oscillator - Colpitts Oscillator - Frequency Stability - Crystal Oscillator. **9**

TOTAL : 45

TEXT BOOKS

1. *Jacob Millman, Christos C Halkias and Satyabrata Jit, "Electronic Devices and Circuits", Tata McGraw - Hill, 4th Edition, 2015.*
2. *Jacob Millman, Christos Halkias and Chetan D Parikh, "Millman's Integrated Circuits", Tata McGraw - Hill, 2nd Edition, 2008.*
3. *Allen Mottershead, "Electronic Devices and Circuits - An Introduction", PHI learning, 2011.*

REFERENCE BOOKS

1. *Jacob Millman and Herbert Taub, "Pulse, Digital and switching Waveforms", Tata McGraw - Hill, 2nd Edition, New Delhi, 2008.*
2. *Robert L. Boylestead and Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice - Hall of India, 11th Edition, New Delhi, 2012.*
3. *Salivahanan, "Electron Devices and Electronic Circuits", Tata McGraw - Hill, 3^d Edition New Delhi, 2012.*

19EE35 - DIGITAL ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : *Solve basic arithmetic calculations in binary, decimal and hexadecimal and illustrate reduction of logical expressions using boolean algebra, k-map and tabulation method and implement the functions using logic gates.*
- CO2** : *Realize combinational circuits for given application and design using logic gates*
- CO3** : *Design and analyze synchronous and asynchronous sequential circuits using flip-flops, able to develop Mealy and Moore Models and formulate the programming table for implementing the logic functions using PLA and PAL.*
- CO4** : *Compare different types of logic families which are the basic unit of different types of logic gates in terms of efficiency.*
- CO5** : *Develop Verilog coding for combinational and sequential logic circuits.*

BOOLEAN ALGEBRA AND MINIMIZATION TECHNIQUES

Review of binary number systems - binary codes - Error detection and correction codes - Boolean postulates and theorems - Minimization of Boolean functions using basic laws - logic gates - Switching functions - Representation of logic functions - Canonical forms - SOP and POS - Simplification of logic functions using Karnaugh maps and Quine McCluskey method - NAND and NOR implementation. **9**

COMBINATIONAL LOGIC CIRCUITS

Binary adder and subtractor - BCD adder - Code converters - Decoders and Encoders - Multiplexers and Demultiplexers - Parity generators and checkers - Magnitude Comparator - Design of combinational logic circuits using logic gates, decoders and multiplexers - Implementation of combinational logic circuits using PROM, PAL and PLA. **9**

SEQUENTIAL LOGIC CIRCUITS

Flip Flops - counters - asynchronous and synchronous types - Modulo counters - Shift registers - Ring counter and twisted ring counter - Mealy and Moore Models - State table - excitation table - State diagram - State reduction - State assignment - Analysis and Design of synchronous sequential circuits - Design of sequence detectors, sequence generators and counters using flip-flops - Introduction to asynchronous sequential circuits. **10**

DIGITAL IC FAMILIES

Input and output characteristics of logic gates - TTL: Standard TTL - Three state output TTL - Schottky TTL - CMOS Logic: Inverter, NAND, and NOR gates - Interfacing TTL and CMOS families- ECL OR/NOR gate - comparison of TTL, ECL, and CMOS families. **9**

DIGITAL SYSTEM DESIGN USING VERILOG

Introduction to hardware description languages and verilog - Module declaration - HDL models of combinational circuits - Gate-level modeling - Dataflow modeling - Behavioral modeling - HDL for registers and counters. **8**

TOTAL : 45

TEXT BOOK

1. *Morris Mano M, Michael D. Ciletti, "Digital Design: with an Introduction to the Verilog HDL", Prentice Hall of India Ltd, 6th Edition, 2019.*

REFERENCE BOOKS

1. *John M. Yarbrough, "Digital Logic Applications and Design", PWS, 2001.*
2. *Richard F. Tindler, "Engineering Digital Systems Design", Harcourt India Pvt. Ltd., New Delhi, 2001.*
3. *John P.Uyemura, "A First Course in Digital Systems Design - An Integrated Approach", Brooks/Cole Publishing Company, 2000.*

19HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of course, students will be able to

CO1 : Understand the principles of karma yoga, duty consciousness and evolution of the universe.

CO2 : Analyze the benefits of yoga and meditation.

CO3 : Understand the benefits of harmony, introspection and examine human values for sustained growth in career and life

LIFE FORCE, CONCIOSNESS AND EVOLUTION OF UNIVERSE

Science of Creativity and Personality Development - Principles of Karma Yoga - Duty Consciousness - Law of Nature - Life Force -Potentiality of the Life Force - Consciousness - Pancha Thanmatras - Biomagnetism. Evolution of the Universe: Creation Theory - Evolution Theory - Evolution of Living Beings: Absolute Space and Force - Seven Constituent Layers in the Body. **(6)**

YOGA AND ITS BENEFITS

Simple and Safe yoga - Upa yoga Practices : Yoga for peace, health, joy, love, well-being and success. Physical exercise - Meditation - Seven centers of meditation - benefits - effect of good vibrations - cause and effect system. **(3)**

HARMONY IN LIFE, INTROSPECTION AND HUMAN VALUES

Harmony in Life : Self, family, society and nature - Introspection : Analysis of thought, Moralization of desire, Neutralization of anger, Eradication of worries and Self realization.

Morals, Values and Ethics - Integrity - Work ethics - Service learning - Virtues - Respect for others - Valuing time - Co-operation -Commitment - Empathy - Self confidence - Challenges in work place - impact of cyber space on individual. **(6)**

TOTAL: 15

TEXT BOOKS

1. Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications 4th Edition, 2009.
2. R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011.

REFERENCES

1. Sadhguru, "Body the Greatest Gadget and Mind is your Business", Diamond Pocket Books Pvt. Ltd, Isha Foundations, 2013.
2. Swami Vivekananda and Swami Nikhilananda, "Karma Yoga and Bhakti Yoga", 2nd Edition, Ramakrishna Vivekananda Publications, 2008.

3. *Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", 4th Edition McGraw Hill, New York, 2005.*
4. *M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 1st Edition, Prentice Hall of India, 2009.*

19EEL36 - DC MACHINES AND TRANSFORMERS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 : Analyze the performance of DC motors/generators by conducting direct load test experimentally.

CO2 : Analyze the performance of transformer by conducting direct load test experimentally.

CO3 : Predetermine the performance of DC machines by conducting Swinburne's test.

CO4 : Compare the performance characteristics obtained experimentally on various DC machines and select suitable DC machines for industrial applications.

CO5 : Draw the equivalent circuit and predetermine the performance of transformers by conducting open circuit and short circuit tests.

LIST OF EXPERIMENTS

1. OCC and Critical Speed of DC Shunt Generator.
2. No Load Speed Control of DC Shunt Motor.
3. Swinburne's Test.
4. Load Test on DC Shunt Motor.
5. Load Test on DC Shunt Generator.
6. Load Test on DC Series Generator.
7. Load Test on DC Series Motor.
8. Load Test on DC Compound Motor.
9. OC and SC Test on Single - Phase Transformer.
10. Predetermination of performance characteristics of Single phase transformer.
11. Load Test on Single - Phase Transformer (R,L,C Loads).
12. IoT Based Motor Monitoring System.
13. Speed Control of PMDC Motor.
14. Design of transformer rating for inductive and non-inductive loads.

19EEL37 - ANALOG AND DIGITAL ELECTRONICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 : *Design and construct simple electronic circuits to accomplish specific functions.*

CO2 : *Observe the amplitude and frequency responses of common amplification circuits*

CO3 : *Construct basic combinational circuits and verify their functionalities*

CO4 : *Design and simulate the combinational and sequential circuits*

CO5 : *Design and analyze the operation of counters and shift registers*

LIST OF EXPERIMENTS

1. Half-wave and Full-wave rectifiers
2. BJT and MOSFET Amplifiers
3. Frequency response of RC coupled amplifier
4. Testing of class B push-pull power amplifier
5. Code converters
6. Multiplexer and Demultiplexer
7. Encoder and Decoder
8. Error Detection and Correction circuits
9. Registers and PRBS Generators
10. Asynchronous and Synchronous Counters

Note: Simulate and verify digital IC experiments using Verilog.

19EE41 - AC ROTATING MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Elucidate and illustrate constructional features, winding details, induced EMF of Synchronous Machines.
- CO2** : Analyze the performance of the three phase Synchronous motors and develop phasor diagram to examine steady state performance and determination of X_d and X_q .
- CO3** : Illustrate the operation and speed control characteristics PMSM and BLDC motors.
- CO4** : Acquire knowledge about the construction, torque slip characteristics and compute equivalent circuit parameters to evaluate the performance of three phase induction motors.
- CO5** : Interpret the double field revolving theory, analyze the performance and starting methods of single-phase induction motor.

SYNCHRONOUS GENERATOR

Constructional features- EMF equation-Phasor diagram-Armature reaction-Synchronous impedance- Predetermination of voltage regulation - EMF, MMF, and Potier methods - Parallel operation of Alternators. **10**

SYNCHRONOUS MOTOR

Principle of operation -Starting methods - Phasor diagram-Effect of load on a synchronous motor -V- curves and Inverted V- curves-Two reaction theory of salient pole alternators - Determination of X_d & X_q . **9**

PMSM and BLDC MOTOR

PMSM: Construction - Principle of operation - EMF equation - Torque Equation - Phasor Diagram - Comparison of conventional synchronous motor with PMSM.

BLDC Motor: Construction - Principle of operation - Electronic Commutation - Types of BLDC Motor-EMF equation - Voltage and Torque equation - Speed Torque Characteristics - Comparison of DC motor and BLDC motor. **9**

THREE PHASE INDUCTION MOTOR

Constructional features- production of rotating magnetic field - torque equation -Phasor diagram - Performance analysis - Torque-slip characteristics- No load and blocked rotor tests-Load test- equivalent circuit- Circle diagram-starting methods - conventional speed control of induction motors. **10**

SINGLE PHASE INDUCTION MOTOR

Principle of operation- Double revolving field theory - Equivalent circuit and Performance characteristics -Methods of starting - Capacitor start, Shaded pole and Repulsion motors. **7**

TOTAL : 45

TEXT BOOKS

1. *M.G.Say, "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors, New Delhi, 2002.*
2. *Kothari D.P., Nagrath, I.J. "Electrical Machines", McGraw Hill Publishing Company Ltd., Fourth Edition, New Delhi. 2017.*

REFERENCE BOOKS

1. *Bhattacharya, S.K., "Electrical Machines", Tata McGraw Hill, 2017.*
2. *P.K.Mukherjee and S.Chakravorti, "Electrical Machines", DhanpatRai Publications, New Delhi, 2011.*
3. *P.S. Bhimbra, "Electrical Machinery", Khanna Publishers, 2003.*
4. *Cyrill. G. Veinott, "Fractional and Subfractional Horse Power Electric motors", TMH Publishers, 1996.*

19EE42 - NETWORKS AND SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Solve circuit theory problems using graph theory concepts.
- CO2** : Appreciate the transient response of electric circuits with DC and AC excitation and solve transient circuits using Laplace Transform techniques.
- CO3** : Apply the concept of complex frequency in studying network functions and analyze two-port network parameters using various models.
- CO4** : Identify the given function for positive realness and synthesize LC, RC, and RL one-port networks using Foster and Cauer forms.
- CO5** : Apprehend the frequency response of active and passive filters.

NETWORK TOPOLOGY

Linear oriented graphs - incidence matrix of a linear oriented graph - Kirchhoff's laws in incidence matrix formulation - circuit matrix of a linear oriented graph - tree and its properties - Kirchhoff's laws in fundamental circuit matrix formulation - Loop analysis of electric networks - cut sets - cut set matrix of a linear oriented graph - Kirchhoff's laws in fundamental cutset formulation - Node-pair analysis of networks - Analysis using generalized branch model. **9**

CIRCUIT TRANSIENTS

Transient concepts - differential equations and initial conditions in RLC networks - transient response of simple RL, RC, and RLC series and parallel circuits to step and sinusoidal inputs using Laplace transform method. **9**

NETWORK FUNCTIONS AND TWO PORT NETWORKS

Concept of complex frequency - Network functions - Driving point and transfer functions and their properties - Poles and Zeros and their significance - Time domain behavior from pole - zero plot - Impulse response of network functions - Two port networks - Z, Y, ABCD and h parameters - Condition for reciprocity and symmetry - Parameter conversion - Interconnection of two port networks - Analysis of typical two port networks - Input and Output impedances of terminated two port networks - Image impedances. **11**

ELEMENTS OF REALIZABILITY AND SYNTHESIS OF ONE-PORT NETWORKS

Hurwitz polynomials - Positive real functions - Frequency response of reactive one port network - Synthesis of reactive one port networks by Foster method and Cauer method - Synthesis of RL and RC networks by Foster method and Cauer method. **8**

FILTERS

The decibel scale - bode plots - passive filters: low pass, high pass, band pass, and band reject filters - Active filters: first order low pass, high pass, band pass, and band reject (or Notch) filter - Scaling: magnitude scaling - frequency scaling - magnitude and frequency scaling - applications. **8**

TOTAL : 45

TEXT BOOKS

1. *Ravish R. Singh, "Network Analysis and Synthesis", TMH, New Delhi, 1st Edition, 2017.*
2. *Roy D.Choudhury, "Networks and Systems", New Age Publications, New Delhi, 4th Edition, 2010.*

REFERENCE BOOKS

1. *Charles K. Alexander and Mathew N.O. Sadiku, "Fundamentals of Electric Circuits" McGraw Hill Education (India) Pvt Ltd, VI Edition, 2019.*
2. *Franklin F. Kuo, "Network Analysis and Synthesis" Wiley India Pvt. Ltd., New Delhi, 2nd Edition, 2012*
3. *Sudhakar A. and Shyammohan S.P., "Circuits and Networks: Analysis and Synthesis", TMH, New Delhi, 2011.*
4. *Ramesh Babu P. and Anandanatarajan, R., "Signals and Systems", SciTech Publications (India) Pvt Ltd, 5th Edition, 2011.*

19EE43 - MEASUREMENTS AND INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Interpret statistical data measurement and evaluate static and dynamic characteristics for electrical and Non-electrical parameters measurement.
- CO2** : Illustrate the functioning of different electro-mechanical and digital measuring instruments along with their application domains.
- CO3** : Analyse and recommend suitable sensors and transducers for measuring non-electrical physical quantities and measurement techniques used in process industries.
- CO4** : Integrate the electronic display and recording devices for the appropriate type of measurement or data recording and logging.
- CO5** : Erudite about the intelligent sensors and data acquisition system in industry for effective measurement, control and data storage.

MEASUREMENT CONCEPTS

Functional Elements of measurement and instrumentation system-Accuracy, Precision, types of errors, calibration and standards in measurement- Factors influencing the selection of Transducers - Classification - Introduction to Intelligent Sensors -MEMS sensors - Nano sensors - System on chip. **9**

ELECTRICAL MEASUREMENTS

Analog meters: PMMC and Moving Iron Instruments: Working, comparison and measurement of DC and AC Voltage and Current - Electrodynamometer type watt meter - Insulation resistance test, Earth resistance: Fall of potential method- Instrument Transformers: CT and PT - Applications

Digital meters: Block diagram and functioning of Multi-Meter, Principles of Net metering- Bi- directional single phase energy meter -Frequency Meter - Wheatstone, Kelvin, Maxwell, Schering and Wein bridges. **10**

NON-ELECTRICAL MEASUREMENTS

Transducers: Linear and Angular displacement: Resistive (Potentiometer), inductive (LVDT) - Liquid Level: Capacitive - piezoelectric, Hall Effect transducers - Flow meters: electromagnetic, ultrasonic types- Air velocity, pressure: Anemometer- Temperature: Thermocouple, RTD, thermistor- principle of Thermography and thermal imaging and applications. Optical sensors: photo-diode, light dependent resistor and photo voltaic cell. **9**

DISPLAY AND RECORDING INSTRUMENTS

Working of Analog CRO - Dual Trace and Dual Beam CROs - Digital Storage Oscilloscopes(DSO) - Signal Analyser- Spectrum Analyzer- Harmonic Analyzer - Mixed signal oscilloscopes(MSO) - Signal Generator - Function Generator - Recorders: X-t recorder- X-Y recorder **8**

INTELLIGENT INDUSTRIAL INSTRUMENTATION

Telemetry Principles : Land Line Telemetry, RF Telemetry - Multiplexing - TDM,FDM and CDM - Functional elements of Data Acquisition System, control - Communication architecture in DAS-SCADA principles and application-Introduction to Intelligent Instrumentation using HART Protocol and communication layers. **9**

TOTAL : 45

TEXT BOOKS

1. Sawhney A.K., "A Course in Electrical and Electronic Measurements", Dhanpat Rai & Sons, New Delhi, 19th Edition, 2019.
2. Syed Akhtar.I and Vibhav Kumar.S, "Electronic Measurement and Instrumentation" I K International publishing House, 2018.

REFERENCE BOOKS

1. Ernest O.Doeblin "Measurement Systems - Applications and Design", McGraw Hill, 2nd Edition 2010.
2. Kalsi H.S., "Electronic Instrumentation", Tata McGraw Hill Co, 3rd Edition, 2010.
3. A.D.Cooper and A.D.Helfrik, "Modern Electronic Instrumentation and Measurement Techniques", 2nd edition, Prentice Hall of India, New Delhi, 2008.
4. E. W. Golding & F. C. Widdis, "Electrical Measurement & Measuring Instrument", 5th edition, A.H.Wheeler& co., India, 2011.

19EE44- LINEAR INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Examine the DC/AC characteristics of Op-amp and design an appropriate compensation for Op-amp.

CO2 : Design of various linear applications using op-amp IC741.

CO3 : Design of various non - linear applications using op-amp IC741.

CO4 : Design of analog circuits such as voltage regulator, VCO and multi - vibrators using other linear IC's.

CO5 : Design of analog computation and signal conditioning circuits using op-amps.

OVERVIEW OF INTEGRATED CIRCUIT TECHNOLOGY VIDEO/ANIMATION TO BE DISPLAYED AND DISCUSSED

Silicon Semiconductor Technology - Wafer processing, Oxidation, Epitaxy, Deposition, Ion implantation Diffusion and Metallization - Basic CMOS processing technology - N-well, P-well process - Twin tub process and Silicon on insulator - Circuit Elements - Resistors, Capacitors and Thin film transistors. **3**

OPERATIONAL AMPLIFIER CHARACTERISTICS

Functional block diagram - Analysis of typical op-amp - Equivalent circuit - Open loop gain - CMRR - Input bias and off set currents - Input and Output off set voltages - Off set compensation techniques - Frequency response - Noise - Stability - Limitation - Frequency compensation techniques - Slew rate. **9**

OPERATIONAL AMPLIFIER APPLICATIONS

DC and AC Amplifier - Inverting and Non-inverting amplifier - Summing, Scaling and Averaging amplifier - Voltage follower - Differential amplifier - Instrumentation amplifier - Voltage to Current and Current to Voltage converters - Integrator and Differentiator - Practical considerations - Active filters and Oscillators. **9**

COMPARATORS AND CONVERTERS

Comparator- Zero crossing detector - Schmitt trigger - Voltage to Frequency and Frequency to Voltage converters - Sample and Hold circuit - D/A converters - A/D converters - Precision rectifiers - Peak detectors - Clipper and Clamper - Log and Antilog amplifier - Multiplier and Divider - Wave form generators. **9**

OTHER LINEAR IC APPLICATIONS

Voltage regulators - IC 7805 - IC 723 - Current limiting and Current boosting - Fixed and Adjustable three terminal regulators - SMPS ICs - PLL - Applications - IC 566 Voltage controlled oscillators - IC 555 timer - Monostable and Astable mode of operations - Applications. **9**

ANALOG COMPUTATION AND SIGNAL CONDITIONING

Solution to integro-differential equations, Signal conditioning of low magnitude signals from sensors - instrumentation amplifier design, filter design, analog buffers, analog interfacing circuits for microcontrollers. **6**

TOTAL : 45

TEXT BOOKS

1. Ramakant A. Gayakward, "Op-Amps and Linear Integrated Circuits", 4th Edition, Prentice Hall of India, New Delhi, 2015.
2. Coughlin F.R. and Driscoll F.F., "Operational Amplifiers and Linear Integrated Circuits", 6th Edition, Prentice Hall of India, New Delhi, 2009.

REFERENCES

1. Roy Choudhury D and Shail Jain., "Linear Integrated Circuits", 5th Edition, New Age Science Ltd., 2018.
2. Sergio Franco, "Design with Operational Amplifiers and Analog and Integrated Circuits", 3rd Edition Tata McGraw Hill Publishing Co., New Delhi, 2012.
3. Michael Jacob J., "Analog Integrated Circuit Applications", 1st Edition, Prentice Hall of India, New Delhi, 2007.
4. Sidney Soclof, "Design & Application of Analog Integrated Circuits", Prentice Hall of India, 1997.
5. David A. Bell, "Operational Amplifiers and Linear ICs", 3rd Edition, Oxford University Press, 2011.

19EE45 - TRANSMISSION AND DISTRIBUTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Analyze HVAC and HVDC transmission, Overhead and underground transmission schemes, skin effect and earth capacitance, Compute the line parameters in single phase lines, three phase lines, bundled conductor lines and double circuit 3-ph lines.
- CO2** : Model the short, medium and long transmission lines by various methods and determine the performance under different loading conditions, Analyze about Ferranti effect, Corona effect, Tuned power lines and Critical voltages on transmission lines.
- CO3** : Understand the mechanical supports for transmission lines and types of insulators, Choose the number of insulators to improve the string efficiency of transmission lines, Compute sag and Tension in various types of transmission lines.
- CO4** : Illustrate the types of cables and Grading of cables, Compute the capacitance in single and three core cables, Locate the cable fault using loop tests.
- CO5** : Describe the types of substation and AC distribution system, Solve the AC distribution system problems and Tariff calculations for AC distribution systems.

INTRODUCTION

Layout of AC power supply scheme by single line diagram - Introduction to EHV AC and HVDC transmission - Comparison between HVAC and HVDC - Overhead and underground transmission scheme - HVDC systems - Comparison of conductor materials in overhead systems. Line Parameters : Resistance of conductors - Skin effect - Inductance of a conductor due to internal and external flux - Inductance and capacitance of single-phase two-wire line, three phase lines with symmetrical and unsymmetrical spacing, Bundled conductor lines and Double circuit three phase lines - Effect of earth on line capacitance. **10**

LINE PERFORMANCE AND CORONA

Regulation and Efficiency of short lines - Medium lines represented by nominal T and Π methods - Long lines - Rigorous solution - ABCD constants - Ferranti effect - Tuned power lines. Phenomenon of corona- Disruptive critical voltage - Visual critical voltage - Corona loss - Radio frequency interference. **9**

MECHANICAL DESIGN OF OVERHEAD LINES

Insulator materials - Insulator types - Voltage distribution over insulator string - Methods of improving string efficiency - Insulator failure - Testing of insulators - Line supports - Types of steel towers - Cross arms - Span, Conductor configuration, spacing and clearances - Sag and Tension calculations- Effect of wind, temperature and ice - Support at different levels - String chart - Conductor vibration. **9**

UNDERGROUND CABLES

Comparison between overhead line and underground cable for transmission - Types of cables - Types of insulating materials - Insulation resistance - Potential gradient - Grading of cables - Capacitance of single and three core cables - Faults and fault location by loop test - Sheath effect - Cable installation - Current rating of cables -Operating problems with underground cables. **9**

DISTRIBUTION SYSTEMS AND SUBSTATIONS

Introduction to Grid system - AC distribution - Radial and Ring main systems - Ring main distributors with interconnectors - Methods of solving AC distribution systems - Tariff calculations- Wheeling Charges -

Substation - Types of substations - Layout and location of substations - Busbar arrangements - Introduction to substation automation protocols - Introduction to Indian Power System - Genco, Transco and Disco.

8

TOTAL : 45

TEXT BOOK

1. C.L.Wadhwa, "*Electrical Power Systems*", New Age International, 2017.

REFERENCES

1. Luces M.FualKeribeery and Watter Coffe, "*Electrical Power Distribution and Transmission*", Pearson Education, 2007.
2. V. K. Mehta and Rohit Mehta, "*Principles of Power system*", S. Chand and Company Ltd., New Delhi, 2011.
3. J.Nagrath and D.P.Kothari, "*Power Systems Engineering*", Tata McGraw Hill, 2019.
4. Dr. S.L.Uppal, "*Electrical Power*", Khanna Publishers, 1988.
5. M.L. Sony, P.V.Gupta, V.S Bhatnagar and A.Chakraborti, "*A Text Book on Power Systems Engineering*", DhanpatRai and Co., Delhi, 1997-98.
6. TorenGonen, "*Electrical Power Distribution*", CBC, 2010.

19EE46 - OOPS AND C++ FOR ELECTRICAL ENGINEERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Distinguish object oriented Programming and traditional programming techniques

CO2 : Develop, compile and debug programs

CO3 : Illustrate key concepts such as encapsulation and polymorphism

CO4 : Use files for reading and writing data

CO5 : Write C++ program for practical electrical applications

PRINCIPLES OF OBJECT ORIENTED PROGRAMMING

Programming Paradigms - Object Oriented Technology - Basic concepts and benefits of OOP - Application of OOP - OOP languages. Introduction to C++: Basic data types - Derived data types - Symbolic constants - Scope resolution operator - Type modifiers - Type casting - Operators and control statements - Input and output statements - Function Prototyping - Inline function - Overloaded function - Introduction to friend function **9**

CLASSES AND OBJECTS

Class specification - Member function - Static data members - Instance creation - Array of objects - Dynamic objects - Static Objects. Constructors - Parameterized constructors - Overloaded Constructors - Constructors with default arguments - Copy constructors - Dynamic constructors - Dynamic initialization using constructors - Destructors. **9**

OPERATOR OVERLOADING AND INHERITANCE

Operator function - Overloading unary and binary operator - Overloading the operator using friend function - Stream operator overloading - Data Conversion.

Defining derived classes - Single Inheritance - Protected Data with private inheritance - Multiple Inheritance Multilevel inheritance - Hierarchical Inheritance - Hybrid Inheritance - Multipath inheritance- Abstract classes - Virtual function and dynamic polymorphism - Virtual Destructor - Nested Classes. **9**

I/O STREAMS

I/O STREAMS - Unformatted I/O operations - Formatted I/O operations - Manipulators - Hierarchy of file stream classes - Opening and closing of files - File pointers and Manipulation - Sequential access file - Random access file. **9**

APPLICATIONS IN ELECTRICAL ENGINEERING

Series RLC circuit transient analysis- Synthesis of typical wave forms-FFT Analysis-Mesh and Nodal analysis-Mason's gain formula-Calculation of efficiency and voltage regulation in transmission lines using T and Π model-Tariff Calculations Power System Analysis: Y- Bus formation, Z- Bus formation, Load flow analysis **9**

TOTAL - 45

TEXT BOOKS

1. *D.S.Malik, "C++ Programming: From Problem Analysis to Program Design", 8th Edition, Cengage Learning, 2018.*
2. *Larry Nyhoff, "Programming in C++ for Engineering and Science", CRC Press, Taylor and Francis Group, 2012. (For Electrical Engineering Applications)*

REFERENCE BOOKS

1. *Stanley B. Lippman and Josée Lajoie, "C++ Primer", 5th Edition, Addison-Wesley, 2015.*
2. *Stephen Prata, "C++ Primer plus", 6th Edition, Addison-Wesley, USA, 2015.*
3. *Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Pearson Education Inc,2015.*
4. *Joseph Valacich and Joey. G, "Essentials of Systems Analysis and Design", 6th Edition, Pearson Education Inc., 2014.*

19EEL47 - AC ROTATING MACHINES LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

- CO1** : Analyze the performance of three phase and single-phase induction machines experimentally by direct and indirect methods.
- CO2** : Select suitable AC machines for an industrial application by experimentally verifying the performance characteristics.
- CO3** : Predetermine the voltage regulation of alternator by EMF, MMF, Potier methods and Slip test experimentally.
- CO4** : Draw the V - curves and Inverted V - curves of synchronous motor
- CO5** : Draw the speed torque characteristics of BLDC motor and IoT based motor monitoring system

LIST OF EXPERIMENTS

1. Performance characteristics of three phase squirrel - cage induction motor by direct load test.
2. Performance characteristics of three phase slip - ring induction motor by direct load test.
3. Predetermination of performance characteristics of three phase squirrel cage induction motor by equivalent circuit and circle diagram methods.
4. Separation of No - load losses of three phase induction motor.
5. Performance characteristics of Single phase induction motor by direct load test.
6. Predetermination of performance characteristics of Single phase induction motor by equivalent circuit method.
7. Predetermination of voltage regulation of three phase non - salient pole alternator by EMF and MMF methods.
8. Predetermination of voltage regulation of three phase Salient pole alternator by slip test.
9. Determination of "V" and "inverted - V" curves of synchronous motor.
10. Load test on cascaded induction motors.
11. Load test on Induction generator.
12. Speed Control of BLDC motor
13. Speed Control of PMSM Motor
14. IoT Based Motor Monitoring System

19EEL48 - LINEAR INTEGRATED CIRCUITS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

CO1 : Design and test waveform generators and various analog circuits for arithmetic operations using IC741 for the given specifications.

CO2 : Design second order filters using IC741 and test their frequency response.

CO3 : Design and test regulated power supply for the given specifications using IC723, IC7805.

CO4 : Design and test ADC and DAC circuits for the given specifications using IC741 and arduino

CO5 : Construct astable and monostable multivibrator using IC555 timer for the given specification.

LIST OF EXPERIMENTS

DESIGN AND TESTING OF THE FOLLOWING CIRCUITS

1. Linear applications of Operational Amplifier
2. Second order Low Pass and High Pass Filters
3. Astable and Monostable Multivibrator using IC 555
4. Precision Rectifier and Zero Crossing Detector
5. Instrumentation Amplifier
6. Square, Triangle and Ramp Waveform Generators
7. Analog to Digital Converters
8. Digital to Analog Converters
9. Voltage Regulator using IC 723
10. Wien bridge oscillator.

SIMULTION USING MULTISIM

1. Voltage Controlled Oscillator
2. RC Phase Shift Oscillator
3. Clippers and Clampers
4. Schmitt Trigger Circuit

19EE51 - CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Appreciate the needs and effects of feedback in a control system; obtain the mathematical models of electrical and mechanical systems, and find transfer function through block diagram reduction and SFG.
- CO2** : Analyze the response of I order and II order systems using time-domain techniques.
- CO3** : Learn the stability concepts and finding the range of open loop gain for stability through various techniques.
- CO4** : Analyze the response of systems using frequency domain techniques.
- CO5** : Design compensators for the given system satisfying the given specifications.

MATHEMATICAL REPRESENTATION OF SYSTEMS

Open loop and Closed loop systems - Physical system - Linear and Non - linear systems - Transfer function - Mathematical modeling of electrical and mechanical systems - Analogous systems - Effect of feedback on system sensitivity - Block diagram representation - Signal flow graphs and their properties - Mason's gain formula. Control system components: Potentiometer, Tachogenerator, Synchro, AC and DC servomotors. **9**

TIME RESPONSE ANALYSIS

Standard test signals - Time response of first order and second order feedback control systems to step input - Time domain specifications - Steady state error - Static error constants - Response with P, PI, PD, PID controllers - System response with additional poles and zeros. **9**

STABILITY AND ROOT LOCUS

Concept of Stability - Necessary conditions for stability - Routh Hurwitz criterion - Relative Stability Analysis. Root locus: concepts of root - locus - Construction of root locus - Determination of open loop gain for a specified damping of the dominant roots **9**

FREQUENCY RESPONSE ANALYSIS

Correlation between time domain and frequency domain specifications - Bode plot - Nyquist stability criterion - Relative stability - Gain margin and Phase margin - Polar plot. **9**

LINEAR SYSTEM DESIGN

Design of lag, lead and lag - lead compensators in frequency domain and time domain. **9**

TOTAL : 45

TEXT BOOKS

1. Nagrath and M.Gopal, "Control Systems Engineering", New Age International Publishers, 6th Edition, New Delhi, 2011.
2. Norman S. Nise, "Control Systems Engineering", John Wiley and Sons Ltd, 6th Edition, Singapore, 2013.
3. A.AnandKumar, "Control Systems", PHI Learning Pvt. Ltd, 2nd Edition, Delhi, 2014.

REFERENCE BOOKS

- 1 *Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Private Ltd., New Delhi, 2013.*
- 2 *M.Gopal, "Control Systems - Principles and Design", Tata McGraw Hill Publishing Company Limited, 4th Edition, New Delhi, 2012.*
- 3 *Benjamin C. Kuo "Automatic Control Systems", Prentice Hall of India, 8th Edition, New Delhi, 2010.*
- 4 *Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson Prentice Hall, 10th Edition, NJ, 2008.*
- 5 *M.N.Bandyopadhyay,"Control Engineering and Practice", Prentice Hall of India Private Ltd., New Delhi, 2004.*

19EE52 - POWER SYSTEM ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Mathematically model and assess the power system network under healthy and faulty conditions.*

CO2 : *Apply mathematical methods to solve the load flow problems and interpret active and reactive power flows.*

CO3 : *Identify the fault and assess the fault conditions using symmetrical components.*

CO4 : *Illustrate the transient behavior of the power system network under open circuit and short circuited conditions.*

CO5 : *Derive the equation to analyze the dynamics of power systems and examine the reliability of electric power systems.*

POWER SYSTEM COMPONENTS AND NETWORK MODELING

Single line diagram - per unit quantities - per unit impedance / reactance diagrams - Complex Power - Representation of Loads - Π equivalent circuit of transformer with off nominal tap ratio - Bus admittance matrix - Formulation of Y bus-Formation of Z bus using step-by- step building algorithm. **9**

LOAD FLOW STUDIES

Load flow equations and methods of solutions - Gauss-Seidel method for load flow studies - Newton Raphson method for load flow studies - Introduction to Bus Voltage Control Methods using STATCOM and UPFC Devices-FDLF method. **9**

FAULT CALCULATIONS

Balanced and unbalanced faults - Types of faults - Symmetrical faults - Consideration of prefault load current - Symmetrical components - Sequence impedances and sequence networks for synchronous machines, transmission lines, transformers - formation of sequence networks - Unsymmetrical fault analysis - single line to ground fault, line to line fault, double line to ground fault. **9**

POWER SYSTEM TRANSIENTS

Travelling waves on transmission lines - Wave equations - Surge impedance - Equivalent circuit for travelling wave studies -Reflection-Refraction - Forked line - Arcing grounds -Switching Transients-Capacitance switching. **9**

POWER SYSTEM STABILITY

Steady state and transient state stability of power systems - Stability limits - Swing equation for single machine infinite bus system - Solution of swing equation by equal area criterion - Methods of improving transient stability - Automatic Voltage Regulators - Load Frequency Control. **9**

TOTAL : 45

TEXT BOOKS

1. *D.P. Kothari, I.J.Nagrath, "Modern Power System Analysis", 4th edition, Tata McGraw Hill, 2011.*
2. *John J. Grainger, W.D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill, 2011.*

REFERENCE BOOKS

1. *C.L.Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2017.*
2. *B.R.Gupta, "Power System Analysis and Design", 3^d Edition, Wheeler Publishers, 2003.*
3. *Hadi Saadat, "Power System Analysis", Tata McGraw Hill, 3^d Edition, reprint, 2008.*
4. *T.K. Nagsarkar, M.S. Sukhija, "Power System Analysis", Oxford University Press, 2007.*
5. *B.M. Weedy, "Electric Power Systems", John Wiley, New York, 2012.*

19EE53 - DATA STRUCTURES AND ALGORITHMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Examine data and define structures to organize large data

CO2 : Use graphs and trees to support search applications

CO3 : Describe how to analyze an algorithm, growth rate and decision making

CO4 : Design new algorithms or modify existing ones for new applications and reason about the efficiency of the result

CO5 : Develop the skills necessary to analyze algorithms that are used in a program.

BASIC DATA STRUCTURES

Arrays - Array of structures - Polynomial representation - Multidimensional Arrays - Sparse Matrices - Transpose and Multiplication of Sparse Matrices - Stacks and Queues: Implementation and Applications.

9

ADVANCED DATA STRUCTURES

Trees: Binary Tree - Tree Traversals - Binary Search Trees - AVL Trees - Splay Trees - B Trees - Red Black Trees

9

GRAPHS ALGORITHMS

Elementary Graph Algorithms - Minimum Spanning Trees - Topological Sorting - Single source Shortest Paths - All Pairs Shortest Paths.

9

SORTING AND HASHING

Insertion Sort - Shell Sort - Heap Sort - Merge Sort - Quick Sort - Radix Sort - External Sort - Analysis of Sorting Algorithms Hashing - Hash Functions - Separate Chaining - Open Addressing - Rehashing - Extendible Hashing.

9

ALGORITHM DESIGN TECHNIQUES (QUALITATIVE TREATMENT ONLY)

The role of Algorithms in computing - Growth of functions. Introduction to algorithms design:

Divide and Conquer - Dynamic Programming - Greedy Algorithm - Backtracking - Branch and Bound - Randomized Algorithms.

9

TOTAL : 45

TEXT BOOKS

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 4th Edition, PHI, 2013.
2. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, "Introduction to Algorithms", 3rd Edition, MIT Press, Cambridge, Massachusetts, 2009.

REFERENCE BOOKS

1. R G Dromey, "How to Solve it by Computers", Pearson Education Asia, 2007.
2. Robert Kruse, C. L. Tando, Bruce Leung and Shashi Mogalia, "Data Structures and Program Design in C", 2nd Edition, Pearson Education, 2006.
3. Jean Paul Tremblay and Paul G Sorenson, "An Introduction to Data Structures with Applications", 2nd Edition, Tata McGraw Hill, 2007.

19EE54 - EMBEDDED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Interpret the register functionalities and architectural features of PIC18Fxxx microcontroller and ARM processor
- CO2** : Develop an assembly language program to process data and access on-chip hardware units using appropriate instructions and addressing modes.
- CO3** : Outline the organizational aspects of three stage pipeline execution process
- CO4** : Illustrate the processor operations by citing examples of pre-conditions and post- conditions, describing registers and memory before and after the instruction execution.
- CO5** : Develop an application software to interface various peripherals for the given design requirements

PIC ARCHITECTURE

PIC Architecture - RISC Architecture -PIC18F458 Pin connection-PIC 18 Configuration registers -WREG register -PIC File Register- Status register-PIC Data format and Directives - Intel Hex format. **9**

PIC PROGRAMMING

Introduction to Assembly language programming -Assembling and Linking a PIC program- viewing register and memory with Simulator-Branch Instructions and Looping-Call instructions and stack-PIC 18 time delay and Instruction Pipelining-I/O Port programming-I/O Bit manipulation programming-Arithmetic and Logic Instructions-Timer and counter programming. **9**

ARM ARCHITECTURE

ARM programmer's model-Load Store Architecture- - Data path and control logic - ARM development tools-3 stage pipeline ARM organization - 5 stage pipeline ARM organization- ARM instruction execution- ARM implementation- Adder Design-Barrel shifter-Multiplier Design-Exception and Interrupt Handling. **9**

ARM PROGRAMMING

ARM Assembly Language Programming- Data processing instructions-Data transfer instructions- Control flow instructions-ARM Instruction set-Conditional execution-Branch and Branch with link-Data processing instructions-multiply instructions-multiple register transfer instructions. **9**

SYSTEM DESIGN

Stand-alone data acquisition system -Keypad interfacing - LCD Interfacing - Stepper Motor interfacing-Speed control of DC Motor - Internet Communication and Control - Serial Communication - Wireless communication. **9**

TOTAL : 45

TEXT BOOKS

1. Steve Furber, *"ARM System-on-Chip Architecture"* Pearson Education Limited, 2012.
2. Muhammad Ali Mazidi, *"PIC Microcontroller and Embedded Systems"* 1st edition, Pearson Education, 2008.

REFERENCE BOOKS

1. John Crisp *"Introduction to Microprocessors and Microcontrollers"* 2nd edition, Elsevier Inc., 2004
2. Andrew N. Sloss, Dominic Symes, Chris Wright *"ARM System Developer's Guide Designing and Optimizing System Software"* Elsevier Inc., 2004
3. William Hohl and Christopher Hinds *"ARM Assembly Language: Fundamentals and Techniques"*, 2nd Edition, CRC Press, 2014.
4. John Lovine, *"PIC Microcontroller Project Book"*, McGraw Hill 2000.
5. John. B. Peatman, *"Design with PIC Microcontroller"*, Pearson Education, 2003.
6. *ARM Architecture, Reference Manual*, ARM Ltd.
7. Rob Toulson, Tim Wilmshurst *"Fast and Effective Embedded Systems Design. Applying the ARM mbed"* 2nd Edition , Elsevier Inc., 2017.

19EEL55 - CONTROL SYSTEMS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Derive the transfer function of a given system experimentally.

CO2 : Design and verify the performance of lag/lead compensators in frequency/time domain.

CO3 : Choose and design a suitable controller to meet the given specifications of an electrical system.

CO4 : Analyze the system response in frequency/time domain using MATLAB software.

CO5 : Design PID controller and state machine and CRIO based speed control of electrical machines using LabVIEW software.

LIST OF EXPERIMENTS

1. Modeling and analysis of physical systems using SIMULINK
2. Mathematical modeling of separately excited DC motor and study of characteristics using SIMULINK
3. Determination of Transfer function constants for armature controlled DC Motor.
4. Determination of Transfer function constants for field controlled DC Motor.
5. Transfer function of 2 phase AC Servo Motor and stability analysis using Matlab.
6. Transfer function of magnetic levitation system under open loop uncompensated and closed compensated system
7. Stability analysis of given LTI system using frequency and time domain methods in SCILAB
8. Design of compensators using bode plots and Matlab.
9. PID controller design for second order system using LabVIEW and Matlab SIMULINK.
10. PWM generation using CRIO and labVIEW simulation software.
11. Analog input measurement and data transfer to CRIO controller using LabVIEW simulation software.
12. Speed control of single phase induction Motor using CRIO and LabVIEW simulation software.
13. Speed control of Three phase induction motor using CRIO and LabVIEW simulation software.
14. Speed control of DC Motor using CRIO and LabVIEW simulation software.
15. Design of state machines (vending machine) using LabVIEW.

19EEL56 - EMBEDDED SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Develop an Assembly Language Program for the given design requirements*

CO2 : *Demonstrate the working of Timer/Counter Module using Assembly language program*

CO3 : *Select suitable sensors to meet the given specification and interface it with the microcontroller to actuate certain output devices.*

CO4 : *Experiment With PWM Technique*

CO5 : *Appraise the use of interrupt driven programming over polling*

LIST OF EXPERIMENTS

Programming PIC18F458 microcontroller using Assembly language - Simulation using MPLAB IDE

1. I/O Port programming
2. Time out generation using on - chip timer module.
3. Counter Programming
4. Code conversion (BCD to ASCII) for RTC implementation
5. Parity checking for error detection

Programming ARM using embedded 'C' - prototyping using mbed LPC1768 device

6. Display interface (LED, LCD, Seven segment display)
7. Generating a sinusoidal and Saw tooth waveform
8. Controlling PWM period with analogue input (POT)
9. Interfacing DC motor
10. Interrupt programming
11. Configuring ADC Module (Sensor interfacing)
12. Stepper motor interfacing
13. IOT based Temperature/Moisture monitoring system.

19EE61 - POWER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Describe the role of Power Electronics as an enabling technology in various applications and to understand the characteristics of the power semiconductor devices.
- CO2** : Select the suitable power semiconductor device, based on the converter type and topology for the given specification and applications.
- CO3** : Ascertain the steady state operation of the power electronic converters based on different operational modes subject to continuous and discontinuous operations.
- CO4** : Seek and reach consensus on formulation of solution methodologies to design the power electronic converters for given applications.
- CO5** : Design, simulate, develop and evaluate the efficiency of power electronic systems such as motion control systems and power supplies for given specifications

POWER SEMICONDUCTOR DEVICES

Introduction - Need for power conversion - Generic Power Converter - Power Semiconductor Switches - Idealized Characteristics- Power diodes - Thyristor family of devices: SCR - TRIAC - GTO - IGCT - Transistor family of devices: Power MOSFETs - IGBTs- steady state and dynamic characteristics - Switching and Conduction losses - Comparison of power semiconductor switches-Intelligent Power Modules - protection circuits - Heat sink calculations- - Introduction of SiC and GaN based power devices - Introduction to driver circuits Synchronization and Isolation-Study of data sheet of power semiconductor devices (Qualitative Treatment only). **9**

AC - DC CONVERTERS

Introduction - Uncontrolled Rectifier - Limitations - phase angle control - Quadrants of operation -Single phase and Three phase semi bridge and full bridge converters - Dual converters - Introduction of high pulse converters - Estimation of performance parameters for continuous current operation - Effects of load and source inductances - Device selection- Development of control circuit (Block Diagram only) **8**

DC - DC CONVERTERS

Principle of chopper operation - Control strategies - Non - isolated switched mode regulators: Buck regulator - Boost regulator- Buck - Boost regulator - Cuk regulator - SEPIC regulator- Comparison of regulators - Isolated switch mode converters: Fly back Converter - Forward Converter - Bridge Converter - Device selection- Development of control circuit (Block Diagram only)- Introduction to resonant power converters (Qualitative Treatment only). **8**

AC - AC CONVERTERS

AC voltage Controllers - Principle of ON - OFF control and phase angle control - Single phase and Three phase voltage controllers- Estimation of performance parameters - Single phase transformer connection changers - PWM based AC voltage controller.

Cycloconverters - Basic principle of operation - Single phase and Three phase cyclo converters - output voltage equation -Device selection for AC - AC converters - Introduction to matrix converter- Device selection- Development of control circuit (Block Diagram only) **8**

DC - AC CONVERTERS

Principle of operation - classifications of inverters - Voltage source inverters and Current source inverters - Single phase and Three phase bridge configurations - Estimation of performance parameters - Voltage control of inverters - Harmonic reduction. Introduction to multi-level inverters - Introduction to active front converter (PWM Rectifier) - Development of control circuit (Block Diagram only)- Device selection Applications (Qualitative Treatment - Block Diagram only): UPS - SMPS - LED Drivers - Electric Vehicles - Solar PV-Wind Energy Systems-Solar PV based water pumping-Solid State Transformer. **12**

TOTAL : 45

TEXT BOOKS

1. M.H.Rashid, "Power Electronics", Pearson Education, New Delhi, 4th Edition, 2017.
2. Mohan.N.Tore. M.Undeland, and William.P.Robbins, "Power Electronic Converters, Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2014.

REFERENCE BOOKS

1. Robert W.Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer Nature Switzerland AG, 3rd Edition, 2020.
2. Yuriy Rozanov, Sergey Ryvkin, Evgeny Chaplygin and Pavel Voronin "Power Electronics basics - operating principles, design, formulas and applications" CRC Press, Taylor & Francis Group, 2015.
3. Andrej. M. Trzynadlowski, "Introduction to Modern Power Electronics", John Wiley and Sons, 3rd Edition, New York, 2016.
4. M.D.Singh and K.B. Khanchandani, "Power Electronics", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2011
5. G.K.Dubey., et al, "Thyristorised Power Controllers", New Age Publishers, Chennai, 2nd Edition, 2010
6. L.Umanand, "Power Electronics: Essentials & Applications", Wiley India Pvt. Limited. New Delhi, 2009
7. http://nptel.ac.in/courses/webcourse - contents / IIT% 20 Kharagpur / Power%20 Electronics/ New_index1.html for Web type,
8. <http://nptel.ac.in/courses/108101038/> for Video Type.
9. <http://ocw.mit.edu/courses/electrical - engineering - and - computer - science/6 - 334 - power - electronics - spring - 2007>

19EE62 - DIGITAL PROTECTION OF POWER SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Summarize the need of digital protection and power system components, and the functional characteristics of different relays.
- CO2** : Illustrate the concepts of protection of machines, transformers and bus zone.
- CO3** : Recommend feasible Digital algorithmic solutions to various protection schemes of power system protection.
- CO4** : Apply the circuit breakers, fuses, and travelling wave concepts for transmission line protection.
- CO5** : Survey about AI-based numerical protection and recent trends to solve the problems encountered in the power system protection.

POWER SYSTEM PROTECTION COMPONENTS: RELAYS, CIRCUIT BREAKERS, CT and VT

Need for Protective Systems-Nature and Causes of Faults-Classification of Protective Relays- Components of Protection System-Relay Construction and Operating Principles- Fault clearing time of a breaker- Current Chopping-Classification of Circuit Breakers-Current, Voltage, Summation Transformer - Phase - sequence current - segregating Network- Overcurrent Protection. **9**

RELAY PROTECTION OF MACHINES, TRANSFORMERS and BUSZONE

Distance Protection-Pilot Relaying Schemes-Differential Protection-Rotating Machines Protection-Transformer and Bus zone Protection. **9**

NUMERICAL PROTECTION

Numerical Relay-NR Algorithms-Mann-Morrison Technique-Differential Equation Technique-Discrete Fourier Transform Technique-Walsh-Hadamard Transform Technique- Numerical Overcurrent, Distance, Differential Protection-Microprocessor Based Numerical Protection. **9**

FUSES-PROTECTION AGAINST OVERVOLTAGES

Fuse Characteristics-Types-Application-Selection of fuses-Causes of Overvoltages- Waveshape of voltage due to Lightning-Protection of Transmission Lines, Sub-stations against Lightning-Protection against Travelling Waves-Surge Protection-BII Level. **9**

MODERN TRENDS IN POWER SYSTEM PROTECTION

Application of Artificial Intelligence to Power System Protection-Application of ANN to Overcurrent Protection, Transmission Line Protection-NN based Directional Relay-ANN and Wavelet Fuzzy combined approach for fault detection, location and classification-Application of ANN and Wavelet to protection of Power System Components-Modern Trends in Power System Protection. **9**

TOTAL : 45

TEXT BOOKS

1. *Badri Ram and D.N.Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, Tata McGraw Hill publishing company Ltd., New Delhi, 2011*
2. *L. P. Singh, "Digital Protection - Protective Relaying from Electromechanical to Microprocessor", 2nd Edition, New Age International Ltd., New Delhi, 2017.*

REFERENCE BOOKS

1. *B.Ravindranath and M.Chander, "Power System Protection and Switchgear", 5th Edition, New Age International Pvt. Ltd., New Delhi, 2014.*
2. *Stanley H.Horowitz and Arun G.Phadke, "Power System Relaying", 4th Edition, John Wiley and Sons Ltd., , 2014.*
3. *C.L.Wadhwa, "Electrical Power Systems", New Age International Pvt. Ltd., 6th Edition, 2011.*
4. *M.L.Soni, P.V.Gupta and U.S.Bhatnagar, "A Course in Electrical Power", 9th Edition, Dhanpat Rai and Sons, 2011.*
5. *Bhavesh Bhalja, R.P. Maheswari, Nilesh G. Chothani, "Protection and Switch Gear", 4th Edition, Oxford University Press, 2011.*

19EE63 - DIGITAL SIGNAL PROCESSING

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Interpret and process the discrete/digital signals to perform various signal operations.

CO2 : Perform statistical analysis and inferences on various types of signals.

CO3 : Apply the principles of z-transforms and Fourier transform analysis for processing digital signals.

CO4 : Realize IIR filter and FIR filter structures.

CO5 : Employ digital signal processing techniques to design discrete time systems and digital filters

INTRODUCTION

Basic elements of a digital signal processing system - Advantages of digital over analog signal processing - Continuous time verses discrete time signals - Sampling of analog signals - Quantization of continuous amplitude signals - Signal representation - Classification of discrete time signal - Operation on signals - Convolution and Correlation of discrete time signals **9**

DISCRETE TIME SYSTEM

Causal, Dynamic, Linear, Time invariant, Stable systems - Frequency analysis of discrete time signals - Fourier series and its properties for discrete time periodic signals - Power density spectrum of periodic signals - Fourier transform and its Properties for discrete time signals **9**

TRANSFORMS

Overview of Z Transform and its application - Discrete Fourier Transform (DFT) and its properties - Fast Fourier Transform (FFT) algorithms - Radix - 2 FFT - DIT & DIF **9**

DIGITAL FILTERS DESIGN

Properties and Structures of FIR and IIR filter - Design of FIR filter using rectangular and hamming windows - Design of IIR filter from analog filters using bilinear and impulse invariance transformation. **9**

REALIZATION OF DIGITAL FILTERS

Realization of FIR filters (Direct Form, Cascade Form, Linear Phase FIR structures) and IIR filters(Direct Form I, Direct Form II, Cascade and Parallel Forms) - Application: Musical sound processing system **9**

TOTAL : 45

TEXT BOOKS

1. Winser Alexander, Cranos M Williams "Digital Signal Processing Principles, Algorithms and System Design" 2nd edition, academic Press, 2017
2. Richard G. Lyons, "Understanding Digital Signal Processing", Prentice Hall, 3rd Edition, 2012
3. Vijay Madiseti "Digital Signal Processing Fundamentals", 2nd edition, CRC press, 2017

REFERENCE BOOKS

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles Algorithm and Application", Prentice Hall of India, 4th Edition, 2007
2. P. Ramesh Babu, "Digital Signal Processing", Scitech Publication Pvt. Ltd., 7th Edition, Chennai, 2018
3. Mitra Sanjit K., "Digital Signal Processing: A Computer Based Approach", Tata Mc Graw Hill, New Delhi, 2007
4. B. P. Lathi, Roger A. Green, "Essentials of Digital Signal Processing", 1st edition Cambridge University Press 2014.
5. Ashok Ambardar, "Analog and Digital Signal Processing", Thomson Asia Pvt. Ltd, 2nd Edition, Singapore, 2002

19EEL64 - POWER ELECTRONICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

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

- CO1** : Apprehend the static and dynamic characteristics of the power semiconductor devices and their selection for a given application
- CO2** : Realize and develop the pulse width modulation techniques for power converters. Also Design and test the control and gate driver circuits for level triggered devices
- CO3** : Study and analyse the operation of the various types of the power electronic converters and to understand their performance parameters. Also to understand the usage of true RMS meters and Power Quality Analyzers for power electronic measurements.
- CO4** : Evaluate I - V & P - V characteristics, Estimate energy generation of solar PV modules and their applications
- CO5** : Simulate the power electronic converters using compatible softwares

LIST OF EXPERIMENTS

1. Steady State and Dynamic Characteristics of Power Electronic Devices.
2. Design of Universal PWM technique and Generation of different types of PWM signals for Power Electronic Converters
3. Design of Gate driver and Isolation circuits of MOSFET/IGBT
4. Load Test on Single Phase Half and Fully Controlled Bridge Converters
5. Load Test on Three Phase Half and Fully Controlled Bridge Converters and Power Quality Study
6. Load Test on Buck, Boost and Buck - Boost Converter
7. Study of Single-Ended Primary-Inductor Converter (SEPIC)
8. Load Test on Single Phase and Three Phase PWM Inverter
9. Load Test on Cascaded Multi Level Inverter (MLI).
10. Study of AC Phase Control using SCR and TRIAC
11. Load Test on Single Phase Cyclo-Converters
12. Study of IV characteristics of Solar PV Modules (Series, Parallel and Series - Parallel combinations)
13. Design, estimation and monitoring of Power Electronic Converters using IoT
14. Design of DC-DC converter for EV Battery charging application.
15. Simulation of Power Electronic Converters and development of controller using dspace.

19EEL65 - POWER SYSTEMS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Design and Select suitable Plug Setting Multiplier and test the over current protective relay using Electro - mechanical instrument
- CO2** : Identify and locate the fault in power system using cable fault locator
- CO3** : Analyze the IDMT characteristics of over/under voltage relay
- CO4** : Measure experimentally the negative sequence components in unbalanced systems
- CO5** : Analyze the harmonics in power system using MATLAB / Simulink & Perform various load flow techniques

LIST OF EXPERIMENTS

1. Determination of Break Down Voltage (BDV) of transformer oil.
2. Load sharing of parallel connected alternators
3. Phase Sequence detection using Static Relay.
4. Over Current detection using Static Over Current Relay & Electromechanical relay
5. Over/Under Voltage detection using Static Relay.
6. Over/Under Frequency detection using Static Relay
7. Earth Fault detection using Static relay.
8. Differential Protection of transformer using Static Relay
9. Varley Loop test by using cable fault locator.
10. Power Quality Analysis (Sag and THD) using simulation software
11. Formation of Y-BUS/ Z-BUS & Load Flow Analysis using Gauss Seidal (GS) Method.
12. LG, LL and 3 phase fault analysis of 3 phase Synchronous machine.
13. Analysis of Hybrid solar and Wind power system.
14. Analysis of EMI.

19EEL66 - MINI PROJECT

L	T	P	C
0	0	6	3

ASSESSMENT : VIVA - VOCE

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : *Analyze the problems in societal and environmental contexts and to provide the technical support for sustainable development without affecting the nature.*
- CO2** : *Develop practical knowledge within the chosen area of technology for project development.*
- CO3** : *Identify, analyze, formulate and design a real time project with a comprehensive and systematic approach by using modern tools.*
- CO4** : *Take part in a team and as an individual in the development of technical projects and to improve their effective team management and financial management skills through project activities.*
- CO5** : *Develop effective communication skills for presentation and to develop plagiarism free technical report preparation.*

19EE71 - SOLID STATE DRIVES AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Analyze the characteristics of motors, load dynamics and performance parameters of DC drives and selection of motor power rating under different load conditions.
- CO2** : Outline the conventional method of DC drive and solid-state Drives for DC motors.
- CO3** : Infer the performance characteristics of three phase Induction motor and the various methods of speed control based on solid state drives
- CO4** : Summarize the concept of suitable power electronic circuitry to drive synchronous motor, brushless DC motor, special machines and SRM.
- CO5** : Formulate suitable drive according to industrial, environmental standards and develop the control schemes for any electric drive. Describe the concept and application of special machines in modern electric drives.

CHARACTERISTICS OF ELECTRICAL DRIVES AND LOADS

History and Development of drive Systems - Comparisons - Concept of electric drive - Block diagram representation - Advantages - Classification - AC and DC drives - Requirements of a good adjustable speed drive - Principle factors affecting the choice of drive - Speed - Torque characteristics of drive motor and load - Joint speed - torque characteristics - Selection of motor power rating for drive motor based on thermal overloading and Load variation factors - Load Equalization **7**

DC DRIVES

Introduction - Speed control of DC motors - Ward - Leonard scheme and its draw backs - Solid state control - Advantages - Performance parameters. Converter fed DC drives - Single phase and Three phase drives - Performance characteristics - Single, Two and Four quadrant operation - Supply side harmonics - Power factor and Effect of ripple on motor performance. Chopper fed DC drives - Chopper fed control of separately excited DC motor, DC Shunt and DC Series motor - Performance characteristics - Quadrants of Operation. **7**

INDUCTION MOTOR DRIVES

Three Phase Induction Motor Analysis and Performance-Operation under unbalanced Condition and non-sinusoidal voltage supply. Methods of speed control of three phase induction motor Stator Side Control: Stator voltage control - Stator frequency control - V/F control - Solid - state speed control schemes with AC voltage controllers - DC link inverters (Phase Controlled and PWM rectifier based) - Cyclo converters - Matrix converter - CSI fed IM variable frequency drives - Introduction to vector control. Rotor Side control: Rotor resistance control - Static rotor resistance control - Injection of voltage in the rotor circuit - Slip power recovery schemes: Static Scherbius - Modified Kramer drive. **12**

SYNCHRONOUS MOTOR DRIVES

Speed control of three phase synchronous motor - True synchronous and Self - controlled modes - Inverter fed synchronous motor drives - Cyclo converter control - Brushless DC motor drives - Current source inverter fed synchronous motor drive - Synchronous reluctance motor drive. **9**

SPECIAL DRIVES AND APPLICATIONS

DC Servo drives principle of operation - AC Servo drives principle of operation - Principle and control Stepper motor drives - Comparison between Servo drive and Stepper drive - Introduction to PLC based drives - Energy Efficient drives - Switched Reluctance motor drives - Solar and Battery powered drives. Selection of drive and Control schemes for Steel industry - Textile industry - Mining - Paper industry - Cement mills. **10**

TOTAL : 45

TEXT BOOKS

1. G.K.Dubey, "*Fundamentals of Electrical Drives*", 2nd edition, Narosa Publishing House, New Delhi, Reprint 2020.
2. Bose B K, "*Modern Power Electronics and AC Drives*", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2014
3. G.K. Dubey, "*Power Semiconductor Controlled Drives*", Prentice Hall, 1989

REFERENCE BOOKS

1. Vedam Subramaniam, "*Electrical Drives and Applications*", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
2. R. Krishnan, "*Permanent Magnet Synchronous and Brushless DC Motor Drives*", CRC Press Taylor & Francis Group, 2010.
3. S.K. Pillai, "*A First Course on Electrical Drives*", New Age International Publishers, 2nd Edition, 2010.
4. M.S.Berde, "*Electric Motor Drives*", Khanna publishers, New Delhi 1997.
5. P.C. Sen, "*Thyristor DC Drives*", John Wiley and Sons, New York, 1981.
6. J.M.D. Murphy, "*Thyristor Control of AC Motor*", Paragon Press, London, 1978

19EE72 - GENERATION OF ELECTRICAL ENERGY

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Classify different types of loads and calculate the load demand - supply curve.

CO2 : Identify the areas of agreement and disagreement in safety aspects and environmental concern of conventional power generation schemes.

CO3 : Design solar PV based grid tied, off grid and hybrid systems for domestic applications.

CO4 : Examine the possibilities of wind energy systems in the particular locality.

CO5 : Assess the various sources of availability to design a microgrid for a given requirements.

LOAD ANALYSIS

Demand for electric power - Load Curves and Load curve analysis - Reliability Evaluation - Outages, Causes and Interruptions - Cost versus Reliability - Short and Long range planning - Load demand - Diversity and Plant factors - Cost and Economic Evaluation **9**

CONVENTIONAL GENERATION SCHEMES

Hydroelectric power plants - Pumped storage plants - Thermal power plants: Steam power stations, Gas turbine stations and Diesel generators - Nuclear power plants - Safety aspects - Environmental concerns **9**

SOLAR PV SYSTEMS

Solar radiation and measurement - Influence of insulation and Temperature - Block diagram of solar photo voltaic system - Solar PV Cell - Characteristics and Types - Arrays and Panels - DC power conditioners - Maximum power point tracking algorithms - AC power conditioners - Line commutated thyristor inverters - Synchronized operation with grid supply - Standalone inverters. Energy Storage: Batteries, types and its parameters.

Solar PV Applications: Water pumping and Street lighting. **9**

WIND ENERGY SYSTEMS

Basic principle of wind energy conversion - Nature of wind power in the wind - Site selection considerations - Components of Wind Energy Conversion System (WECS) - Classification of WECS - Generating Systems - Schemes of electrical generation. Applications - Water pumping and Village electrification. **9**

COGENERATION AND MICROGRID

Distributed generation versus traditional power systems - Concepts of micro grid - Additional sources of micro grids: Biomass and fuel cells - Structure and Configuration of AC and DC micro grid - Modes of operation and Control of micro grid: Grid connected and Islanded mode - Active and Reactive power control and protection issues. **9**

TOTAL : 45

TEXT BOOKS

1. *P Breeze, "Power Generation Technologies", Elsevier, 3rd Edition, 2019*
2. *Mukund R. Patel, "Wind and Solar Power Systems", 2nd Edition, CRC Press, New York, 2009*
3. *S. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", Institution of Engineering and Technology (IET Press), 2014.*
4. *Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", 3rd edition, PHI , Delhi, 2015*

REFERENCE BOOKS

1. *Digambar M. Tagare, "Electricity Power Generation: The Changing Dimensions", John Wiley & Sons, 2011.*
2. *C.L.Wadhwa, "Electrical Power Systems", New Age International, 2012*
3. *Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Private Limited, 2nd edition, New Delhi, 2017.*
4. *Adolf Goetzberger and Volker Hoffmann, "Photovoltaic Solar Energy Generation", Springer - Verlag Berlin Heidelberg, 2005.*
5. *Roger Messenger and Jerry Venture, "Photovoltaic Systems Engineering", CRC Press, New York, 2007.*

19EE73 - SMART GRID

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Explain the basic concepts of smart grid , its components, architecture and distinguish from traditional grid
- CO2** : Identify suitable power electronic converters for WAMPCS and select appropriate compensation methods for solar PV, micro - hydro, wind and battery storage connected micro - grids
- CO3** : Diagnose and control the grid quality using different communication algorithms / systems and security concerns
- CO4** : Summarize various metering services in smart grid & outline the concepts of attacks in metering
- CO5** : Decide smart grid pathway through various case studies

INTRODUCTION

Review Basic Elements of Electrical Power Systems - Evolution of Electric Grid - Definitions - Today's Grid Vs the Smart Grid - Need for Smart Grid - smart grid Roadmap -Transforming to smart grid- Interoperability Framework of Smart grid - Functions of Smart Grid and its Components - Overview of the technologies required for the Smart Grid - Concept of Resilient &Self Healing Grid - Present development & International policies in Smart Grid - Smart Grid Market Drivers - Stakeholders Roles and Function - Standards for Smart Grid - Opportunities, Challenges and Benefits. **9**

SMART GRID TECHNOLOGIES

Technology Drivers - Smart Energy Resources - Sustainable Energy Options for the Smart Grid - Variability Issues Associated with Sustainable Energy Technology - Demand Response Issues - Power Electronics in the Smart Grid - Smart substations - Power Quality issues in Smart Grid - Power Quality Conditioners for Smart Grid - Energy Storage Technologies: Batteries - Flow Battery - Fuel Cell and Hydrogen Electrolyze SMES - Super Capacitors E- mobility. **9**

INFORMATION AND COMMUNICATION TECHNOLOGY

Communication Technology - Two - way Digital Communications - Standards for Information Exchange - Communication Infrastructure and Protocols for Smart metering - Standards for smart metering - IEC 61850 - Interoperability - Smart Grid Network Interoperability - Local Area Network (LAN) - MODBUS - DNP3 - Home Area Networks (HAN) / Home Energy Networks (HEN) - Wide Area Network (WAN) - Broadband over Power Line (BPL) - IP based Protocols - Basics of Web Service - Cloud Computing. Cyber Security: Symmetric key encryption - Public key encryption - Authentication - Cyber security concerns associated with AMI - Cyber Security Challenges in Smart Grid - Load Altering Attacks - False Data Injection Attacks -Alarming Smart grid threats- Mitigation Approaches - Standards **9**

SMART METERS AND ADVANCED METERING INFRASTRUCTURE

Introduction to Smart Meters - Sensor Networks - Wide Area Monitoring Systems (WAMS) - Energy Management System (EMU)-Phasor Measurement Units (PMUs)-GIS and Google Mapping tools - Advanced Metering infrastructure (AMI) drivers and benefits - AMI protocols, standards and initiatives - AMI needs in the smart grid - SCADA - RTU - Distribution System Modeling - Intelligent Electronic Devices(IED) - Fault Detection, Isolation and Restoration - Self Healing Systems - Monitoring & Protection- IEC 61968- 9 **9**

SMART GRID PATHWAYS TO DESIGN AND CASE STUDIES

Introduction to Smart Grid Pathway Design - Barriers and Solutions to Smart Grid Development - Automation at Generation, Transmission, Distribution and End User Level. Demonstration Projects - Advanced Metering - Case Study for Renewable Energy Resource Integration: Smart city - Description of Smart Grid Activity - Approach for Smart Grid Application - Benchmarking - Smart grid for world's largest Power systems- Development targets interconnection with USA- Case study on south Korean smart grid Test bed on Jeju Island.

9

TOTAL : 45

TEXT BOOKS

1. *Bernd M. Buchholz Zbigniew Styczynski, "Smart Grids Fundamentals and Technologies in Electricity Networks", Springer Berlin Heidelberg, Mar.2020*
2. *James Momoh, "Smart Grid - Fundamentals of Design and Analysis", IEEE Press, John Wiley & Sons, INC., New Jersey, 2012.*
3. *Janaka.E.Kanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons Ltd., West Sussex, 2012.*

REFERENCE BOOKS:

1. *ErsanKabalci, Yasin Kabalci, "From Smart Grid to Internet of Energy", 1st edition Elsevier Science,2019*
2. *Stephen F. Bush, "Smart Grid : Communication - Enabled Intelligence for the Electric Power Grid", Wiley - IEEE Press, 2014*
3. *Ali Keyhani, "Design of Smart Power Grid Renewable Energy System", IEEE Press, John Wiley & Sons, INC, New Jersey, 2011*
4. *Stuart Borlase, "Smart Grids: Infrastructure, Technology and Solutions", Taylor and Francis Group, CRC Press, 2013*
5. *K S Manoj,"Smart Grid, Concepts To Design", Notion press India, 2020*

19EEL74 - ELECTRICAL DRIVES LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : *Decide a suitable drive for a particular application based on power rating and characteristics of the application*
- CO2** : *Determine the braking characteristics of DC shunt motor and Induction motor*
- CO3** : *Assess the converter topologies, inverter topologies control principles and modern tools used in DC drives, AC drives and special electric drives*
- CO4** : *Demonstrate the speed control of DC motors by using converters and chopper fed drive and also to demonstrate the speed control of AC motors by using inverter fed AC drive*
- CO5** : *Integrate the drive-based energy saving technique through experimental verification and to perform the speed control techniques for special electric machines by using drive*

LIST OF EXPERIMENTS

1. Dynamic Braking Characteristics of DC Shunt Motor
2. Dynamic Braking and Reverse Current Braking Characteristics of Three - Phase Induction Motor.
3. Speed Control of DC Motor using Phase Controlled Converter
4. Speed Control of Induction Motor using Scalar and Vector Controlled Drive
5. DSP Based Speed Control of Three Phase Squirrel Cage Induction Motor
6. Load Test on Three Phase Induction Motor with Eddy Current Loading
7. PLC Based Speed Control of Three Phase Induction Motor Drive
8. Load Test on DC Shunt Motor Using Single Phase Dual Converter Drive
9. Performance and Harmonic Measurement of Air Compressor using AC drive
10. Performance analysis of Solar PV based DC and AC Pump
11. Study of BLDC Drives
12. Speed Control of Three Phase Induction Motor using Matrix Converter Drive
13. Speed Control of Switched Reluctance Motor Drive
14. Speed Control of Servo Motor Drive.
15. Load Test on Induction Generator by Feeding Back to Mains

19EEL75 - PROFESSIONAL COMPETENCY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Demonstrate knowledge in the program domain.*

CO2 : *Develop the problem solving skill by analyzing the given criteria*

CO3 : *Present views cogently and precisely*

CO4 : *Exhibit professional etiquette suitable for career progression.*

CO5 : *Prepare the students to face the competitive examinations and interview*

TITLES TO BE COVERED

1. Electric circuits
2. Electromagnetic fields
3. Electrical Machines
4. Electrical and Electronic Measurements
5. Analog Electronics
6. Digital Electronics
7. Control Systems
8. Power Electronics
9. Power Systems
10. Signals and Systems

19EE76 - PROJECT WORK PHASE I

L	T	P	C
0	0	6	3

ASSESSMENT : VIVA - VOCE

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : *Interpret the electrical, electronics and other engineering concepts and principles related to the project work*
- CO2** : *Demonstrate the technical skills to provide feasible solutions for real - life problems relevant to the society*
- CO3** : *Enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills.*
- CO4** : *Apply engineering ethical principles in societal and environmental contexts and to realize the importance of project management tools, estimation and costing*
- CO5** : *Analyze, estimate and manage a project within a stipulated project time line and communicate effectively on complex engineering problems*

19EE81 - PROJECT WORK PHASE II

L	T	P	C
0	0	10	5

ASSESSMENT : VIVA - VOCE

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : *Demonstrate the technical skills to provide feasible solutions for real - life problems relevant to the society*
- CO2** : *Enhance the management skills to achieve the project goal by working as a team and also improve technical writing skills.*
- CO3** : *Apply engineering ethical principles in societal and environmental contexts and to realize the importance of project management tools, estimation and costing*
- CO4** : *Analyze, estimate and manage a project within a stipulated project time line and communicate effectively on complex engineering activities*
- CO5** : *To develop a product as a solution for complex engineering problems and a need for sustainable development*

ELECTIVE COURSES
PROFESSIONAL ELECTIVES
19EEE01 - DESIGN OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : *Classify the materials used for the construction of electrical machines and also to determine the MMF in magnetic parts of rotating machines.*
- CO2** : *Decide the appropriate parameters and design the major parts of DC machines.*
- CO3** : *Determine and choose appropriate parameters for the design of major parts of synchronous machines for given specifications.*
- CO4** : *Decide and select appropriate parameters for the design of stator and rotor of threephase induction machines.*
- CO5** : *Decide the appropriate parameters and design the major parts of single phase induction motor.*

INTRODUCTION

Design factors - Limitation in design - Various Conducting materials, Insulating materials and Magnetic materials. Design of Magnetic Circuits: MMF calculation for Air gap and Teeth - Iron losses and Magnetizing current calculations. Design of Armature Windings: Types of Winding for AC and DC Machines. Introduction to machine design software: Speed, JMAG, Maxwell. **9**

D.C. MACHINES

Output equation - Choice of Specific loadings - Choice of poles and speed - Main Dimensions - Length of Air gap - Design of Armature - Design of Field System - Commutator and Brush Design. **9**

SYNCHRONOUS MACHINES

Choice of Electric and Magnetic loadings - Main dimensions - Length of Air gap - Short circuit ratio - Stator core design and Rotor core Design for salient pole and turbo alternators - Design of Pole and Field winding - Design of damper windings. **9**

THREE PHASE INDUCTION MOTORS

Output equation - Choice of Electric and Magnetic loadings - Main dimensions - Stator core design - Length of Air gap - Rotor core Design - No load current calculation - Stator and Rotor Resistance calculations - Introduction to Energy Efficient Motors. **9**

SINGLE PHASE INDUCTION MOTOR

Single phase induction motor: Main dimensions - Design of stator - Rotor design- Introduction to CAD. **9**

TOTAL : 45

TEXT BOOKS

- 1 A.K. Sawhney, "A course in Electrical Machine Design", Dhanpat Rai & Sons, Reprint, 2010.
- 2 K.G.Upadhaya, "Design of Electrical Machines", New Age International, 1st Edition, 2008.
- 3 K.Sen, "Principles of Electrical Machine Design" - Oxford & IBH pub. Co. Pvt. Ltd., 2nd Edition, 2001.
- 4 K.M.V.Murthy,"Computer Aided Design of Electrical Machines",BS Publications,2008.

REFERENCE BOOKS

- 1 R.K.Agarwal, "Principles of Electrical Machine Design" - S.Kataria & Sons, 5th Edition, New Delhi, Reprint, 2014.
- 2 V.N. Mittle, "Design of Electrical Machines", Standard Publishers Distributors, 5th Edition,2014.
- 3 Juha Pyrhones, Tapans Jokines,"Design of Rotating Electrical Machines", John Wiley and Sons, 2009.
- 4 M.V. Deshpande, "Design and Testing of Electrical Machines", PHI Learning Private Limited, Delhi, 2013.
- 5 A.Shanmugasundaram, G.Gangadharan,R.palani, "Electrical machine Design data book, New Age Pvt. Ltd, Reprint of 1st Edition 2007.

19EEE02 - SPECIAL ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe the open loop, closed loop speed control and power controllers for stepper motors.

CO2 : Illustrate the concepts of working and controllers used for Reluctance motors.

CO3 : Describe the electronic commutation and controllers of Permanent magnet brushless DC motors.

CO4 : Describe the self and vector control schemes of Permanent magnet Synchronous motors.

CO5 : Choose appropriate Special machines in computerized machining, Robotics and Aviation.

STEPPER MOTORS

Constructional features - Principle of operation - types - Modes of excitation - Single phase stepping motors - Torque production in variable Reluctance (VR) stepper motor - Dynamic characteristics - Drive systems and circuit for open loop control - Closed loop control of stepping motor - Microcontroller based controller. **9**

RELUCTANCE MOTORS

Switched Reluctance Motors: Constructional features - Principle of operation - Torque equation - Power controllers - Characteristics and control. Microcontroller based controller - Sensor less control - Derivation of output equation - Synchronous Reluctance Motors: Constructional features - Axial and Radial air gap Motors. Operating principle - Reluctance torque - Phasor diagram - Motor characteristics. **9**

PERMANENT MAGNET BRUSHLESS DC MOTORS

Commutation in DC motors - Difference between mechanical and electronic commutators - Hall sensors - Optical sensors - Multiphase Brushless motor - Square wave permanent magnet brushless motor drives - Torque and EMF equation - Torque - speed characteristics - Microcontroller based controller - Sensor less control. **9**

PERMANENT MAGNET SYNCHRONOUS MOTORS

Principle of operation - EMF - Power input and Torque expressions - Phasor diagram - Power controllers - Torque speed characteristics - Self control - Vector control - Current control schemes - Sensor less control - Adaptive fuzzy control **9**

LINEAR ELECTRICAL MACHINES

Linear Machines - Basic difference between Linear Electrical Machines(LEMS) and Rotating Machines - Classification of LEMS - Linear motors and Levitation machines - Linear induction motors - Linear synchronous motors - DC linear motors - Linear levitation machines - Machines used in CNC, Robotics and Aviation **9**

TOTAL : 45

TEXT BOOKS

- 1 *T.J.E. Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.*
- 2 *T.Kenjo, "Stepping Motor and their Microprocessor Controls", Clarendon Press London, 1995.*
- 3 *B K Bose, "Modern Power Electronics & AC drives", Pearson Education Asia, 2002.*
- 4 *K.Venkataratnam, "Special Electrical Machines", Universities Press, First Edition 2008.*

REFERENCE BOOKS

- 1 *R. Krishnan, "Switched Reluctance Motor Drives", CRC Press,2001*
- 2 *J.R. Hendershot Jr and TJE Miller," Design of Brushless Permanent - Magnet Motors", Magna physics publishing and clarendon press, Oxford - 2010*
- 3 *Kenjo T, "Power Electronics for the Microprocessor Age", Oxford University Press, 1994.*
- 4 *Ali Emadi (Ed), "Handbook of Automotive Power Electronics and Motor Drives", CRC Press, 2005*
- 5 *H A Toliyat, S Campbell, "DSP Based Electro Mechanical Motion Control", CRC Press, 2004.*

19EEE03 - MODELING AND ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Describe the fundamentals of electromagnetic energy conversion for singly and doubly excited systems.
- CO2** : Analyze standard methods to determine accurate modeling/simulation parameters for DC machines.
- CO3** : Illustrate reference frame theory.
- CO4** : Examine the steady state operation and dynamic operation for load variation of induction machines
- CO5** : Illustrate the behavior of synchronous machines under transient and steady state conditions.

PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION

Magnetic circuits - Stored magnetic energy - Co - energy - Force and Torque - Singly and doubly excited system - MMF pattern for DC and AC machines - Calculation of air gap mmf and per phase machine inductance using physical machine data. **9**

DC MACHINES

Voltage and Torque equations - Dynamic characteristics of permanent magnet and shunt DC motors state equations - Solution of dynamic characteristics by Laplace transformation. **9**

REFERENCE FRAME THEORY

Static and Rotating reference frames - Transformation of variables - Reference frames - Transformation between reference frames - Transformation of a balanced set - Balanced steady state phasor and voltage equations - Variables observed from several frames of reference. **9**

INDUCTION MACHINES

Voltage and Torque equations in machine variables - Transformation in arbitrary reference frame - Voltage and Torque equation in reference frame variables - Analysis of steady state operation - Free acceleration characteristics - Dynamic performance for load variations - Computer simulation. **9**

SYNCHRONOUS MACHINES

Voltage and Torque equation in machine variables - Transformation in rotor reference frame (Park's equation) - Voltage and Torque equation in reference frame variables - Analysis of steady state - Dynamic performance for load variations - Computer simulation. **9**

TOTAL : 45

TEXT BOOKS

- 1 Paul C.Krause, Oleg Wasyzczuk and Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, 2nd Edition, 2005.
- 2 R.Krishnan, "Electrical Motor Drives, Modelling, Analysis and Control", Prentice Hall of India, 2002.
- 3 Mritunjay Bhattacharyya, "Electrical machines: modeling and analysis", PHI learning Pvt. Ltd, 2016.

REFERENCE BOOKS

- 1 A.E.Fitzgerald, Charles Kingsley, Jr. and Stephen D.Umans, "Electric Machinery", TataMcGraw Hill, 5th Edition, 1992.
- 2 Subramanyam V., "Thyristor Control of Electric Drives", Tata McGraw Hill Publishing Company Limited, New Delhi 1998.

19EEE04 - DIGITAL CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Design compensators for the given system satisfying the given specifications.

CO2 : Determine the stability of the discrete-time systems and design a stable system using root-locus and frequency response plots.

CO3 : Device and simulate state feedback controller with full order and reduced order observer.

CO4 : Estimate the states of a system using Kalman filter with the given model of the system.

CO5 : Convert the given continuous-time system to discrete form, design suitable digital controllers and estimators under deterministic and stochastic conditions.

INTRODUCTION

Basic concepts of digital control systems - block diagram - analog to digital and digital to analog conversion - sampling and hold devices - multiplexing - sampling and sampling theorems. **9**

Z TRANSFORM

Definition and evaluation - basic properties - inverse Z transform - pulse transfer function - starred Laplace transform - applications. **9**

MAPPING BETWEEN Z PLANE AND S PLANE

Representation of poles and zeros in the Z plane - relation between Z plane and S plane - mapping - correspondence between pole location in the Z plane and system time response - analysis of simple loop containing a discrete time controller. **9**

STABILITY ANALYSIS AND DESIGN

Jury's stability test - Schurcohn Stability test - discrete root locus - frequency response methods - bilinear transformation - LMI techniques - design using root locus and Bode plot- discrete Nyquist stability criterion. **9**

DISCRETE STATE SPACE ANALYSIS

Introduction - state space representation of discrete systems - canonical forms - state transition matrix - solving discrete time state equations. **9**

TOTAL : 45

TEXT BOOKS

- 1 Katsuhiko Ogata, "Discrete-Time Control Systems", II Edition, Pearson Education Asia, Singapore, 2005.
- 2 Gopal M, "Digital Control and State Variable Methods", III Edition, Tata McGraw Hill Publishing Co.Ltd., New Delhi, 2009.

REFERENCE BOOKS

- 1 Gene F. Franklin J. David Powell and Michael Workman, "Digital Control of Dynamic Systems", 3rd Edition, Addison Wesley Longman, 2006.
- 2 Benjamin C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press, 2007.
- 3 R. Isermann, "Digital Control", Vol 1 Narosa Publications, 1993

19EEE05 - SYSTEMS THEORY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Model the given physical system in state space.

CO2 : Identify the interaction between various elements in a control system and analyze its stability.

CO3 : Determine the controllability and observability of the given system.

CO4 : Design state feedback controllers and observers for the given system.

CO5 : Analyze the behavior of feedback controlled systems.

STATE-SPACE ANALYSIS

Overview of classical control systems - advantages of state model - concepts of state, state variables and state model - state model for linear time-invariant continuous time systems - transfer function from state model - state transition matrix - properties - solution of state equations. **9**

DESIGN OF CONTROL SYSTEMS IN STATE-SPACE

Linear transformation - invariance of state model - concept of controllability and observability - controllable and observable canonical forms - Kalman and Gilbert tests - pole-placement by state feedback - Ackermann's formula - full order and minimum-order state observers. **9**

PHASE-PLANE ANALYSIS

Nonlinear systems - common physical nonlinearities - jump resonance - phase plane and phase portraits - singular points - types - construction of phase trajectories: analytical, isoclines, delta methods - limit cycle oscillations - stability analysis. **9**

DESCRIBING FUNCTION METHOD

Basic concepts - derivation of describing functions for saturation, dead-zone, backlash, ideal relay, relay with dead-zone, relay with saturation, relay with hysteresis - stability analysis by describing function. **9**

LIAPUNOV STABILITY ANALYSIS

Concepts of definiteness of sign - quadratic forms - Liapunov theorems on the stability and instability of nonlinear systems - asymptotic stability of linear systems by the second method of Liapunov -Krasovskii's theorem on the global asymptotic stability of nonlinear systems - variable-gradient method for generating Liapunov functions. **9**

TOTAL : 45

TEXT BOOKS

1. J. Nagrath and M.Gopal, "Control Systems Engineering", New Age International, New Delhi, 6th edition 2018.
2. Roy Choudhury D, "Modern Control Engineering", Prentice Hall of India, New Delhi, 2009.

REFERENCE BOOKS

- 1 Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
2. John E. Gibson, "Nonlinear Automatic Control", McGraw-Hill Book Company, Inc, 1963.
3. Hassan K. Khalil, "Nonlinear Systems", 3rd Edition, Prentice Hall, 2002.
4. Yasumichi Hasegawa, "System Theory of Continuous Time Finite Dimensional Dynamical Systems", The Memories of Tsuyoshi Matsuo and R. E. Kalman, Springer, Cham, 2020.

19EEE06 - EMBEDDED CONTROL OF ELECTRIC DRIVES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Realize the fundamental concepts of electric drive systems and load dynamics

CO2 : Devise the solid-state speed control methods for DC motors using embedded controller

CO3 : Illustrate underlying Converter and Inverter principles for electric drives

CO4 : Infer the open loop and closed loop operation of synchronous motors using various methods

CO5 : Interpret the basic principle of operation and control of SRM Motor and BLDC Motor.

INTRODUCTION

Electrical Drives - Driving forces and evolving technologies - Advantages and application range of electric drives - Energy savings through drive system - Elements of drive system - Drive characteristics - Load dynamics and steady state stability - Multiquadrant operation - Electric motors for drives - Modern trends in industrial drives and control - Motor Control Sensors: Voltage, Current and Speed sensing - Evaluation of microcontrollers for motor control - Introduction of digital signal controllers based electric drive system

9

DC MOTOR DRIVES

Introduction to DC motor drives - Speed control of DC motor drive with controlled rectifiers and choppers - Embedded controller-based implementation of DC drives - Converter structure - Modes of operation - Control algorithm - Development of speed control algorithm for DC drives using digital signal controllers

9

INDUCTION MOTOR DRIVES

Speed Control Methods - PWM inverter fed induction motor drives - Vector control - Open loop and Closed loop PWM control - Sensor less IM drives: a study - Direct torque and Flux control - Space vector PWM control - Embedded controller-based speed control implementation for IM drive - Control algorithm of speed measurement during high speed/low speed regions - Development of closed loop control block using digital signal controllers.

10

SYNCHRONOUS MOTOR DRIVES

Open loop VSI fed drive and its characteristics - Self-control - Torque control - Torque angle control - Maximum Torque per Ampere control - Power factor control - Brush less excitation systems - Starting methods - Field oriented control - Design of closed loop operation of Synchronous motor drive systems. PM Synchronous Motor Drives: Types and Torque developed in PMSM - Stationary and rotor reference frame modeling of PMSM - PMSM control system.

10

SPECIAL MACHINES DRIVES

Switched Reluctance Motor drive: Fundamentals and control of SRM drives - Open loop and Closed loop torque and speed control. Brushless DC Motor Drives: Principle of operation - Torque generation - Open loop and Closed control of BLDC drive.

Stepper Motor Drives: Types and basic operation - Development of speed control algorithm for stepper motor drive using digital signal controllers.

8

TOTAL : 45

TEXT BOOKS

- 1 G.K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2014.
- 2 Bose B K, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2014
- 3 Vedam Subramaniam, "Electrical Drives and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
- 4 Werner Leonhard, "Control of Electric Drives", 3rd Edition, Springer, 2006.

REFERENCE BOOKS

- 1 G.K. Dubey, "Power Semiconductor Controlled Drives", 2nd edition Prentice Hall, Reprint 2018
- 2 R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press Taylor & Francis Group, 2017.
- 3 Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 3rd edition 2016.
- 4 S.K. Pillai, "A First Course on Electrical Drives", New Age International Publishers, 3rd Edition, 2012.
- 5 Richard Valentine, "Motor Control Electronics Handbook", McGraw Hill, New York, 2006.
- 6 Hamid A. Taliyat, Steven Campbell, "DSP - Based Electromechanical Motion Control", SRS Press, 2004.
- 7 Ertan, H.B., Üçtug, M.Y., Colyer, R., Consoli, A. (Eds.), "Modern Electrical Drives", Nato science series E, 2000
- 8 M.S.Berde, "Electric Motor Drives", Khanna publishers, New Delhi 1997.
- 9 P.C. Sen, "Thyristor DC Drives", John Wiley and Sons, New York, 1981.
- 10 J.M.D. Murphy, "Thyristor Control of AC Motor", Paragon Press, London, 1978
- 11 Data Manual of "TMS320 F 28335 Digital Signal Controllers", Texas Instruments, 2012. Available in <http://www.ti.com/DSC>.
- 12 Qian Cheng and Lei Yuan, "Vector Control of an Induction Motor based on a DSP", Master of Science Thesis, Chalmers University of Technology, Sweden, 2011.
- 13 Bob King and Edgar Saenz, "Stepper Motor Control with an MC68 HC 11E9 Microcontroller", Released by Free Scale Semiconductor document (AN 1285/D) available in <http://www.freescale/AN1245/D>.
- 14 M.N.Cirstea,et.al, "Neural and Fuzzy Logic Control of Drives and Power Systems" Newnes - An imprint of Elsevier Science, Oxford, 2012

19EEE07 - ROBUST CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Design a robust control using classical and state space approach.

CO2 : Design a roust control using linear quadratic approach

CO3 : Design a robust control using H-infinity methods

CO4 : Synthesize controllers by solving LMI problems for the given design specifications..

CO5 : Design a robust control for uncertain systems

OVERVIEW AND PRELIMINARIES

Overview on Robust control, Basics from Matrix Algebra, Norms of signals and systems. Classical Control, Root locus, Nyquist plots, Robustness and Disturbance rejection in SISO systems. Multivariable Linear Systems: Continuous time State space models, Discrete time state models. Transfer-functions, Frequency response, Poles, Zeros and Modes. Stability, Change of Basis, Controlloability Observability and Observer Feedback. Performance

12

LINEAR QUADRATIC CONTROL

The Linear Quadratic Regulator (LQR) problem: LQR solution using the minimum principle, Generalization of LQR; LQR properties with classical interpretations; Optimal observer design- Kalman-Bucy filter. The Linear Quadratic Gaussian (LQG) problem: Introduction, LQG problem formulation and solution, Performance and Robustness of optimal state feedback, Loop Transfer Recovery (LTR)

9

MODERN H_2 AND H_∞ OPTIMAL CONTROL

Modern H_2 and H_∞ optimal controller design and to LMI-based synthesis techniques for such controllers and for multi-objective design. Optimal regulator problem with finite time horizon, Riccati differential equation. Singular value plots, input and output directions; Mixed sensitivity design, H_∞ loop shaping, choice of weighting filters

12

LINEAR MATRIX INEQUALITIES

Design specifications as LMI constraints (H_2 , H_∞ and pole region); Controller synthesis by solving LMI problems, multi-objective design.

6

ROBUST CONTROL OF UNCERTAIN SYSTEMS

Small gain theorem, representation of parameter uncertainty; Balanced realization and model order reduction.

6

TOTAL : 45

TEXT BOOKS

- 1 *K. Zhou, J. Doyle, and K. Glover, "Robust and Optimal Control", Prentice-Hall, 2006.*
- 2 *G. E. Dullerud and F. Paganini, "A Course in Robust Control Theory: a convex approach", Vol. 36, Springer Science & Business Media, 2013.*
- 3 *Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", Pearson, 8th Edition, 2018.*

REFERENCE BOOKS

- 1 *J. Ackermann, "Robust Control - Systems with Uncertain Physical Parameters", Springer-Verlag, 1993*
- 2 *S. P. Bhattacharya, H. Chapellat and L. H. Keel, "Robust Control: The Parametric Approach", Prentice-Hall, PTR, NJ07458, 1995.*
- 3 *Andrzej Bartoszewicz, "Robust Control: Theory and Applications", InTech, 2011.*
- 4 *Basil Kouvaritakis, Mark Cannon, "Model Predictive Control - Classical, Robust and Stochastic", Springer, 2015.*
- 5 *Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 5th Edition, 2010*

19EEE08 - POWER QUALITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Realize the basic concepts of utility distribution and industrial power quality phenomena

CO2 : Classify the transients and elucidate the concepts and mitigation techniques

CO3 : Interpret the causes and consequences of short and long interruptions and able to choose suitable the mitigation techniques

CO4 : Identify the source, effects and mitigation techniques and explicate the earthing and bonding system

CO5 : Comprehend the need for monitoring the power quality and assess the power quality measurement data for any industrial plant

INTRODUCTION TO POWER QUALITY

Power Quality definition - Need for power quality - sensitive loads - Nonlinear loads - inter connected power systems - Deregulation - Power quality characteristics - types of power quality problems - Transients: Impulsive, Oscillatory - Voltage Variations-Short, Long Duration- Voltage Imbalance-Waveform Distortions:- DC Offset, Harmonics, Notching, Noise - Power Frequency Variations. Sources of power quality problems- Effects of power quality problems - Responsibilities of the suppliers and user of electrical power - power quality standards- Computer Business Equipment Manufacturers Associations (CBEMA) and ITIC curves- Cost of Poor Power Quality. **8**

TRANSIENTS

Definition - Power system transient model - Parameters-types - Causes of transients -Sources- Internal Capacitor switching transients- Transients from load switching- External - Lightning transients - Effects of transients- Mitigation- Principles of Protection -Insulation Coordination - Devices for over voltage protection- Standards. **9**

SHORT AND LONG DURATION INTERRUPTIONS

Short duration interruptions - Definition - Magnitude, Duration - Causes of voltage sag, swell and interruption- Sources of voltage sag and short interruptions - Voltage during fault and post fault period, Current during fault period - Effects of voltage sag and short interruptions- Overview of mitigation methods(Qualitative treatment only)-Standards and voltage sag indices. Long duration interruptions-Definition - Failure, Outage, Interruption - Origin of interruptions - Causes of long interruptions - Principles of regulating the voltage - Voltage regulating devices, Applications : Utility side, End-User side -Reliability evaluation - Cost of interruptions. **11**

HARMONICS AND GROUNDING

Harmonics-Description of the Phenomena -Parameters- Voltage Distortion - Current Distortion - Definitions and terms -Sources of Current and Voltage - Harmonics Sources - Effects of Harmonics- - Guidelines for harmonics voltage and current limitation- standards and measures IEEE and IEC standards.

Harmonic filters: Harmonic Distortion Evaluations-Devices for Controlling Harmonic Distortion- Passive, Active and hybrid filters (Qualitative treatment only)-Case Studies.

Grounding-Definitions and terms -Typical Earthing System- Reasons for grounding - National Electrical Code (NEC) grounding requirements - Utility Power system grounding - End-User power system grounding- Typical Wiring and Grounding Problems-Solutions to Wiring and Grounding Problems. **12**

POWER QUALITY MONITORING AND SURVEY

Introduction - Power quality monitoring- Monitoring Considerations - Evolution of power quality monitoring-
Brief introduction to power quality measurement equipments - Planning, Conducting and Analyzing power
quality survey - Assessment of Power Quality Measurement

Data - Utility-Customer interface-Introduction to thermo graphy in power quality assessment- Industrial
Case Studies-Power Quality Monitoring Standards. **5**

TOTAL : 45

TEXT BOOKS

1. Roger.C. Dugan, Mark.F. McGranaghram, Surya Santoso, H. Wayne Beaty, "Electrical Power Systems Quality", McGraw Hill, 3rd Edition, 2017.
2. C.Sankaran, "Power Quality" CRC Press, 2011, New York

REFERENCE BOOKS

1. Angelo Baggini, "Handbook of Power Quality" John Wiley & Sons, New York 2011.
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques" Wiley & Sons, United Kingdom, 2015.
3. Barry W. Kennedy, "Power Quality Primer" MC Graw Hill Publications, New York.2006
4. M.H.J.Bollen,"Understanding Power Quality Problems: Voltage Sags and Interruptions", Wiley,2011.
5. J.Arrillage, N.R.Watson And S.Chen, "Power System Quality Assessment", John Wiley&Sons,New York,2000.
6. Derek.A.Paice, "Power Electronic Converter Harmonics", IEEE Industrial Application Society, IEEE Press, New York 1996.
7. Short.T.A., "Distribution Reliability and Power Quality", CRC Press Taylor and Francis Group, 2006.
8. Fuch, Ewald, etal, "Power Quality in Power Systems and Electrical Machines" Academic Press / Elsevier, 2nd Edition, 2015.

19EEE09 - ADVANCED POWER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe different power semiconductor devices.

CO2 : Analyse resonant converters.

CO3 : Select appropriate phase shifting converter for a multi-pulse converter.

CO4 : Evaluate various multi-level inverter configurations.

CO5 : Comprehend various power electronic converters used for hybrid system. Compare various FACTS devices for VAR compensation.

EMERGING POWER SEMICONDUCTOR DEVICES

Power MOSFETs - IGBT - IGCT - IGET - ETO - MOS Controlled thyristor and their driver circuits - Intelligent power modules - Thermal design - protection - gating circuits - digital signal processors used in gate control - SiC and GaN power semiconductor devices. **6**

ADVANCED DC - DC AND RESONANT CONVERTERS

Non - isolated dc - dc converters: SEPIC, Zeta in DCM and CCM. Isolated dc - dc converters - SEPIC, Zeta, half bridge, push -pull and bridge in DCM and CCM-applications, merits and demerits. Zero voltage and Zero current switching - Classification of resonant converters - Basic resonant circuit concepts - Load resonant converters - Resonant switch converters - Zero voltage switching, Clamped voltage topologies - Resonant DC link inverters and Zero voltage switching - High frequency link integral half cycle converters - Applications in SMPS and lighting. **12**

POWER CONDITIONERS AND IMPROVED UTILITY INTERFACE

Single - phase, single - stage converters, Power factor correction at AC mains - Power line disturbances - Noise and Surge reduction - Power conditioners - Static Servo Stabilizer - Uninterruptable power supply (UPS) - Types - Design of UPS - Filter design. Generation of current harmonics - Current harmonics and power factor - Harmonic standards and Recommended practices - Need for improved utility interface - Improved single phase utility interface - Improved three phase utility interface - EMI and RFI. **9**

MULTI-LEVEL CONVERTERS AND MULTIPULSE CONVERTERS

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters. Concept of multi-pulse, Configurations for m- pulse (m=12,18,24) converters, Different phase shifting transformer (Y - Δ 1, Y - Δ 2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications **9**

FACTS DEVICES

Introduction - Principles of reactive power control in load and transmission line compensation - Series and Shunt reactive power compensation - Concepts of Flexible AC Transmission Systems (FACTS) - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitors (TSC) - Static VAR Compensators (SVC) - Static Synchronous Compensator (STATCOM) - Static Series Synchronous Compensator (SSSC) - Unified Power Flow Controller (UPFC) - Interline Power Flow Controller (IPFC). **9**

TOTAL : 45

TEXT BOOKS

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics Converters, Applications and Design", Wiley, India, 3rd Edition, New Delhi, 2012.
2. Euzeli dos Santos, Edison R. da Silva, "Advanced Power Electronics Converters: PWM Converters Processing AC Voltages "Wiley - IEEE Press, Newyork,2014.

REFERENCE BOOKS

1. Timothy. J.E. Miller, "Reactive Power Control in Electric Systems",BSP Books Pvt. Ltd., New Delhi, 2010.
2. Derek A. Paice, "Power Electronic Converter Harmonics - Multipulse Methods for Clean Power", IEEE Press, 1999.
3. James W. Clark, "AC Power Conditioners - Design and Applications", Academic Press Inc, California,1990
4. M. H. Rashid, "Power Electronics, circuits, Devices and Applications", Pearson India, New Delhi, 4th Edition,2014.
5. P.C. Sen, "Modern Power Electronics", S.Chand Publishers, 5th Edition, New Delhi, 2000.
6. N. G. Hingorani and L. Gyugyi, "Understanding FACTS",IEEE Press, Delhi,5th edition,2001.
7. A. I. Pressman, "Switch Mode Power Supply Design",McGraw - Hill, New York, 8th edition,2015.
8. J. Arrillaga, Y. H. Liu and N. R. Waston, "Flexible Power Transmission - The HVDC Options", John Wiley & Sons Ltd,Chichester, UK, 2007.
9. Vijay K. Sood, "HVDC and FACTS Controllers - Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Massachusetts, 2004.

19EEE10 - POWER AND ENERGY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify the demand supply gap of energy in current scenario.

CO2 : Carry out Auditing of energy equipment and to prepare energy flow diagrams and energy audit report

CO3 : Analyse the energy economic analysis methods and tools used.

CO4 : Evaluate the techno economic feasibility of the energy conservation technique adopted.

CO5 : Identify and evaluate the common energy conservation opportunities in different energy intensive industrial equipments

INTRODUCTION

Global energy scenario - Role of energy managers in industries - Energy forecasting - Limitations of energy resources - Renewable energy resources - Load management - Demand Side Management (DSM) - Energy conservation in realistic distribution system Energy monitoring - Auditing - Targeting - Energy pricing - Energy security. **9**

ENERGY AUDIT

Energy auditing - Data to be collected in auditing - Needs, methodology and types of audit - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications. **9**

ENERGY ANALYSIS

Real Factory Systems: Process system optimization - Electrical system optimization - Cogeneration - Heating, ventilation and air conditioning systems. Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Real buildings systems: Consumption - Cost vs lifecycle cost - Building design - HVAC systems - Water supply systems - Lighting systems. **9**

PLANNING AND MONITORING

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting - Elements - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM). **9**

OPPORTUNITIES

Supply Side: Methods to minimize supply - Demand gap, Renovation and Modernization of power plants - Reactive power management - Energy conservation in boilers, compressors, water heaters and coolers, HVAC and FACTS. Demand side: Energy conservation in Lighting, Motors, Pumps and Fan systems - Energy efficient motors. **9**

TOTAL : 45

TEXT BOOKS

1. *Amlan Chakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2018.*
2. *"General Aspects of Energy Management and Energy Audit", BEE Guide book, 2015.*
3. *Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2016.*

REFERENCE BOOKS

1. *Y P Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.*
2. *Craig B. Smith, Kelly E. Parmenter, "Energy Management Principles: Applications, Benefits, Savings", Pergamon Press, New York, 2015.*
3. *D. P. Sen Gupta, K. R. Padiyar, Indranil Sen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.*
4. *Albert Thumman, "Fundamentals of Energy Engineering", Prentice Hall, May 1984.*
5. *Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & Case study", Hemisphere, Washington, 1980.*
6. *Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988.*
7. *Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.*

19EEE11 - ENERGY STORAGE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Infer the need Energy storage and compare various energy storage methods

CO2 : Categorize the types of batteries and relate their usage for different applications by a proper mode

CO3 : Analyze different electric , magnetic & thermal energy storage systems and relate those in various applications..

CO4 : Select a suitable PCM for Energy storage and conservation

CO5 : Explain the working of fuel cells, flywheel and evaluate the energy storage technologies for power plant and heating applications.

ENERGY STORAGE: GLOBAL SCENARIO, NEED & INTRODUCTION

Energy production and consumption in various sectors, Projected energy consumption for the next century - Environmental issues: Ozone layer depletion and Global warming. Need for energy storage - Types of energy storage (Physical & Electrical systems) - Comparison of different energy storage technology- Energy and power balance in a storage unit - Mathematical model of storage - Econometric model of storage **8**

ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

Batteries: Basic concepts - Battery performance - Safety issues. Types of Batteries: Principle of operation- Primary, Secondary Batteries, Lithium, Solid - state and Molten solvent batteries; Lead acid batteries - Nickel Cadmium Batteries - Sodium ion batteries - Modern Batteries - Battery management system - generic model of a battery. **10**

MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS

Superconducting Magnet Energy Storage (SMES) systems - Capacitor and Batteries: comparison and application. Super Capacitor: Electrochemical Double Layer Capacitor (EDLC) - Principle of working, Structure, Performance, Application and Supercapacitor Stacking - Energy and Power Densities of Electrochemical Supercapacitors- Role of activated carbon and Carbon nano - tubes. **9**

THERMAL ENERGY STORAGE

Fundamental concepts - Types - Phase Change Materials (PCMs) and its properties- - Selection criteria of PCMs. Solar Thermal Latent Heat TES systems - Energy conservation through LHTES systems - LHTES systems in refrigeration and air - conditioning systems. - compressed air energy storage systems (CAES) **9**

OTHER ENERGY STORAGE TECHNOLOGIES AND APPLICATIONS

Fuel cells: Principle - Difference between batteries and fuel cells - Types of Fuel cells. Flywheel energy storage -hydrogen storage- conversion from hydrogen into electricity- Pumped storage system - Applications: Power plant applications, Green house heating, Heating applications in Industry, Food Preservation, Energy storage plug in hybrid Electric vehicles **9**

TOTAL : 45

TEXT BOOKS

1. Alfred Rufer, "Energy Storage Systems and Components" CRC Press, 2018
2. Glaize, C, "Lithium Batteries and other Electrochemical Storage Systems", Wiley Publications, 2013.
3. Ru - shiliu, Leizhang and Xueliang sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley publications, 2012
4. Ibrahim Dincer and Mark A. Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons, 2nd Edition, 2010.
5. Robert A. Huggins "Energy storage", Springer US, 1st Edition, 2010

REFERENCE BOOKS

- 1 Yasar Demirel, "Energy Production, Conversion, Storage, Conservation, and Coupling", Edition, Springer, 1st edition, 2012
- 2 Aiping Yu, Victor Chabot, and JiuJun Zhang, " Electrochemical Supercapacitors for Energy Storage and Delivery", CRC Press, 2013
- 3 Kordesch K and Simader G, "Fuel Cell and Their Applications", Wiley - Verlag publisher, Germany 1996
- 4 James Larminie and Andrew Dicks, "Fuel Cell Systems Explained", Wiley Publications, 2003.
5. A.G. Ter-Gazarian, " Energy Storage for Power Systems" 2nd Edition, The Institution of Engineering and Technology, 2011

19EEE12 - UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Illustrate the suitable lighting schemes and interpret the energy conservation measures.

CO2 : Analyze the electric motors' characteristics for traction system and explain the concepts of train movement and braking system.

CO3 : Classify the methods of heating and infer the applications of electrolysis

CO4 : Illustrate the energy audit procedure and describe the protocols of environment and climate change.

CO5 : Identify and analyze the energy conservation measures of various electrical systems.

ILLUMINATION

Terms and Definitions - Laws of illumination - Calculation of illumination - Choice of Lighting - Different types of lighting sources and Energy efficiency - Light control - Lighting Schemes - Street lighting and Flood lighting - Lighting standards for industries and commercial buildings - Energy conservation measures for lighting. **9**

ELECTRIC TRACTION

Choice of an Electric Motor - Traction Motors - Characteristics - Systems of railway electrification - Train movement and energy consumption: Speed time curves , Power and energy output from driving axles, Specific energy output and consumption - Electric braking - Aircraft electrical system **9**

HEATING AND ELECTROLYSIS

Methods of electric heating - Resistance heating - Arc furnaces - Induction heating - Dielectric heating. Faraday's laws of electrolysis - Applications of electrolytic Process: Electroplating, Production of metals, Electro forming, Anodizing- Current and Energy Efficiency - Power Supplies - Types of rectifiers. **9**

ELECTRICAL ENERGY AUDIT

Electricity billing, Electrical load management and Maximum demand control, Energy efficiency in electrical system and energy audit - Energy Conservation Act 2001 and its features - Energy and demand charges - Transmission and Distribution losses - Reactive power management for power factor correction - Environment and climate change - Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures - Prototype Carbon Fund (PCF). Government Schemes: Bachat Lamp Yojna - UJALA. **9**

ELECTRICAL ENERGY CONSERVATION

Energy Conservation potential in motors, Pumps, Fans and Compressors - Refrigeration and HVAC system - operation and maintenance practices for electrical energy conservation - Case studies. **9**

TOTAL : 45

TEXT BOOKS

1. J.B.Gupta, "Utilisation of Electric power and Electric Traction", S.K.Kataria and Sons, 2015
2. R.K.Rajput, "Utilisation of Electrical Power", Laxmi publications (P). Ltd., 2018

REFERENCE BOOKS

1. *A guide book on "Energy efficiency in electrical utilities" by Bureau of Energy Efficiency (BEE) , 2015*
2. *A guide book on "General aspects of energy management and energy audit" by Bureau of Energy Efficiency (BEE), 2015*
3. *C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International Pvt. Ltd., 2016.*
4. *Dr.N.V.Suryanarayana, "Utilisation of Electric power", Wiley Eastern Limited, New Age International Limited, 2018.*
5. *H.Partab, "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., New Delhi, 2016*

19EEE13 - ELECTRICAL SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify and analyze the precautions and protection of electrical hazards

CO2 : Select and use the suitable personal protective equipment according to the working environment

CO3 : Interpret the safety procedures for the specific work place

CO4 : Analyze and apply the various grounding techniques

CO5 : Infer the electrical safety against low voltage and high voltage and to manage the medical equipments

INTRODUCTION AND HAZARDS OF ELECTRICITY

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only) **9**

ELECTRICAL SAFETY EQUIPMENT

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials. **9**

SAFETY PROCEDURES

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit. **9**

GROUNDING AND ELECTRICAL MAINTENANCE

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing - Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard. **9**

VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure-Stationary battery safety - Accident prevention - Accident investigation - First aid - Rescue techniques - Electrical safety program structure and development - Safety meetings - Safety audits. **9**

TOTAL : 45

TEXT BOOK

1. *John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th edition, Mc Grew Hill, 2012*

REFERENCE BOOKS

1. *Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013*
2. *Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014*
3. *Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection association, Quincy, 2011*
4. *Electrical Safety booklets issued by Government bodies*

19EEE14 - ENERGY EFFICIENT LIGHTING SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.

CO2 : Perform the calculation of luminance parameters in various applications.

CO3 : Identify the criteria for selection of lighting equipment's and control systems in various applications.

CO4 : Impart design and technology for Interior lighting and Exterior lighting applications

CO5 : Review the various technologies used in Smart lighting systems.

INTRODUCTION: BASICS OF LIGHTING

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting. 7

LIGHTING CALCULATIONS AND LIGHT SOURCES

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software.

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps - Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy.

12

LIGHTING EQUIPMENTS AND STANDARDS

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system. 9

LIGHTING APPLICATIONS

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles. 8

SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting. 9

TOTAL : 45

TEXT BOOKS

1. *Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.*
2. *Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3^d Edition, 2008*
3. *Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press, Washington DC, 1st Edition, 2010.*
4. *Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.*

REFERENCE BOOKS

1. *Lighting Engineering: Practical Hand Book, INDALUX 2002*
2. *IES Lighting Handbook, 10th Edition, 2011.*
3. *NPTEL Course: Illumination Engineering*
4. *Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.*

19EEE15 - POWER SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After learning the course the students would be able to:

CO1 : Predicting the sizes and location of generating stations, substations.

CO2 : Illustrating of power system earthing and measurement of earthing resistance.

CO3 : Analyzing of insulation co-ordination.

CO4 : Interpretation of generation planning, transmission planning and distribution planning.

CO5 : Modeling of primary and secondary distribution network.

DESIGN OF POWER SYSTEM

Introduction-selection of sizes and location of generating stations-selection and specifications of transmission lines -sizes and location of substations, interconnection. **9**

POWER SYSTEM EARTHING

Objectives-definition- tolerable limits of body currents, soil resistivity, earth resistance, tolerable step, actual step and touch voltage-design of earthing grid-concrete encased electrode- tower footing resistance-measurement of earth resistance (R)-measurement of soil resistivity-impulse behaviour of earthing system. **9**

INSULATION CO-ORDINATION

Introduction, definitions- determination of line insulation-B.I.L and insulation levels of sub-station equipment-lightning arrester selection-power system overvoltage- tentative selection of arrester voltage ratings-selection of arrester discharge currents-arrester discharge voltage-establishment of impulse voltage level of equipment-protective margin-establishment of separation limits-location of lightning arrester. **9**

POWER SYSTEM PLANNING AND IMPROVEMENT

Introduction, methods of power system planning and improvement-power system improvement scheme, determination of the voltage regulation and losses in a power system-shifting of distribution transformer centre- financial aspects of the power system improvement scheme-Forecasting load and energy requirements-generation planning-transmission system planning-distribution system planning-reliability of electrical power systems-methods of measuring power system reliability **9**

DESIGN OF DISTRIBUTION SYSTEMS

Development of a distribution plan- transmission and distribution systems- types of distribution systems arrangements- primary distribution design- secondary distribution design- distribution substations-calculation of distributor sizes: voltage drops, voltage regulation, Lamp flicker **9**

TEXT BOOKS

1. *Electrical Power System Design* - M. V. Deshpande, TMH publication, 2001.
2. *Substation Design and equipment* - P. S. Satnam & P. V. Gupta, Dhanpat Rai and Co. 2018.

REFERENCE BOOKS

1. *Electrical Power System Analysis and Design* - B. R. Gupta, S. CHAND Publications, 6th Ed.2011.
2. *M.L. Sony, P.V.Gupta, V.S Bhatnagar and A.Chakraborti, "A Text Book on Power Systems Engineering", Dhanpat Rai and Co., Delhi, 1997 - 98.*
3. *Electrical Power System Planning* - A. S. Pabla, TMHpublication 1998.

19EEE16 - HIGH VOLTAGE TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Distinguish the layout of HVAC/HVDC systems and analyze the choice of EHV AC/HVDC transmission systems in practice.
- CO2** : Interpret an analysis on corona effects, construe the losses associated with transmission lines and suggest the appropriate conductors to meet the losses.
- CO3** : Demonstrate the power circle diagram and implement the circuitry for various controllers used in EHVAC transmission systems.
- CO4** : Plan an appropriate electric power transmission system between two destinations to satisfy the pre-defined load requirement without compromising the technical performance.
- CO5** : Comment over the causes of overvoltage, suggest the methods of protection and illustrate EHV cable transmission system.

EHVAC AND HVDC TRANSMISSION - INTRODUCTION

Introduction to EHVAC and HVDC transmission - Comparison between HVAC and HVDC overhead and underground transmission scheme - Standard transmission voltages - Factors concerning choice of HVAC - Block diagram of HVAC and HVDC transmissions schemes **6**

EHV LINE CONDUCTORS

Properties of bundled conductors - Inductance and Capacitance of EHV lines - Surface voltage gradient on single, double and more than three conductor bundles - Corona effects - Power loss - Increase in radius of conductor - Charge voltage diagram - Qualitative study of corona pulses, their generation and properties **8**

EHVAC SYSTEMS

Properties of EHVAC transmission at power frequency - Generalized constants - Power circle diagram and its use - Voltage control using compensators - High phase order transmission. **8**

HVDC SYSTEMS

Review of rectification and inversion process - Constant Current and Constant Excitation angle Modes of operations - Analysis of DC transmission systems - Harmonics on AC and DC sides and Filters for their suppression - Multiterminal DC transmission systems - Parallel operation of AC and DC transmission systems - Modern developments in HVDC transmission. **11**

OVER VOLTAGES & EHV CABLES

Overvoltage in EHV systems, origin and types - Ferro resonance overvoltage - Switching surges - Reduction of switching surges on EHV systems - Introduction to EHV cable transmission - Electrical characteristics of EHV cables - Properties of cable insulation materials - EHV insulators - Characteristics and pollution performance - Protection of HVAC and HVDC systems **12**

TOTAL : 45

TEXT BOOKS

1. *Begamudre, Rakosh Das, "Extra high voltage AC transmission engineering", 4th Edition, new academic science, 2013*
2. *S.Rao, "EHVAC and HVDC Transmission and Distribution Engineering (Theory, Practice and Solved Problems)", Khanna Publishers, 3rd Edition, 2004*
3. *Hao Zhou et al., "Ultra-high Voltage AC/DC Power Transmission" Springer-Verlag Berlin Heidelberg, 1st edition, 2018*

REFERENCE BOOKS

1. *Jos Arrillaga , "High Voltage Direct Current Transmission", 2nd Edition, Institution of Engineering and Technology, 2008*
2. *T.J.E.Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 2010*
3. *G.K.Dubey, S.R.Doraida, A.Joshi and R.H.K.Sinha, "Thyristorised Power Controllers", New Age International Publishers, 2012*
4. *K.R. Padiyar, "HVDC Power Transmission Systems", New Age International Publications, 3rd Edition, 2017.*

19EEE17 - DEREGULATED POWER SYSTEM

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe the role and essential of restructuring the power system.

CO2 : Identify the roles and responsibilities of different entities in power market

CO3 : Ascertain the security and describe ancillary service management in deregulated power system

CO4 : Recognize and interpret the importance of congestion management in deregulated environment.

CO5 : Comprehend the various pricing methods in deregulated power system

INTRODUCTION

Deregulation - Reconfiguring Power systems - Unbundling of electric utilities - Background to deregulation and the current situation around the world - Benefits from a competitive electricity market after effects of deregulation - Role of the independent system operator **9**

DEREGULATED POWER SECTOR

Separation of ownership and operation - Deregulated models - Operational planning activities of ISO: ISO in Pool markets - ISO in Bilateral markets - Operational planning activities of a GENCO - GENCO in Pool and Bilateral markets - market participation issues - competitive bidding- Power wheeling - Transmission open access - Pricing of power transactions **9**

SECURITY IN DEREGULATED POWER SYSTEMS

Security management in deregulated environment and congestion management in deregulation - Ancillary services management - General description of some ancillary services - Ancillary services management in various countries - Reactive power management in some deregulated electricity markets. **9**

TRANSMISSION CONGESTION MANAGEMENT

Definition of congestion - Reasons for transfer capability limitation - Importance of congestion management in deregulated environment - Effects of congestion - Desired features of congestion management schemes - Classification of congestion management methods **9**

PRICING OF TRANSMISSION NETWORK USAGE AND LOSS ALLOCATION

Power wheeling - Issues involved- Principles of transmission pricing - Classification of transmission pricing methods - Rolled-in transmission pricing methods: Postage stamp method, Incremental postage stamp method, Contract path method, MW-Mile method - Distance based
- Power flow based - Power flow tracing - Marginal transmission pricing paradigm - Composite pricing paradigm - Introduction to loss allocation - Classification of loss allocation methods. **9**

TOTAL : 45

TEXT BOOKS

1. Venkatesh P, Manikandan B V, Charles Raja S and Srinivasan, "A Electrical Power Systems Analysis, Security and deregulation", PHI Publications, 2nd Edition 2017
2. Tripathi M M, Restructured Power System and Electricity Market Forecasting Createspace Independent Publications, First Edition 2015

REFERENCE BOOKS

1. Pinni Srinivasa Varma and Sankar velamury, "Power System Deregulation Lap Lambert Academic Publishing", First Edition 2017
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
3. Kundur P "Power System Stability and Control", Tata McGraw Hill Third Edition 2012.
4. Mohammad Shahidehpour, M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", CRC Press, 2001
5. Daniel Kirschen and Goran Strbac, "Fundamentals of Power System economics" John Wiley & Sons Ltd, 2018.

19EEE18 - ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Apprehend the fundamentals and importance of electric vehicles and its components

CO2 : Select the suitable drive scheme based on the motor and topology for the given specification and applications

CO3 : Design and categorize the battery system for electric vehicles and hybrid electric vehicles

CO4 : Recognize the suitable battery charging scheme for different environments and applications.

CO5 : Describe the significance of E-mobility and its various business opportunities

ELECTRIC VEHICLES

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance - Gradability **9**

ELECTRIC PROPULSION

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives - Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- Matching the electric machine and the internal - combustion engine (ICE), Sizing the propulsion motor, sizing the power - electronics, selecting the energy storage technology, Communications- supporting subsystems **9**

BATTERIES

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices **9**

BATTERY CHARGING

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolated charger topology - Transformer less topologies. **9**

E-MOBILITY

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **9**

TEXT BOOKS

1. *Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition CRC Press, 2018.*
2. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021*

REFERENCE BOOKS

1. *James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd edition, Wiley, 2012*
2. *Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.*
3. *J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd edition, London, UK, 2010.*
4. *R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.*
5. *Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.*

19EEE19 - ENERGY AUDIT IN THERMAL AND ELECTRICAL UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Preaudit the energy

CO2 : Analyse the possibility of energy savings

CO3 : Analyze the methods of energy savings

CO4 : Design the solutions

CO5 : Identify and perform appropriate energy management

Energy Efficiency in Thermal Utilities -I

- Fuels and Combustion: Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal, and gas.
- Boilers: Types, combustion in boilers, performance evaluation, analysis of losses, feedwater treatment, blowdown, energy conservation opportunities..
- Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.
- Insulation and Refractories: Insulation-types and application, the economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss.
- FBC boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, Retrofitting FBC system to conventional boilers, saving potential. **9**

Energy Efficiency in Thermal Utilities -II

- Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate, and flash steam recovery system, identifying opportunities for energy savings
- Cogeneration: Definition, need, application, advantages, classification and saving potentials.
- Waste Heat Recovery: Classification, advantages, and applications, commercially viable waste heat recovery devices, saving potential.
- Energy Management & Audit: Definition, need and types of an energy audit. Energy management (audit) approach-understanding energy costs, benchmarking, energy performance, matching energy use to the requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.
- Material and Energy balance: Facility as an energy system, methods for preparing process flow, material, and energy balance diagrams. **9**

Energy Efficiency in Electrical Utilities

- Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.

- Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy-saving opportunities with energy-efficient motors.
- Energy-Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy-efficient motors, soft starters with energy savers, variable speed drives, energy-efficient transformers, electronic ballasts, occupancy sensors, energy-efficient lighting controls.

9

Energy Efficiency in Thermo Electric Utilities - I

- Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities
- HVAC and Refrigeration System: Vapor compression refrigeration cycle, refrigerants, the coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.
- Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system, saving potentially
- Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.
- Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

9

Energy Efficiency in Thermo Electric Utilities - II

- Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy-saving opportunities assessment of cooling towers.
- Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.
- Diesel Generating system: Factors affecting the selection, energy performance assessment of diesel conservation avenues

9

TOTAL : 45

Energy Performance Assessment for Equipment and Utility Systems

Open Book examination on the following energy performance assessments for equipment and utility systems:

- Boilers, Furnaces
- Cogeneration, Turbines (gas, steam)
- Heat Exchangers
- Electric Motors, Variable Speed Drives
- Fans and Blowers, Water Pumps, Compressors
- HVAC systems
- Lighting Systems
- Performing Financial Analysis.
- Applications of Non-conventional & Renewable Energy Sources (NRES)
- Waste minimization and resource conservation

TEXT BOOKS

1. *Mehmet Kano?lu, Yunus A. Çengel, "Energy efficiency and management for engineers", McGraw-Hill Education, 2020*
2. *Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Handbook", 9th edition, River Publishers, Taylore and Francis Group, 2020*
3. *Energy Efficiency in Thermal Utilities, Bureau of Energy Efficiency (BEE), Guide books*
4. *Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency (BEE), Guide books*

REFERENCE BOOKS

1. *Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2017*
2. *Wayne C. Turner," Energy Management Handbook", Eighth Edition, 2012*
3. *Stephen A. Roosa, Steve Doty, "Energy Management Handbook", 2018*
4. *General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency (BEE), Guide books*
5. *Energy Performance Assistance for Equipment and Utility Systems, Bureau of Energy Efficiency (BEE), Guide books*

19EEE20 - REAL TIME EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Illustrate embedded and real time system development processes.
- CO2** : Develop real time scheduling algorithms and Cite real life examples for real time systems
- CO3** : Outline program level optimization for low power consumption and build a reliable real time system.
- CO4** : Summarize real time kernel concepts and Use appropriate testing techniques to develop fault tolerant embedded systems.
- CO5** : Distinguish between traditional and real time databases problems

INTRODUCTION

Real life Examples for Embedded Systems - Real Time Embedded Systems - Developing Embedded Systems - Linkers and Linking process - Executable and Linking format - Mapping to Target embedded system - Embedded System Initialization - Target system tools - Boot Scenarios - System software initialization - On - chip debugging. **9**

RTOS

Structure of a real time system - Characterization of real time systems and tasks - Hard and Soft timing constraints -Foreground , Background Systems - Critical Sections - Resources - Tasks - Context Switching - Kernel - Round robin - Task priorities - EDF - RM scheduling - Deadlock - Inter task communication - Interrupts - Memory requirements - Real time Kernels summary. **9**

SOFTWARE PERFORMANCE OPTIMIZATION

Program Optimization - Program Level Performance Analysis: Elements of program performance - Measurement driven performance analysis Program Level Energy and Power Analysis - Analysis and Optimization of Program Size. **9**

RELIABILITY AND FAULT TOLERANCE

Metrics for Reliability - Faults, Failures, Bugs - Testing techniques - Fault tolerance - CPU testing - Memory testing - System integration tools. **9**

DESIGN EXAMPLES

Data compressor - Alarm clock - Cell phone - Compact disc - DVD - Digital still camera - Audio player - Video accelerator **9**

TOTAL : 45

TEXT BOOKS

1. Marilyn Wolf, "Computers as Components: Principles of Embedded Computer Systems Design", Morgan Kaufman Publishers, 2019.
2. C.M.Krishna and Kang G.Shin, "Real Time Systems", Tata McGraw Hill, 2019

REFERENCE BOOKS

1. Philip A.Laplante, "Real Time Systems Design and Analysis: An Engineers Handbook", Prentice Hall of India, 3rd Edition, New Delhi, 2018.
2. Jean J.Labrosse, "MicroC/OS - II - The Real - Time Kernel", CMP Books, 2nd Edition, 2018.
3. Qing Li , "Real time Concepts for Embedded Systems ", CRC Press, 2016.
4. David E. Simon, "An Embedded Software Primer" Pearson Education, 2016
5. Rajib Mall, "Real-Time Systems: Theory and Practice", First Edition, Pearson Education, 2012.
6. Jane Liu, "Real-Time Systems", First Edition, Prentice Hall, 2012.

19EEE21 -VLSI DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe the construction and working of MOS transistors

CO2 : Analyze the performance of VLSI subsystems

CO3 : Differentiate the logic implementation of commercial FPGAs

CO4 : Demonstrate the need for chip level and system level VLSI testing

CO5 : Compare the testing techniques for chip level and board level circuits

MOS AND CMOS CIRCUITS

nMOS, pMOS and CMOS Fabrication process - Electrical properties of MOS and BiCMOS circuits - nMOS inverter - pull-up to pull-down ratio - BiCMOS inverter - latch-up in CMOS circuits - stick diagrams - design rules and layout **9**

SUB SYSTEM DESIGN

Sheet resistance - capacitive loads - inverter delays - propagation delays - wiring capacitances. Switch logic - gate logic - combinational logic - structured design - clocked sequential circuits - bus drivers - power dissipation for CMOS and BiCMOS circuits - current limitations. **9**

PROGRAMMABLE LOGIC DEVICES

Programmable Logic Arrays (PLAs) - Programmable Array Logic Devices (PALs) - Complex Programmable Logic Devices (CPLDs) - 22V10 PAL Device - Altera MAX 7000 - Field Programmable Gate Arrays (FPGAs) - Altera Flex 10K, Xilinx XC4000 FPGA family architectures - Xilinx Spartan series FPGAs - Using CAD - Tools to implement circuits in CPLDs and FPGAs. **9**

VLSI SYSTEM TESTING

VLSI testing -need for testing, manufacturing test principles, design strategies for test, chip level and system level test techniques. **9**

TESTING TECHNIQUES

Basics of Testing: Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing. Classification of sequential ATPG methods. Fault collapsing and simulation **9**

TOTAL : 45

TEXT BOOKS

1. John F.Wakerly, "Digital Design Principles and Practices", 5th Edition, Pearson Education , 2018
2. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw-Hill Higher Education, 2013
3. N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.

REFERENCE BOOKS

- 1 Wayne Wolf, "Modern VLSI Design : System On-Chip Design", Pearson Education Asia Pvt. Ltd., 2008.
2. Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design",2006
3. W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers. 2006

19EEE22 - FPGA BASED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Distinguish FPGA and custom VLSI

CO2 : Illustrate the key features of FPGA fabrics

CO3 : Design data path controller using standard FPGA design techniques

CO4 : Outline the testing techniques for Electronic systems

CO5 : Perform system level design for real time application

INTRODUCTION

Digital Design and FPGA - Role of FPGA - FPGA Types - FPGA Vs Custom VLSI - Goals and Techniques - Design Challenges-Design abstraction - Methodologies **9**

FPGA FABRICS

FPGA Architectures - SRAM Based FPGA - Logic Elements - Interconnection Networks - Antifuses - Logic Blocks - Chip I/O - Logic Elements - Interconnect - Circuit Design - Architecture of FPGA Fabrics - Logic Element Parameters - Interconnect Architecture-Pin out. **9**

DATA PATH CONTROLLER

Behavioral Design - Data path controller Architecture - Scheduling and allocation - Power - Pipelining - Design methodologies - Processes - Standards - Verification Design Example: Digital Signal Processor. **9**

ELECTRONIC SYSTEM TESTING

Introduction-Integrated Circuit Testing-Printed Circuit Board Testing-Boundary Scan Testing- Software Testing **9**

SYSTEM LEVEL DESIGN

Introduction-Electronic System Level Design-Case Study-DC Motor Control-Digital Filter Design-Translation Automation **9**

TOTAL : 45

TEXT BOOKS

1. Wayne Wolf , "FPGA Based System Design" , Prentice Hall , Pearson Education, Inc. 2004.
2. Ian Grout, "Digital Systems Design with FPGAs and CPLDs", Elsevier, 2008
3. Stephen M. Trimberger, "Field-Programmable Gate Array Technology", Springer, 2012

REFERENCE BOOKS

- 1 Stephen Brown , "Fundamentals of digital logic with verilog design", McGraw Hill Education, 2017
2. Charles Roth, Lizy K. John, ByeongKil Lee, "Digital Systems Design Using Verilog", Global Engineering, 2014
3. John. F. Wakerly , " Digital Design", Pearson Education, India, 2012
4. Joseph Cavanagh, " Digital Design and Verilog HDL Fundamentals", CRC Press,2017

19EEE23 - ROBOTICS AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Recognize, identify and select the major components of a robot for system specifications.

CO2 : Model the kinematics and dynamics of manipulators.

CO3 : Plan manipulator trajectories based on the kinematics of the robot.

CO4 : Choose a specific robot controller for various applications.

CO5 : Employ sensors for real time robotic application to include artificial intelligence in expert systems.

INTRODUCTION

Introduction to robotics: Evolution of Robotics - Laws of Robotics - Classification - Robot Anatomy - DOF - Specification - Resolution - Repeatability and Precision movement. Introduction to robotic drives: Hydraulic, Electric and Pneumatic drives - Linear and Rotary actuators - End - Effectors. **9**

ROBOTIC ARM MODELING

Forward and Inverse Kinematics: Rotations and translation of vectors - Transformations and Homogenous transformations - Denavit - Hartenberg representation - Velocity kinematics - Manipulator Jacobian. Dynamics: Euler - Lagrange Equations - Equation of motion. (Algorithmic approaches only) **9**

ROBOTIC CONTROL

Trajectory planning - Control of robot manipulator: PID control scheme - Variable structure control - Resolved motion control - Computed torque control with effect of external disturbance - Force control of robotic manipulators - Sliding mode and Adaptive control. **9**

ROBOTIC SENSORS

Need for sensing system - Classification of robotic sensors - Status sensors, Environmental sensors, Quality control sensors, Safety sensors and Work cell control sensors - Non optical and Optical position sensors - Velocity sensors - Proximity sensors - Contact and Non-contact type sensors - Touch and Slip sensors - Force and Torque sensors - Selection of right sensors. Introduction to robotic vision systems: Stationary and Moving camera - Object recognition and categorization - Need for vision training and adaptation. **9**

ROBOTIC DESIGN AND APPLICATIONS

Robotic Design: System specification - Selection of Motor and Drive mechanism - Controller Design - Vision system consideration and Method of programming. Industrial Applications: Future scope of robotics - Safety in robotics - Robot intelligence and Task planning - Application of artificial intelligence and Expert systems in robotics. **9**

TOTAL : 45

TEXT BOOKS

1. Deb. S. R, "*Robotics Technology and Flexible Machine Design*", Tata McGraw Hill Publisher, paperback 2010.
2. Fu K.S, Gonzalez RC and Lee CSG., "*Robotics Control, Sensing vision and Intelligence*", McGraw Hill Publisher, 1987

REFERENCE BOOKS

1. Antoni Grau, Zhuping Wang, "*Industrial Robotics: New Paradigms*", BoD - Books on Demand, 2020.
2. Mikell. P. Groover, Michell Weis, Roger. N. Nagel and Nicolous G. Odrey, "*Industrial Robotics Technology, Programming and Applications*", McGraw Hill publisher, 2005
3. Richard D Klafter, Thomas A. Chmielewski and Michael Negin, "*Robotic Engineering: An Integrated approach*", Prentice Hall of India, New Delhi, 2005.
4. Krishna Kant, "*Computerized based Industrial Control*" PHI, 2nd edition, 2012.
5. Carol Fairchild, Dr. Thomas L. Harman, "*ROS Robotics By Example - Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame*", 2nd Revised, 2019.

19EEE24 - DIGITAL CONSUMER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe the concepts of audio, video and digital display devices

CO2 : Outline the working of digital display devices

CO3 : Categorize the digital devices for internet and PC and analyze their applications

CO4 : Identify applications of the domestic digital devices

CO5 : Assess the usage of emerging consumer devices for industrial applications

DIGITAL GENERATION AND CONSUMER DEVICES

Generation - Digitization of consumer products - Home networking - Era of digital consumer devices - Market Forecast - Market drivers - Success factors and challenges - Digital home. Perspective on global marketing - Process of consumer behavior - Connecting consumer research and consumer behavior. **9**

DIGITAL AUDIO AND VIDEO SYSTEMS

Microphones and Loud speakers - Construction, working principles and applications; Principles of digital audio systems - Internet audio formats and players - Components of MP3 - Components of digital TV - SDTV and HDTV technologies - Digital home theater systems. **9**

DIGITAL DISPLAY DEVICES AND DIGITAL IMAGING

LED Video - LCDs - Plasma Display Panels - Field Emission Displays - Digital light Processor - Comparison of different digital displays - Digital camcorders - Digital display interface standards. **9**

INTERNET AND PC DEVICES

Printers - Scanners - Smart Card readers - Benefits of using ebooks and challenges - Mobile phones and smart phone - DVD types and working, applications and challenges. **9**

EMERGING CONSUMER DEVICES

Net TV - Pen Computing and Digital notepad - Lighting control - Home control and security - Energy management systems - Home theatre and Entertainment - Vehicle Security - Home networking - PLC and Xilinx solutions. Geo - Spatial maps - Smart transportations. **9**

TOTAL : 45

TEXT BOOKS

1. Bali S.P, "Consumer Electronics", Pearson Education, India, 2010.
2. Amit Dhir, "The Digital Consumer Technology - Hand book", Elsevier Publications, 2004.

REFERENCE BOOKS

1. Gupta R.G, "Audio Video systems", Tata Mc Graw Hill Publisher, 2010.
2. R.R Gulati, "Color Television - Principles & Practice", Wiley Eastern Limited, New Delhi, 2003.
3. Thomas M. Coughlin, "Digital Storage In Consumer Electronics", Elsevier Publications, 2008.

19EEE25 - ELECTRONIC PRODUCT DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Integrate engineering principles with real applications from a systems perspective

CO2 : Fabricate printed circuit boards intended for projects in industries.

CO3 : Analyze different hardware design and testing methods.

CO4 : Analyze different software design and testing methods.

CO5 : Equip themselves with the different product testing methods.

PRODUCT DESIGN AND DEVELOPMENT

Overview of product ion development stages - Assessment of reliability - Ergonomic and aesthetic design - Techno commercial feasibility of a product - Quality assurance - Packing and storage - Estimating power supply requirement - HCMOS power dissipation - Power supply protection devices - Enclosure sizing and supply requirements - Selection of materials for enclosure - Noise reduction - Grounding, Shielding and Guarding Techniques - Thermal reduction. **9**

PRINTED CIRCUITED BOARD DESIGN PCB

Layout considerations - Issues related to PCB design - Parasitic elements in PCB due to vias - Parasitic elements in PCB due to traces - Multilayer PCB - Soldering Techniques - Automation in PCB design and manufacturing - High speed and EMI/ EMC considerations in PCB design - Packaging for semiconductor devices and IC's - Reliability issues in IC's - Introduction to SMD. **9**

HARDWARE DESIGN AND TESTING METHODS

Logic Analyzer - Digital Oscilloscope - Spectrum analyzer - Signal integrity issues - Mixed signal oscilloscope - Monte - Carlo Analysis - Evaluation of virtual instrumentation - Electronic gears. **9**

SOFTWARE DESIGN AND TESTING METHODS

Software design - Use of simulators - Use of emulators - Use of compilers - Algorithmic state machines - Finite state machines. **9**

PRODUCT TESTING

Environmental testing - Temperature testing - Humidity testing - Vibration test - Bump test - EMI/EMC Compliance testing - EMI/ EMC Test setup - Conducted emission test using time domain principle - Radiated emission test. **9**

TOTAL : 45

TEXT BOOKS

1. R.G. Kaduskar and V.B. Baru, "Electronic Product Design" Wiley India, 2nd Edition, New Delhi, 2014.
2. James Angus and Anthony Ward, "Electronic Product Design", CRC Press, 1996.
3. Bert Haskell, "Portable Electronic Product Design and Development", Mc. Graw Hill, 2004.

REFERENCE BOOKS

1. Anand M.S, "*Electronic Instruments and Instrumentation Technology*", Prentice Hall of India, 2004.
2. John R Barnes, "*Robust Electronic Design Reference Book*", Volumes I and II, Kluwer Academic Publishers, New York, 2004.
3. Ott H.W, "*Noise Reduction Techniques in Electronic System*", John Wiley & Sons, New York, 1988.
4. Bruce R Archambeault, "*PCB Design for Real - World EMI Control*", Kluwer Academic Publishers, New York, 2002.
5. Mourad Samiha and Zorian Yervant, "*Principles of Testing Electronic Systems*", John Wiley & Sons, New York, 2000.
6. Walter C.Bosshart, "*Printed Circuit Boards: Design and Technology*", Tata McGraw Hill, New Delhi, 2005.
7. Stillwell, Richard, "*Electronic Product Design for Automated Manufacturing*", United States, CRC Press, 2018.

19EEE26 - MEDICAL ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Differentiate and analyse the biomedical signal sources.*

CO2 : *Elucidate cardiovascular system and related measurements.*

CO3 : *Explain the brain, respiratory and nervous systems and related measurements*

CO4 : *Measure non-invasive diagnostic parameters.*

CO5 : *Recommend problem solving and service procedures for safety use of medical instruments as per medical standards.*

BIO-POTENTIAL MEASUREMENTS.

Basic components of a biomedical system - Cell Resting and action potentials - Physiological measurements
Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes- Electrode electrolyte interface and equivalent circuit- Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier - Different types of biotelemetry systems and patient monitoring, Use of Standard HL7. **9**

CARDIAC SYSTEM

ECG sources - Normal and Abnormal waveforms - Lead systems and recording systems - Cardiac pacemaker - External pacemaker - Implantable pacemaker - Different types of pacemakers - Fibrillation - Defibrillator - AC defibrillator - DC defibrillator - Arrhythmia monitor. **9**

NEUROLOGICAL SYSTEM AND SKELETAL SYSTEM

EEG - Wave characteristics -Frequency bands - Spontaneous and evoked response - 10-20% Lead system- Recording - Analysis of EMG waveforms - muscle latent velocity - Muscle and nerve stimulation - Fatigue characteristics **9**

RESPIRATORY MEASUREMENT AND VENTILATOR

Spirometer - Heart-Lung Machine - Oxygenators - Pnemograph - Artificial Respirator - IPR type - Functioning: Ventilators, Dialysis : Acute and Renal failure -Dialysis types and - Types of Machine - Blood Gas Analyser - pO₂, pCO₂, measurements. Finger-tip oximeter, ESR, GSR, measurements. **9**

THERAPHATIC AND MONITORING INSTRUMENTS

Electromagnetic and Ultrasonic blood flow meter - Equipment of physiotherapy - Transcutaneous Electric Nerve Stimulator (TENS) - Ultrasonic therapy - Extra corporeal shockwave lithotripsy - Diathermy - Audiometers - Medical Imaging: MRI and CT scan (Principle and Quantitative approach only) - Electrical safety Management and Maintenance: shock hazards, leakage current- safety of Medical Equipment. **9**

TOTAL : 45

TEXT BOOKS

1. *Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 3^d Edition, 2014.*
2. *Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2010.*

REFERENCE BOOKS

1. *John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2011.*
2. *Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and sons, New York, 2001.*
3. *Prof.Venkataram S.K, "Biomedical Electronics and Instrumentation", Galgotia Publications Pvt. Ltd., 2003.*
4. *Webb, Andrew G, " Principles of Biomedical Instrumentation. India", Cambridge University Press, 2018.*

19EEE27 - ANALOG AND DIGITAL COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Distinguish different analog modulation schemes for their efficiency and bandwidth.
- CO2** : Predict the behaviour of a communication system in presence of noise.
- CO3** : Evaluate pulsed modulation system and analyze their system performance.
- CO4** : Illustrate various optimal detection schemes.
- CO5** : Distinguish different digital modulation schemes and can compute estimate the bit error performance.
- CO6** : Distinguish different analog modulation schemes for their efficiency and bandwidth.

ANALOG MODULATION TECHNIQUES

Principles of Amplitude Modulation Systems - DSB, SSB and VSB modulations- Angle Modulation- Representation of FM and PM signals- Spectral characteristics of angle modulated signals- Noise in Analog Modulation - Review of probability and random process- Gaussian and white noise characteristics- Noise in amplitude modulation systems- Noise in Frequency modulation systems- Pre-emphasis and De-emphasis- Threshold effect in angle modulation. **9**

PULSE MODULATION

Sampling process- Pulse modulation (PAM, PCM, PWM, PPM) - Differential pulse code modulation- Delta modulation **9**

SIGNAL DETECTION THEORY

Elements of Detection Theory- ISI, Optimum detection of signals in noise - Coherent communication with waveforms- Probability of Error evaluations - Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion- Pass band transmission. **9**

DIGITAL MODULATION

Digital Modulation schemes : Phase Shift Keying, Frequency Shift Keying- Quadrature Amplitude Modulation - Continuous Phase Modulation and Minimum Shift Keying- Digital Modulation trade-offs. **9**

EQUALIZATION TECHNIQUES

Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver) - Equalization Techniques - Synchronization and Carrier Recovery for Digital modulation. **9**

TOTAL : 45

TEXT BOOKS

1. Haykin. S., "Communications Systems", John Wiley and Sons, 2009, 5th Edition.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002, 2nd Edition.

REFERENCE BOOKS

1. *B. Carlson, Introduction to Communication Systems, McGraw-Hill, 4th edition 2009.*
2. *Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, Third Edition(Reprint),2008.*
3. *Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication'', Kluwer Academic Publishers, 2004.*
4. *Proakis J.G., ``Digital Communications'', 4th Edition, McGraw Hill, 2001.*
5. *J.S.Beasley & G.M.Miler, Modern Electronic Communication, 9th edition, Prentice-Hall, 2008.*
6. *Grami, Ali, "Introduction to Digital Communications. Netherlands, Elsevier Science", 2015.*
7. *Douglas.V.Hall, "Microprocessors and Interfacing: Programming and Hardware", Revised second Edition, Tata McGraw Hill, NewDelhi, 2006.*

19EEE28 - MULTIMEDIA SYSTEM

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify the taxonomy of compression techniques and describe information theory

CO2 : Interpret audio and video compression techniques.

CO3 : Ascertain the different approaches to image and text compression

CO4 : Conceive the video compression techniques and outline the wavelet based Compression

CO5 : Analyze challenges of implementing Internet Protocol and discover the applications.

INTRODUCTION AND TEXT COMPRESSION

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Video and Digital Audio - Storage requirements for Multimedia Applications - Need for Compression - Taxonomy of compression techniques - Overview of information theory - Static Huffman coding - Dynamic Huffman coding - Lempel - Ziv coding - Lempel - Ziv Welsh coding. **9**

AUDIO COMPRESSION

Audio compression techniques - Frequency domain and filtering - Basic sub band coding - Application to speech coding - G.722 - Application of audio coding: MPEG audio - Silence compression - Speech compression techniques - Vocoders - Linear predictive coder **9**

IMAGE COMPRESSION

Approaches to image compression - Graphics interchange format - Tagged image file format, Digitized documents - Digitized pictures - JPEG - Quad trees - DCT coding - Wavelet methods - Filter banks - EZW coding - SPIHT coding - JPEG 2000 standards. **9**

VIDEO COMPRESSION

Video signal representation - Video compression techniques - MPEG1, 2, 4 - Motion estimation - H.261, H.263 - Overview of wavelet based compression - PLV performance real time compression. **9**

VoIP TECHNOLOGY

Basics of IP transport - VoIP challenges - H.323/ SIP Network Architecture, Protocols, Call establishment and release - VoIP and SS7 - Quality of Service - CODEC Methods - VoIP applicability **9**

TOTAL : 45

TEXT BOOKS

1. Fred Halsall and James F. Kurose, "Multimedia communication Applications, Networks, Protocols and standards", Pearson Education Limited, 2004.
2. Prabhat K Andleigh and Kiran Thakrar, "Multimedia Systems and Design", Prentice Hall of India, Reprint 2015.

REFERENCE BOOKS

- 1 Sayood Khaleed, "Introduction to Data Compression", Morgan Kauffman publication, 4th Edition, 2012
2. Tay Vaughan, "Multimedia: making it work", TMH, 7th Edition, 2007.
3. Marcus Goncalves, "Voice over IP Networks", McGraw Hill Publisher, 1999
4. Jerry D. Gibson, "Multimedia Communications: Directions and Innovations", Morgan Kaufmann Publication, 2nd Edition, 2001
5. David Solomon, "Data Compression the complete reference", Springer publisher, 4th Edition, 2007.

19EEE29 - AUTOMATION, RENEWABLE ENERGY AND FPGA LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

CO1 : Apply an industrial IoT to access the data via industrial IoT

CO2 : Develop a controller for a plant/actuator using PCS7

CO3 : Design combinational and sequential logical relations to be implemented in FPGA based on applications

CO4 : Design a controller in FPGA to control electric drives

CO5 : Illustrate the basic concept of renewable energy generated by solar, wind, battery and super capacitor-based power generation.

LIST OF EXPERIMENTS

Automation Lab

1. Access of Analog and Digital I/Os via Industrial IoT 2040 using Python, C/C++ compiler
2. Interfacing of IoT 2040 Gateway with Android Application.
3. Hardware configuration of PCS7 - combinational logics.
4. Design logic for traffic light controller using PCS7
5. Design a level process with PID controller for a real time plant
6. Study of Distributed Control System architecture and ES/OS Configuration of AS410 CPU in PCS7.
7. RF Communication and control of two end Nodes
8. Application server and End device Communication
9. Real time Data Monitoring and Device Control
10. Smart meter interfacing using LoRa
11. IoT based 1 phase pwm inverter

FPGA PROGRAMMING LAB

(Language: Verilog | Software: Xilinx | FPGA Board: Spartan 3E, Spartan 6)

1. Combinational circuits - Adders, encoders and decoders
2. Sequential circuits - counters and shift registers
3. Wallace Multiplier
4. 4-bit ALU
5. Programming an UART Module using FPGA
6. Analog input measurement using FPGA and data transfer to real time controller
7. PWM Generator for power electronic converters
8. Quadrature Encoder Interfacing Module
9. Speed control of Single Phase Induction Motor using FPGA
10. Speed control of Three Phase Induction Motor using FPGA
11. Speed control of DC Motor using FPGA
12. FPGA and IoT based static over current relay with test set-up

RENEWABLE ENERGY LAB

1. Characteristics of PV panel
2. Maximum power tracking of PV panel
3. Load test on Active front end PWM rectifier
4. Load test on Solar based DC-DC boost converter
5. Charging and Discharging Characteristics of bidirectional buck-boost converter for a super capacitor.
6. Study of transmission line simulator
7. Study of DC micro grid.

19EEE30 - COMPUTER ARCHITECTURE AND PARALLEL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Illustrate the basic computer organization and to design a micro sequencer based control unit

CO2 : Analyze and infer the various memory organizations

CO3 : Recall the concepts of various IO organizations

CO4 : Categorize the multiprocessor architecture and relate the performance

CO5 : Describe the concepts of parallel processing architecture

INTRODUCTION

Classes of computers - Defining Computer Architecture - Trends in Technology - Trends in Power and Energy in Integrated Circuits - Trends in Cost - Dependability - Measuring - Reporting and Summarizing Performance - Quantitative Principles of Computer Design. **7**

DESIGN OF CPU

CPU organization - General register organization - Stack organization - Instruction formats - Addressing modes - Data transfer and manipulation - Program control - Hardwired and micro programmed control. Design and implementation of basic micro sequencer - Designing mapping logic - Design of ALU - Look up Rom - Wallace trees - CISC and RISC characteristics. **9**

MEMORY AND I/O ORGANIZATION

Memory Hierarchy - Main memory - Cache memory - Virtual memory concepts - IO interface - Modes of data transfer - Programmed IO and Interrupt driven data transfer - Direct memory access - Asynchronous data transfer - IO processor and IO channels. **9**

MULTIPROCESSOR ARCHITECTURE

Organization of multiprocessor system - Interconnection networks - Multiprocessor scheduling strategies - Shared memory architecture - Symmetric shared memory and distributed shared memory - Cache coherence - Snooping and directory based cache coherence - Synchronization - Parallel memory organization **10**

PARALLEL PROCESSING ARCHITECTURE

Principles of pipelining - Implementation - Pipeline hazards and resolution - Performance issues - Instruction level parallelism and thread level parallelism - Instruction prefetch and branch handling - Vector processor - Effectiveness of vectorization - Array processor - Parallel algorithms - Bubble sort - matrix multiplication - Superscalar processor. **10**

TOTAL : 45

TEXT BOOKS

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd Edition, 2017
2. John L Hennessy and David A Patterson, " Computer Architecture: A quantitative approach", Morgan Kaufmann publishers, 5th Edition, 2018.
3. David. A. Patterson, John L. Hennessy, "Computer Architecture: A Quantitative approach", Fifth Edition, Elsevier, 2018.

REFERENCE BOOKS

1. *Kai Hwang and Faye A. Briggs, "Computer Architecture and Parallel Processing", Tata McGraw Hill, 2018.*
2. *Carl Hamacher, Zvonko Vranesic, Safwatzaky, "Computer Organization", McGraw Hill, 6th Edition, 2016.*
3. *John D Carpinelli, "Computer system Organization and Architecture", Pearson Education, India. 2016.*

15EEE31 - MULTICORE ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify the problems related to multiprocessing and describe the concepts of shared memory

CO2 : Illustrate the thread - level parallelism

CO3 : Formulate various programming constructs in multi-core architecture.

CO4 : Describe various memory architectures

CO5 : Summarize various multicore programming models for given specifications.

SUPERSCALAR PROCESSORS

Fundamentals of Superscalar Processor Design - Introduction to Multi core Architecture - Chip Multiprocessing - Homogeneous Vs heterogeneous design - SMP - Multi core Vs Multithreading. **9**

MEMORY ORGANIZATION

Shared memory architectures - Synchronization - Memory organization - Cache Memory - Cache Coherency Protocols - Design of Levels of Caches. **9**

PARALLEL PROGRAMMING

Fundamental concepts - Designing for threads - scheduling - Threading and parallel programming constructs - Synchronization - Critical sections - Deadlock - Threading APIs **9**

POWER PC ARCHITECTURE

RISC design - PowerPC ISA - PowerPC Memory Management - Power Multi core architecture design - Power 6 Architecture. **9**

PROGRAMMING SUPPORT FOR MULTI - CORE/MANY - CORE PROCESSORS

Cell Broad band engine architecture - PPE (Power Processor Element) - SPE (Synergistic processing element) - Cell Software Development Kit - Programming for Multi core architecture. **9**

TOTAL : 45

TEXT BOOKS

1. Hennessey & Patterson, "Computer Architecture A Quantitative Approach", Harcourt Asia, Morgan Kaufmann publication, USA, 2018.
2. Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw - Hill Publications, 2014.

REFERENCE BOOKS:

- 1 Michael J Quinn, "Parallel programming in C with MPI and OpenMP", Tata McGraw Hill, 2015
- 2 Joseph JaJa, "Introduction to Parallel Algorithms", Addison - Wesley publisher, 2012.
- 3 IBM Journals for Power 5, Power 6 and Cell Broadband engine architecture.2015.
- 4 Richard Y. Kain, "Advanced Computer Architecture: A System Design Approach", PHI, 2012
- 5 Rohit Chandra, Ramesh Menon, Leo Dagum, and David Kohr, "Parallel Programming in Open MP", Morgan Kaufmann Publication, 2016.

19EEE32 - DATA COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Explain the need for the OSI model and the functions performed by each layer of the OSI model.

CO2 : Realize the basic network concepts and their transmission mode.

CO3 : Evaluate the signal conversions and understand the transmission of signals through different cables.

CO4 : Describe the different networking and internetworking devices and their applications.

CO5 : Explain the process of communication from source to destination through various layers of the communication protocol.

BASIC CONCEPTS

Introduction - Line configuration topology - Transmission mode - Categories of networks - Internetworks - OSI Model and Functions of the Layers. **9**

SIGNALS AND TRANSMISSION

Various types of signals - Analog to Digital and Digital to Analog conversion - Interfacing - Co - Axial Cables - Fibre Optics - Wireless - Multiplexing - Error detection and correction. **9**

DATA LINK CONTROL AND PROTOCOLS

Flow control - Error control - Asynchronous protocols - Synchronous protocols - Character and Bit oriented protocols - TCP / IP Protocol - Point to Point protocol - X.25 Protocol. **9**

NETWORK AND SERVICES

Local Area Network - Ethernet - Token ring - Token bus - Fibre Distributed Data Interface - Metropolitan Area Networks - IEEE 802.16 - Switching - Integrated Services Digital Network - Asynchronous Transfer. **9**

NETWORKING AND INTERNETWORKING DEVICES AND APPLICATIONS

Repeaters - Bridges - Routers - Gateways - Routing algorithm - Distance vector and link state Routing - Client - Server model - Domain Name System - Simple Mail Transfer Protocol - Simple Network Management Protocol - Hypertext Transfer Protocol - World Wide Web. **9**

TOTAL : 45

TEXT BOOKS

1. William A.Shay, "Understanding Data Communications and Networks", Brooks /Cole Publishing Company, 2008.
2. Behrouz. A. Forouzan, "Data Communications and Networking", 5th Edition, Tata McGraw Hill Publisher, 2017.
3. Curt White, "Fundamentals of Networking and Data Communications", South-Western College Publishing, 2013.
4. William Stallings, "Data and Computer Communications", 10th Edition, Prentice Hall of India, New Delhi, 2014.
5. A.S. Tanenbaum, "Computer Networks", Prentice Hall of India, 6th Edition, New Delhi, 2020.

REFERENCE BOOKS

1. S.Keshav,"An Engineering Approach to Computer Networking", Addison Wesley, 2010.
2. Srikant and Lei Ying, "Communication Networks: An Optimization, Control and Stochastic Networks Perspective", Cambridge University Press, UK,2014
3. Larry L. Peterson and Bruce S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Elsevier, 2012.
4. Dimitri Bertsekas and Robert Gallager,"Data Networks", Prentice Hall of India", 2nd Edition, 2004.

19EEE33 - FOG COMPUTING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Describe the knowledge in systems, protocols and mechanisms which supports fog computing

CO2 : Illustrate major security and privacy problems in the fog computing scenarios and how they are addressed with the security mechanisms.

CO3 : Identify the high level architecture of fog computing models.

CO4 : Formulate the cloud providers and software platforms.

CO5 : Design and implement a computing applications novel fog

INTRODUCTION

Introduction to Fog Computing / Network - Definitions - Characteristics - Four layer fog computing architecture in smart cities **9**

SEVEN LAYER FC

Physical Devices & Device Controllers - Connectivity - Edge (Fog) Computing - Data Accumulation - Data Abstraction - Application- Collaboration & Processes - Interaction between each level. **9**

IoT FOR FC

IoT/IoE applications on the fog infrastructure - Cloud and IoT estimation - Comparison with Cloud Computing (CC) - Benefits of using Fog Computing. **9**

CHALLENGES & SOFTWARE PLATFORMS

Overview and Comparison of Microsoft Azure - Amazon Web Services - Google Cloud Platform - Security and Reliability - Storage - Monitoring and Automation - Introduction to Open-source softwares: Eucalyptus - Open Nebula - Open Stack - Apache Cloud Stack. **9**

APPLICATIONS

Healthcare and Activity Tracking - Smart utility services - Augmented reality - Caching and Preprocessing - Cognitive systems and Gaming. **9**

TOTAL : 45

TEXT BOOKS

1. Amir Vahid Dastjerdi, Harshit Gupta, Rodrigo N. Calheiros, Soumya K. Ghosh, and Rajkumar Buyya, "Fog Computing: Principles, Architectures and Applications", Morgan Kaufmann Publications, Burlington, Massachusetts, USA.28 Jan 2016.
2. Amir Vahid Dastjerdi and Rajkumar Buyya, University of Melbourne "Fog Computing: Helping the Internet of Things Realize its Potential" on IEEE Computer Society,2016

REFERENCE BOOK

- 1 Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly, 2009.

19EEE34 - INTERNET OF THINGS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify the architecture, emerging industrial infrastructure and challenges involved in deployment of IoT.

CO2 : Interpret the use of devices, gateways and hardware design constraints in IoT.

CO3 : Describe the design principles to realize enterprise integrated Web of Things

CO4 : Demonstrate the technical design constraints involved in IoT based industrial automation

CO5 : Apply the application of IoT in Industrial and Commercial Building Automation

M2M To IoT

Introduction - Architecture of IoT - Challenges of IoT - M2M to IoT - IoT global context - Differing Characteristics - Deployment and Operational - IoT reference Model and architecture **9**

IoT FUNDAMENTALS

Devices and gateways - Local and wide area networking - Data management - Business processes in IoT - Everything as a Service (XaaS), M2M and IoT Analytics - Knowledge Management. **9**

DESIGN PRINCIPLES

An emerging industrial structure for IoT - The international driven global value chain - Global information monopolies - Building architecture - Design principles - Needed capabilities, Standards considerations. **9**

DESIGN CONSTRAINTS

Technical Design constraints - Hardware Design constraints - Data representation and visualization - Interaction and remote control. Introduction to Python and Library files and its applications. **9**

INDUSTRIAL AUTOMATION

Middleware - Service - oriented architecture based device integration - SOCRADES - Realizing the enterprise integrated Web of Things - IMC - AESOP - Web of Things to the Cloud of Things.

Case study: Cisco IoT System, Network connectivity, IOx and Fog Applications, Data analytics, Security, Cyber and Physical Management and Automation - Application platform. **9**

TOTAL : 45

TEXT BOOKS

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatias Karnouskos and David Boyle, "From Machine -to - Machine to the Internet of Things: Introduction to a New Age of Intelligence", Academic Press, 1st Edition, 2014.
2. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands - on - Approach)", VPT, 1st Edition, 2014.

REFERENCE BOOKS

- 1 Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", A - press Publications, 1st Edition, 2013.
2. J.P. Vasseur, A. Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kaufmann, 2010.

19EEE35 - DATA ANALYTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify big data and its analysis techniques.

CO2 : Apply Probability and Statistics in Data Analysis

CO3 : Analyze the data for machine learning algorithms.

CO4 : Justify the performance measure of algorithms using Python language

CO5 : Identify appropriate data in real life applications

TECHNOLOGY FOUNDATION FOR BIG DATA

Fundamentals of Big Data - Classification and characteristics of Big Data -Types of Data Analysis - Introduction to Opensource frameworks - Hadoop Environment - Mapper - Reducer - Combiner - Partitioner - Searching - Sorting - Compression - Hive - Introduction to features of MongoDB, Cassandra, Spark, Kafka **9**

MATHEMATICAL FOUNDATIONS

Population and Sample - Measures of Central Tendency - Measures of Deviation - Measures of Shape - Correlation Analysis-Bayes Theorem - Probability Density functions and distributions - Hypothesis Testing - Dimensionality Reduction - Principal Component Analysis - Analysis of Variance (ANOVA) **9**

DATA ANALYSIS IN MACHINE LEARNING

Overview of Machine learning concepts - Bias/variance, over fitting and train/test splits - Types of Machine learning - Supervised, Unsupervised, Semi-supervised- Classification and Regression algorithms-Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees - Metrics - Linear Regression-model assumptions - Regularization (lasso, ridge, elastic net) - Analysis of Time Series - Bagging and Boosting (to balance bias and variance) and random forest - Neural Networks-Learning And Generalization, Overview of Deep Learning - Unsupervised learning: K Means and Hierarchical clustering - Reinforcement learning **9**

PROGRAMMING TOOLS FOR DATA SCIENCE

Visualizing Data: Bar Charts, Line Charts, Scatter plots - Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction - Basics of Python (file handling, case- folding, spell check, split, strip, Regex, find, replace, etc.) - Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK **9**

APPLICATIONS OF DATA ANALYTICS

Solar and Wind Forecasting algorithms - Naïve Bayes algorithms for Protective Relay - Connected homes - Smart thermostats - Wearable's: Fitness bands - Real - time analytics and Industrial automation - Connected cities - Smart meters - Connected cars - Fleet management. **9**

TOTAL : 45

TEXT BOOK

1. U.Dinesh Kumar, " Business Analytics- The Science of Data - Driven Decision Making", Wiley, 2018

REFERENCE BOOKS

1. Goldman Sachs, *"Big Data Analytics and the Internet of Things"*, Datameer, 2015.
2. Robert Stackowiak, Art Licht, Venu Mantha and Louis Nagode, *"Big Data and The Internet of Things: Enterprise Information Architecture for A New Age"*, A press, 2015.
3. Michael Wessler, OCP & CISSP, *"Big Data for Dummies"*, John Wiley & Sons, Inc, 2013.
4. Grolemond and Garrett, *"Hands - On Programming with R"*, O'Reilly Media, 2014.
5. Ebook: Dr. Mark Gardener *"Beginning R: The Statistical Programming Language"*, ISBN: 978 - 1 - 118 - 16430 - 3, 2012.
6. Judith Hurwitz, Alan Nugent, and Dr. Fern Halper, *"Big Data for Dummies"*, John Wiley & Sons, Inc, 2013.
7. Seema Acharya, Subhashini Chellappan, *" Big Data and Analytics"*, Wiley,2018

19EEE36 -VIRTUAL INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Summarize the fundamental concepts of Digital and Virtual Instrumentation.

CO2 : Compare the interfacing of RS232, RS 422, RS 485 and USB standards with PC.

CO3 : Recall the concepts of various bus protocol implementations in virtual instrumentation.

CO4 : Choose the data acquisition components for the given application.

CO5 : Develop and emulate the real-time hardware applications virtually using LabVIEW Software.

REVIEW OF DIGITAL INSTRUMENTATION

Representation of PC based DAQ System - Sampling theorem - Linearization and Quantization of amplitude and time - Analog I/O - Digital I/O - Counter/timer - DAQ software architecture - Networked data acquisition.

9

FUNDAMENTALS OF VIRTUAL INSTRUMENTATION

Concept of virtual instrumentation-PC based data acquisition-Typical onboard DAQ card-Resolution and Sampling frequency-Multiplexing of analog inputs-Single-ended and Differential inputs-Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer - counter and analog outputs on the universal DAQ card.

9

CLUSTER OF INSTRUMENTS IN VI SYSTEM

PC Interfacing - RS232, RS422, RS485 and USB standards - IEEE 488 standard-ISO-OSI model for serial bus-Introduction to bus protocols of MOD Industrial Ethernet-CAN.

9

GRAPHICAL PROGRAMMING ENVIRONMENT IN VI

Concepts of graphical programming-Lab-view software-Concept of VI's and sub VI-Display types-Digital and Analog Chart- Oscilloscope types - Loops - Case and sequence structures - Types of data - Arrays - Formulae nodes - Local and global variables - String and File I/O.

9

ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI

Fourier transform - Power spectrum - Correlation - Windowing and filtering tools - Simple temperature indicator - ON/OFF controller - PID controller - CRO and DSO emulation - Simulation of a simple second order system -Signal generation.

9

TOTAL : 45

TEXT BOOKS

1. Robert H. Bishop, "Learning with Lab - view", Prentice Hall, 1st Edition,2014.
2. Jovitha Jerome, "Virtual Instrumentation using LabVIEW", PHI Learning Pvt. Ltd.,2010

REFERENCE BOOKS

1. KevinJames, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes publications,2000.
2. Gary W.Johnson, Richard Jennings, "Lab-view Graphical Programming", McGraw Hill Professional Publishing, 4th Edition, 2011.
3. Sanjay Gupta and Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw - Hill Inc,2010.

19EEE37 - CYBER PHYSICAL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Interpret the core principles behind CPS

CO2 : Identify the components required to build CPS

CO3 : Identify safety specifications and critical properties

CO4 : Inference the abstractions in CPS design

CO5 : Inference the pre- and post-conditions and invariants for CPS models

INTRODUCTION TO CYBER-PHYSICAL SYSTEMS

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, Auto-SAR, IIoT implications, Building Automation, Medical CPS **7**

CPS - PLATFORM COMPONENTS

CPS Hardware platforms - Processors, Sensors, Actuators, CPS Network - Wireless Hart, CAN, Automotive Ethernet, CPS Software stack - RTOS, Scheduling Real Time control tasks. **9**

PRINCIPLES OF AUTOMATED CONTROL DESIGN

Dynamical Systems and Stability Controller Design Techniques, Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise, State flow **9**

CPS IMPLEMENTATION

From features to software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion **9**

SAFETY ASSURANCE OF CYBER-PHYSICAL SYSTEMS

Advanced Automata based modeling and analysis, Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, Formal Analysis: Flow pipe construction, reachability analysis, CPS SW Verification, Frama-C, CBMC Secure Deployment of CPS **11**

TOTAL : 45

TEXT BOOKS

1. Raj Rajkumar, Dionisio De Niz , and Mark Klein, "Cyber-Physical Systems", Addison-Wesley Professional, 2016.
2. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015.
3. Lee E A and Seshia S A, "Embedded Systems: A Cyber-Physical Systems Approach", MIT Press, 2017.

REFERENCE BOOKS

- 1 André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics., Springer, 2010,ISBN 978-3-642-14508-7.
2. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme, 2011.
3. P. Tabuada, Verification and control of hybrid systems: a symbolic approach, Springer-Verlag 2009
4. A.J. van der Schaft, J.M. Schumacher, An Introduction to hybrid dynamical systems, Lecture Notes in Control and Information Sciences, Vol. 251, Springer-Verlag, London, 2000.
5. Borrell F, Bemporad A and Morari M, Predictive control for Linear and Hybrid Systems, Cambridge University Press (2017)

19EEE38 - INTELLIGENT TECHNIQUES FOR ELECTRICAL ENGINEERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Interpreting the basics of intelligent techniques and the role of artificial intelligence in industrial controllers..

CO2 : Explain the fundamental modeling of a controller using fuzzy, expert systems and neural systems

CO3 : Apply the fundamental of fuzzy logic and reasoning to handle uncertainty and solve the control engineering problems

CO4 : Implementing genetic algorithms to basic optimal control problems.

CO5 : Outline the basic concepts of a heuristic algorithm to solve engineering problems

INTRODUCTION TO AI & EXPERT SYSTEMS

Introduction to Artificial Intelligence and Computational Intelligence -Expert Systems - Fundamental Concepts, Architecture - Knowledge Base - Inference Engine Components and Mechanisms - Expert Systems Application - Expert System for Control in Power Systems. **9**

NEURAL NETWORKS

Biological neurons - NN terminology, Activation functions, Fundamental models; Architectures - Feed forward & Feedback NN, Types of NN based on learning methods, Applications of NNs- Identification, Control - Case Study - Neural Network Applications for Power System Monitoring and Control. **9**

FUZZY SYSTEMS

Introduction - Fuzzy versus Crisp, Fuzzy sets, Fuzzy relations, Fuzzy Systems: Fuzzy logic- universe of discourse, membership function, Quantifiers, Inference, Fuzzy Rule based system, Defuzzification methods, Fuzzy Controller, Constructing Fuzzy Model, Application of Fuzzy Logic in Control System. **9**

DECISION TREES & MULTIAGENT SYSTEMS

Introduction - Decision Trees - Construction - Pruning - Oblique Decision Trees - Applications of Decision Trees in Power Systems - Introduction to Multiagent Systems, Multiagent Technology Overview - Applications of Multiagent Systems in Power Engineering **9**

HEURISTIC OPTIMIZATION TECHNIQUES

Introduction to Genetic Algorithm; GA steps - Selection, Crossover and Mutation; Application of GA to optimal control problems - Particle Swarm Optimization, Ant Colony Algorithm, Unsupervised Learning and Hybrid Methods. **9**

TOTAL : 45

TEXT BOOKS

1. Michael Negnevitsky, "Artificial Intelligence-A Guide to Intelligent Systems", Addison-Wesley, 3rd Edition, 2011.
2. Simon Haykin, "Neural Networks & Learning Machines", Pearson Education, 3rd Edition, 2016.

3. John Yen Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley & Sons, 4th Edition, 2016
4. Omid Bozorg - Haddad, Mohammad Solgi, "Meta-Heuristic & Evolutionary Algorithms for Engineering Optimization", John Wiley & Sons, 2017

REFERENCE BOOKS:

- 1 Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson, 2015.
- 2 George J. Klir and Bo Yuan, "Fuzzy sets and Fuzzy Logic", Prentice Hall, Pearson, 2015
- 3 B. Yegnanarayana, "Artificial Neural Networks", PHI Learning Pvt. Ltd., 2009.
- 4 Xin-She Yang, "Nature-Inspired Optimization Algorithms", 1st Edition, Elsevier, 2014
- 5 Ben Coppin , "Artificial Intelligence Illuminated", Jones & Bartlett Learning, 2004.
- 6 S. N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", 3rd Edition, John Wiley & Sons, 2018

19EEE39 - INDUSTRIAL AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Design and develop a suitable controller for automated system involving different disciplines to achieve more reliable and flexible system.
- CO2** : Demonstrate hardware design, understand its internal operation and employ PLC programming for factory automation, process control and fault detection.
- CO3** : Comprehend and define business strategies and plan toward the Fourth Industrial Revolution.
- CO4** : Discuss the fundamental requirements of process control systems and describe the architecture of various distributed control systems.
- CO5** : Choose suitable automation hardware for the given industrial application.

BUILDING BLOCKS OF AUTOMATION SYSTEM

Automation strategies - Production economics - Costs in manufacturing - Break Even analysis. Smart Sensors, Transducers and Motion Actuators - PID Controller - Digital PID Controller. Multi microprocessor Systems - Local Area Networks - Analog and Digital I/O Modules - Supervisory Control and Data Acquisition Systems - Remote Terminal Unit - Intelligent Electronic devices (IEDs)-Industrial Process Models. **9**

PROGRAMMABLE CONTROLLERS

Introduction - Relay logic - PLCs - hardware design - Programming of PLCs - PLCs Internal operation and signal processing - Programming of PLC Systems. Application to Robotics and FMS - PLC to factory automation - PLC in process control - PLC maintenance - Internal PLC faults - Faults external to PLC - Programmed error - Watch dogs - Safety - Hardware safety circuits - Troubleshooting. **9**

DISTRIBUTED CONTROL AND INDUSTRIAL COMMUNICATION SYSTEMS

Introduction - DDC Structure - DDC Software - Fundamental requirements of Process Control System - System Architecture - Distributed Control Systems - Configuration - Popular Distributed Control Systems. Data communication link, Reliability, Digital signal formats, Error detection, Correction and Recovery circuit, Message and Packet switching, RS485, Industrial Ethernet, Concept of Fieldbus, Study of MODBUS protocol, HART. **9**

INTRODUCTION TO INDUSTRY 4.0

Introduction - The Various Industrial Revolutions -Defining Industry 4.0 -Main Characteristics of Industry 4.0 - The Value Chain - Industry 4.0 Design Principles - Building Blocks of Industry 4.0 - Smart Manufacturing -Digitalization and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0- Smart Factories- Real-World Smart Factories: GE's Brilliant Factory - Siemens' Amberg Electronics Plant (EWA) - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation- The Journey so far: Developments in India, USA, Europe, China and other countries.**9**

INDUSTRIAL CONTROL APPLICATIONS

Industrial Control Applications - Cement Plant - Thermal Power Plant - Water Treatment Plant. Irrigation Canal Management - Steel plant - Petroleum Refineries - Pharmaceutical Industries - Automobile Industries - KAIZEN, SIX SIGMA - IoT in industrial control applications. **9**

TOTAL : 45

TEXT BOOKS

1. Mikell. P. Groover, "Automation Production Systems and Computer Integrated Manufacturing", Pearson India Education Series Pvt. Limited, 4th Edition, New Delhi, 2016.
2. Krishna Kant, "Computer - Based Industrial Control ", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCE BOOKS:

- 1 Alp Ustundag, Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation, Springer International Publishing AG; 1st ed. 2018
2. Curtis D. Johnson, "Process Control Instrumentation Technology", Pearson India Education Services Pvt. Ltd., 8th Edition, 2015.
3. David W. Pessen, "Industrial Automation: Circuit Design and Components", Wiley India Pvt. Ltd., New Delhi, 2011.
4. Ian G. Warnock, "Programmable Controllers operation and Application", Prentice Hall International, UK, 2008.
5. K.L. Sharma, "Overview of Industrial Process Automation", Elsevier, 2011.
6. Tan KokKiong and AndiSudjana Putra, "Drives & Control for Industrial Automation", Springer, 2010.
7. W. Bolton, "Programmable Logic Controllers", Elsevier, Fifth Edition, 2011.
8. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, 2nd Edition, 5th Edition, 2019.

19EEE40 - DEEP LEARNING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Apply Mathematical foundations in deep learning

CO2 : Examine the performance measure of algorithms

CO3 : Analyze machine learning algorithms.

CO4 : Formulate Deep learning algorithms

CO5 : Identify appropriate networks in real life applications

MATHEMATICAL FOUNDATIONS

Linear Algebra : Vectors, Matrices and Tensors - Linear Dependence and Span - Norms - Eigen Decomposition - Singular Value decomposition - Principal Component Analysis

Probability and Information Theory : Population and Sample - Measures of Central Tendency - Measures of Deviation - Measures of Shape - Correlation Analysis- Probability Distributions - Baye's Rule - Linear regression - Logistic Regression **9**

MACHINE LEARNING BASICS

Learning Algorithms - Capacity, over fitting and Under fitting - Hyper parameters and Validation Sets - Estimators , Bias and Variance - Supervised and Unsupervised Learning Algorithms **9**

DEEP NETWORKS

Deep feed forward networks - Gradient Based Learning - Back Propagation - Regularization - Dataset Augmentation - Multitask Learning - Early stopping - Difficulty of training deep neural networks, Greedy layer wise training - Bagging - Optimization strategies **9**

CONVOLUTIONAL AND RECURRENT NETWORKS

Convolution Neural Networks: Convolution - Pooling - Variants - Structured output - Data types- Unsupervised features

Recurrent Neural Networks: Back propagation through time- Long Short Term Memory- Gated Recurrent Units - Bidirectional LSTMs - Bidirectional RNNs **9**

RECENT TRENDS AND APPLICATIONS

Recent trends: Variational Auto encoders - Generative Adversarial Networks - Multi-task Deep Learning - Multi-view Deep Learning

Applications: Vision, NLP, Speech **9**

TOTAL : 45

TEXT BOOKS

1. Ian Good fellow and Yoshua Bengio and Aaron Courville , "Deep Learning", MIT Press, 2016.
2. Josh Patterson, " Deep Learning: A Practitioner's Approach, O'Reilly Media:, 2017

REFERENCE BOOK

1. François Chollet, "Deep Learning with Python", Manning Publications, 2021

19EEE41 - SWITCHED MODE POWER CONVERSION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Recall the concepts of switched mode power conversion

CO2 : Analyze different non isolated DC-DC converters under steady-state condition.

CO3 : Design of magnetic components of dc-dc converters

CO4 : Analyze different soft-switched and resonant converters and power-factor correction techniques

CO5 : Select the EMI suppression techniques for different switched mode converters

INTRODUCTION AND TRANSFORMER-ISOLATED CONVERTERS

Linear converters Vs switching converters - Basic principles of switch-mode power conversion - Single-switch and multi-switch transformer-isolated DC-DC converters - Flyback and forward converters; transformer isolated half-bridge, full-bridge converters. Push-pull converters. Voltage fed and current-fed converters. **9**

MAGNETIC COMPONENT DESIGN

Magnetic core materials and performance; basic inductor and transformer design; practical magnetic design; design aspects to be considered for designing transformers for specific applications - flyback, push-pull, bridge, forward converters. **9**

SWITCHING REGULATOR CONTROL

Small-signal models for switching regulators - Performance analysis and design of closed-loop system under different control methods, and operating modes. Measurement of small signal transfer functions. **9**

SOFT-SWITCHED AND RESONANT CONVERTERS

Hard-switching vs soft-switching - Introduction to resonant power converters and their characteristics - Detailed study of a few soft-transition converters - **7**

POWER-FACTOR CORRECTION, ELECTROMAGNETIC INTERFERENCE AND CHAOS ANALYSIS

Problems due to harmonics in the current drawn by equipment - Basic concept of active single phase power factor correction (PFC) techniques - Performance analysis and comparison of different PFC techniques -Introduction to EMI and Non-linear phenomena in switched mode power converters: Chaos. **11**

TOTAL : 45

TEXT BOOKS

1. Middlebrook, R. D. (Robert David), and Slobodan Cuk, *Advances in Switched-Mode Power Conversion, TESLA , Volumes I and II, 2nd Edition, 1983.*
2. Marty-Brown, "Practical Switching power supply design" Academic Press, 1990
3. Abraham Pressman, Keith Billings, Taylor Morey," *Switching Power Supply Design*", Third edition, 2009.

REFERENCE BOOKS

1. Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, reprint of the original 2nd edition, 2012.
2. Flynn Whittington, "Switched Mode Power Supplies", Universities Press; Second edition, 2009
3. Simon Ang, Alejandro Oliva, "Power-Switching Converters ", CRC Press, Vol. No., third Edition, 2010. 1. Philip T Krein, "Elements of Power Electronics ", Oxford University Press, 2nd Edition, 2012.
4. Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design" John Wiley & sons. 2013 (reprint).
5. Keith Billings, Taylor Morey "Switch mode Power Supply Handbook, "McGraw Hill, third edition, November 2010.
6. L Umanand, S R Bhat , "Design Of Magnetic Components For Switched Mode Power Converters", New Age International (P) Ltd., Publishers, 2017
7. Lazar Rozenblat, "Switching Power Supply Design: A Concise Practical Handbook", Kindle Edition, 2021.
8. Tse, C.K., di Bernardo, M, "Complex behavior in switching power converter", CRC Press 2003.

19EEE42 - UTILIZATION OF SOLAR ENERGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Infer the solar thermal energy system for thermal energy collection and storage and its' use in the buildings.

CO2 : Design the solar PV system for the given applications and to explain the data monitoring system.

CO3 : Interpret and analyze the applications of solar thermal energy system

CO4 : Interpret and analyze the applications of solar PV system

CO5 : Identify the factors involved in economic analysis and explain about E-waste management.

SOLAR THERMAL ENERGY SYSTEM

Solar collectors: Liquid flat plate collectors, Concentrating collectors, advantages and disadvantages and comparison - Thermal energy storage: Sensible heat storage and latent heat storage - solar pond - Solar heating of buildings: Principle and system components - Solar cooling of buildings: Principle and system components - Solar pond: Principle of operation, applications of solar ponds - Basic concepts of energy efficient buildings

9

SOLAR PHOTOVOLTAIC ENERGY SYSTEM

Design aspects of solar PV installation: Technical and general requirements of solar PV module, Main components of solar PV system: Solar panel, Batteries (types, parameters and factors affecting battery performance, Charge controllers, Converter requirements) - installation practices of solar panel -sizing of wires - Electrical safety standards and requirements - Data monitoring system: Remote monitoring - On-site monitoring

10

SOLAR THERMAL APPLICATIONS

Principle of operation: Solar furnace, Solar Distillation, Solar Water Heating, Solar Air Heating and solar pumping system - Industrial process heat: Types and choice of solar collectors, examples for industrial applications - Solar green house concepts

10

SOLAR PV APPLICATIONS

Home Lighting Systems - Street lighting systems - Battery Charging Stations - PV powered water pumping system - PV powered refrigeration system - Military uses - Solar lanterns - Solar energy utilization in space - MNRE schemes for grid connected and off-grid applications

9

ECONOMIC ANALYSIS AND E-WASTE HANDLING

Initial cost - Annual cost - Annual savings - Cumulative savings - Life cycle savings - Payback period - Present worth factor - operation and maintenance cost - Economic Analysis Methods.

E-waste - Indian Scenario - Health and environmental hazards - Recycling concepts of E-waste - E waste generation and handling of solar power plants

7

TOTAL : 45

REFERENCE BOOKS

1. *S.P. Sukhtme & J.K. Nayak, "Solar Energy: Principles of thermal collection and storage", McGraw-Hill Education (India), 3rd edition, 2015*
2. *G.D. Rai," Solar energy utilization", Khanna Publishers, New Delhi, 2017*
3. *H P Garg & J. Prakash, "Solar Energy - Fundamentals and applications", Mcgrew Hill Education, New Delhi, 2016*
4. *Chetan Singh Solanki, "Solar Photovoltaics, Fundamentals, Technologies and Applications", PHI learning, New Delhi 2009.*
5. *Hand book on installation and maintenance of solar panel - Government of India*
6. *Ministry of Electronics and Information Technology (MeitY) - Relevant downloads*

19EEE43 - WEARABLE SENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify the development areas of wearables and its impact on various sectors

CO2 : Design & recognize various electrodes in monitoring devices for healthcare applications

CO3 : Discuss biochemical and gas sensors as wearable devices in medical & other allied industries

CO4 : Realize Electronic textiles in wearable technology and acquire the knowledge in textile sensors

CO5 : Comprehend the design & development of various wearable's for physiological changes and other detections in human body

INTRODUCTION

Wearable Devices development -advent of wearable computing -wearable sensors in various sectors: Industry sectors' overview - sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

Wearable haptics: World of wearable's - Attributes of wearable's - Intelligent clothing: The meta wearable - Challenges and opportunities - Future of wearable's - Need for wearable haptic devices - Categories of wearable haptic and tactile display

9

WEARABLE DEVICES FOR HEALTH CARE

Design, fabrication & geometry of Electrode- Wearable Bioelectric impedance devices for Galvanic skin response; Wearable ECG device, wearable EEG device, Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement - wearable surface electrodes, SEMG Signal Conditioning- Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor- Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles - thermistor, infrared radiation, thermopile

9

WEARABLE SENSORS

Introduction - Challenges in chemical and biochemical sensing -Types Invasive, Non-invasive Wearable inertial sensors- Flex sensor, pulse oximeter, glucose sensor, Inertial sensor, dehydration sensor, pH sensor, heart rate sensor, gas sensor, haptic glove, fitness tracker-Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Conductive textile electrodes, Knitted Piezoresistive Fabric (KPF) sensors

9

TEXTILE SENSOR TECHNOLOGY

Introduction to Textile electrode- smart fibers to textile sensors - Interlaced network-Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors-FBG sensor in Intelligent Clothing and Biomechanics.- textile sensor technology for athletes

9

APPLICATIONS OF WEARABLE'S

Wearable's for the Monitoring of Physical and Physiological Changes in Daily Life- Wearing Sensors Inside and Outside of the Human Body for the Early Detection of Diseases- Wearable and Non-Invasive

TEXT BOOKS

1. *Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York*
2. *Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, 1st Edition, Academic Press, Cambridge*
3. *Kate Hartman, "Make: Wearable Electronics: Design, prototype, and wear your own interactive garments", 2014, 1st Edition, Maker Media, Netherlands*

REFERENCE BOOKS

- 1 *John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida*
- 2 *Michael J. McGrath, Clíodhna Ní Scanaill, "Sensor Technologies Healthcare, Wellness, and Environmental Applications" 2013, Apress, springer*
- 3 *Subhas C. Mukhopadhyay" Wearable Electronics Sensors For Safe and Healthy Living",2015, Springer International Publishing*
- 4 *Katsuyuki Sakuma "Flexible, Wearable, and Stretchable Electronics" 2020,CRC Press*
- 5 *Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland*
- 6 *Gerd Keiser, "Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi.*

ONE CREDIT COURSES

19EEOC06 - ELECTRICAL SAFETY STANDARDS AND PRACTICES

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Expand skills to identify the presence of electrical hazards and measures the risks

CO2 : Select appropriate safety equipment for human protection.

CO3 : Realize the safety procedures, Maintenance and grounding.

CO4 : Realize the importance of Accident Prevention, First Aid and Rescue Techniques.

CO5 : Aware the International standards and certification for safety practices

FUNDAMENTALS OF ELECTRICAL SAFETY

Review of practical electricity - Fundamentals of electrical safety - Hazard Analysis: Primary and Secondary hazards, Human body Response to current magnitudes, Causes of Injury and death - Switch gears used for electrical system protection (Switch, Fuse, MCB, ELCB, Isolators). **6**

EQUIPMENT'S, PROCEDURES AND GROUNDING

Electrical safety equipment's for human protection - General Electrical Safety procedures - Importance of Equipment grounding - Maintenance program - Accident Prevention methods - First Aid and Rescue Techniques. **6**

SAFETY STANDARDS AND CERTIFICATION

Introduction of IE Rules - International Electrical Safety Standards - Electrical safety license and Certification for Practices: NFPA 70E Electrical Safety and OSHA Electrical Safety Work Practices (OESWP) **3**

TOTAL : 15

TEXT BOOKS

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, "Electrical Safety Hand Book", McGraw Hill, New York, USA, 2012.
2. Massimo A. G. Mitolo, "Electrical Safety of Low-Voltage Systems", McGraw- Hill, USA, 2008.

REFERENCES

1. Mohamed A El-Sharkawi, "Electric Safety: Practice and Standards", CRC press, New York, 2013.
2. "Indian Electricity Rules 1956", Ministry of Power- Government of India, 2010
3. Palmer Hickman, "Electrical Safety-Related Work Practices", Jones & Bartlett Publishers, London, 2009.
4. Kenneth G. Mastrullo, Ray A. Jones, "The Electrical Safety Program Book", Jones and Bartlett Publishers, London, 2003.

19EEOC07 - SCILAB PROGRAMMING

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Obtain the necessary knowledge to solve numerical problems through Scilab capacities

CO2 : Recognize and interpret the mathematical modeling in SCILAB-XCOS.

CO3 : Design and develop the tool boxes in SCILAB and hardware interfacing.

INTRODUCTION

Introduction to simulation software- The general environment and the console - Simple numerical calculations - The menu bar - The editor - The graphics window - Windows management and workspace customization. **3**

PROGRAMMING

Variables, assignment and display - Loops Tests - 2D and 3D plots - Supplements on matrices and vectors - Calculation - accuracy - Solving differential equations **3**

FUNCTIONS

Variables - Numbers - Operators Functions - Expressions - The format Function, Suppressing Output, Entering Long Statements, Command Line Editing. **3**

TOOLBOXES

SCILAB Simulation - Tool Boxes In SCILAB - Creating toolboxes in SCILAB **3**

INTERFACING WITH SCILAB

Introduction to SCILAB and GUI - Interfacing with LabVIEW - interfacing with Arduino **3**

TOTAL : 15

TEXT BOOKS

1. Rachna Verma, Arvind Verma "Introduction to SCILAB", Cengage publications. 2018
2. Sandeep Nagar" Introduction to Scilab: For Engineers and Scientists" A press,2017.
3. Ramachandran, Hema "Scilab- A free software to Matlab". S-Chand publications 2012.

REFERENCE BOOKS

1. Book by Tejas Sheth "Scilab: A Practical Introduction to Programming and Problem Solving",
2. Alain Vande Wouwer, Carlos Vilas, and Philippe Saucez "Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications" Springer 2017.
3. Varodom Toochinda "Feedback Control with Scilab and Arduino" E-book
4. Anita Gehlot, Rajesh Singh, Bhupendra Singh "Arduino and Scilab based Projects" Bentham Science Publishers Pte. Ltd. Singapore - 2019

19EEOC08 - MACHINE VISION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Summarize the basic theory and algorithms that are widely used in digital image processing

CO2 : Discover current applications in the field of Image Processing

CO3 : Perform image manipulation with Open CV, including smoothing, blurring.

CO4 : Utilize Python and OpenCV to draw shapes on images and video

CO5 : Apply Neural Networks concepts with Tensor Flow and PyTorch

MACHINE VISION OVERVIEW

Introduction, definition, Active vision system, Machine vision components, hardware's and algorithms, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions **5**

OPENCV-TENSORFLOW-PYTORCH

OpenCV - Image processing techniques using OpenCV with hands on coding examples - Background subtraction and its applications with hands on coding examples-Object detection and classification Tensorflow- Object detection and classification Pytorch - Three industry scenarios - LPR detection, face recognition, car counting. **5**

INDUSTRIAL APPLICATIONS

Industrial machine vision in production and services, structure of industrial m/c vision, generic standards, rules of thumb, illumination, optics, image processing, interfacing machine vision system. **5**

TOTAL : 15

TEXT BOOKS

1. *Kenneth Dawson-Howe, A Practical Introduction to Computer Vision with OpenCV (Wiley-IS&T Series in Imaging Science and Technology) 1st Edition, Kindle Edition, 2014*
2. *Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill,2012*

REFERENCE BOOKS

1. *Haralick& Shapiro, "Computer and Robot Vision", Vol II, 1993*
2. *GerardMedioni and Sing Bing Kang "Emerging topics in computer vision,2004*
3. *Michael Avendi, PyTorch Computer Vision Cookbook: Over 70 recipes to master the art of computer vision with deep learning and PyTorch 1.x Kindle Edition, 2016*

19EEOC09 - CYBER SECURITY IN MANUFACTURING AND SMART GRID

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Analyze the risks and threat issues in industrial control system

CO2 : Elaborate the components and architecture of SCADA system

CO3 : Compare the ICS and SCADA system based on the attributes like security and threats

CO4 : Apply the knowledge of SCADA to an ICS.

CO5 : Analyze the case studies related to Industry 4.0, ICS,SCADA.

INDUSTRY 4.0

Industry 1.0 to 4.0 Journey- Industry 4.0 Overview - Industrial Automation Components Industrial Control System (ICS) **3**

INDUSTRIAL CONTROL SYSTEM (ICS)

Industrial Control System (ICS) introduction - ICS Components - ICS Network & Communications- ICS Security Risks & Threats **3**

SCADA

SCADA introduction - SCADA Components - SCADA Objectives & Functions - SCADA Architecture- SCADA Software - SCADA Security Risks & Threats **3**

ICS & SCADA

ICS & SCADA - Network Security Threats & Solutions - ICS & SCADA - Application Security Threats & Solutions - ICS & SCADA - Org Security Threats & Solutions - ICS & SCADA - Physical Security Threats & Solutions **3**

CASE STUDIES

Major incidents related to Industry 4.0, Industrial Control System (ICS), SCADA, ICS & SCADA - Solutions related to Industry 4.0, Industrial Control System (ICS), SCADA, ICS & SCADA - Case Studies **3**

TOTAL : 15

TEXT BOOKS

1. Gilbert N. Sorebo, Michael C. Echols, "Smart Grid Security -An End-to-End View of Security in the New Electrical Grid", CRC Press, 1st Edition, India, 2012.
2. Eric D. Knapp , Joel Thomas Langill, "Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control", Syngress, December 2014.

REFERENCE BOOK

1. Goel, S., Hong, Y., Papakonstantinou, V., Kloza, D, "Smart Grid Security", Springer, 2015.

19EEOC10 - ROBOTICS AND AUTOMATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Interpret and identify Industrial robotics, automation and digital twin technology.
- CO2** : Bridge the gap between the industries and institutions working in the area of robotics and automation
- CO3** : Conceive organizational aspects and analyze the architecture of Digital Twin Technology.
- CO4** : Facilitate the future industry tools NX CAD -3D Design Modeling, COMOS - Virtual Plant Control, SIMIT - Real Time simulation - With and Without H/W SIMATIC - Industry Distributed Controller ,Industrial IoT Gateway.
- CO5** : Develop an application software to interface various peripherals with given design requirements

INTRODUCTION

Overview of Process Simulate & Virtual Commissioning Case Study : Electric Vehicle Battery Pack Assembly-Integrated Mechatronics Engineering for Automation. **3**

DIGITAL TWIN

Digital Twin for Process Industry-Holistic approach Digital Twins for Optimizingthe value chain-COMOS: Lifecycle data platform **3**

ROBOTICS

Robotics modeling and control- Kinematics- Control of Index finger Exoskeleton using Surface- EMG signal-Neural Network control- Applications of Robotics. **3**

SOFTWARE

Introduction to PCS 7-Architecture of SIMATIC PCS V9.0-Real time examples- Perspectives in DCS and PLC. **3**

IOT

Trend in IOT- Smart manufacturing- Industry 4.0- Manufacturing Execution systems- Delta Vector Control Drive-C2000 series. **3**

TOTAL : 15

TEXT BOOKS

1. Gerardus Blokdyk, "Digital twin A Complete Guide"- 2019 Kindle Edition
2. Bruno Siciliano and Oussama Khatib, "Handbook of Robotics"- Springer International Publishing 2018

REFERENCE BOOKS

- 1 Anand Iyer, "Digital Twin: Possibilities of the new Digital twin technology" Kindle 2017 Edition.
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics" MIT Press, 2018
3. Ian Barkin, Pascal Bornet, Jochen Wirtz, "INTELLIGENT AUTOMATION" 2020
4. By Frank Lamb, "Industrial Automation: Hands On" McGraw-Hill Education, 2020

19EEOC12 - AWS CLOUD PRACTITIONER ESSENTIALS

- Module 1 : Introduction to Amazon Web Services
- Module 2 : Compute in the Cloud
- Module 3 : Global Infrastructure and Reliability
- Module 4 : Networking
- Module 5 : Storage and Databases
- Module 6 : Security
- Module 7 : Monitoring and Analytics
- Module 8 : Pricing and Support
- Module 9 : Migration and Innovation
- Module 10 : The Cloud Journey
- Module 11 : AWS Certified Cloud Practitioner Basics

19EEOC13 - INTRODUCTION TO IOT

- Chapter 1 : Everything is connected
- Chapter 2 : Everything Becomes Programmable
- Chapter 3 : Everything Generates Data
- Chapter 4 : Everything can be automated
- Chapter 5 : Everything needs to be secured
- Chapter 6 : Educational and Business Opportunities

19EEOC14 - TCS ION CAREER EDGE YOUNG PROFESSIONAL

- Module 1 : Communicate to Impress
- Module 2 : Deliver Presentations with Impact
- Module 3 : Develop Soft Skills for the Workplace
- Module 4 : Gain Guidance from Career Gurus
- Module 5 : Write a Winning Resume and Cover Letter
- Module 6 : Stay Ahead in Group Discussions
- Module 7 : Ace Corporate Interviews
- Module 8 : Learn Corporate Etiquette
- Module 9 : Write Effective Emails
- Module 10 : Learn Corporate Telephone Etiquette
- Module 11 : Understand Accounting Fundamentals
- Module 12 : Gain Foundational Skills in IT
- Module 13 : Understand Artificial Intelligence (AI) - Part 1
- Module 14 : Understand Artificial Intelligence (AI) - Part 2

EEC COURSES

19HOC31 - COMMUNICATION SKILLS FOR ENGINEERS - I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Gain confidence, enhance Personality and develop positive attitude in their work and life.
- CO2** : Effectively communicate and present opinions using appropriate functional expressions for a given situation
- CO3** : Compose Emails, Reports for a given business scenario using appropriate sentence construction and in the prescribed format.
- CO4** : Generate ideas and speak on a given topic in a competitive scenario like Debate, Group Discussion, and Public Speaking.

PERSONALITY DEVELOPMENT

Motivation and Self Confidence, SCOT Analysis - Personality Development - What is Personality, Developing Positive Attitude towards work and life, Building Relationship with others - Personality Development - Paradigms of Human Interaction, Fear Management. **4**

VERBAL COMMUNICATION

English Conversation - Asking and Giving Opinions - English Conversation -Thanking People, Asking and Giving Suggestions - English Conversation - Asking for Direction, Agreeing and Disagreeing - Role Play-Business. **5**

BUSINESS COMMUNICATION

Email Writing - Format, Etiquettes and Tips - Report Writing -Introduction, elements and tips - Drafting a report - Error Identification - Rules, Common Mistakes and Exercises - Sentence Completion Filler (fill in the blanks using apt words). **5**

PUBLIC SPEAKING

How to start and sustain a conversation - Debate - Extempore - Group Discussion - Importance and Process - Public Speaking - Introduction, Tips - Drafting a Public Speech - Interview - Types, Dos and Don'ts - Mock Press. **6**

TOTAL : 20

REFERENCES

1. <https://nptel.ac.in/content/storage2/courses/109104030/references/references.pdf> (online resource)
2. John Seelay, Oxford Guide to Effective Writing and Speaking, 2nd Edition, Kindle Edition by Oxford University Press, 2007.
3. Sabina Pillai, Agna Fernandez, Soft Skills and Employability Skills -Published by Cambridge University Press, 2017.

19HOC41 - COMMUNICATION SKILLS FOR ENGINEERS - II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Solve objective questions on analogy, Statement and Argument, Statement and Conclusion, Data Sufficiency and Sentence improvement within a given time.

CO2 : Construct grammatically correct sentences

CO3 : Speak confidently to describe a process, present information on the specified topic and disseminate information in a professional manner.

SELF EVALUATION

Self believe and self Esteem - Activities based on Current Events **2**

VERBAL AND LOGICAL RESONING

Analogy - Introduction, Types and Exercises - Statement and Argument - Statement and Conclusion - Data Sufficiency - Sentence Improvement - Critical Reasoning/Theme Detection **5**

GRAMMAR

Basic Grammar- Subject Verb Agreement - One word substitute - Preposition- Cause and Effect -Basic level questions and Moderate level questions **4**

PRESENTATION TECHNIQUES

Describing a Process - Presentation Skills - Introduction, Planning and Preparation - Presentation on a Topic - Group Discussion - Dos and Don'ts - Functional Expressions used in Group Discussion - Interview Skills - Ideal Grooming for an interview, Preparing for the Interview. **9**

TOTAL : 20

REFERENCES

1. Sanjay Kumar, PushpLata, *Communication Skills 2nd Edition*, published by Oxford University Press, New Delhi, India, 2015.
2. Anthony Manning, Chris Sowton and Craig Thaine, *Cambridge Academic English*, published by Cambridge University Press, U P, India, 2012.

19HOC51 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Solve objective questions on Syllogisms, Data Interpretation, Critical Reasoning, Theme Detection, Sentence Completion and Business Vocabulary

CO2 : Develop appropriate responses for business phone calls and negotiate effectively.

CO3 : Speak with appropriate body language for a technical speaking task.

CO4 : Project the appropriate grooming and the right etiquettes, for interview and group discussion task.

VERBAL APTITUDE

Syllogisms-Paragraph Comprehension -Data Interpretation-Critical Reasoning/Theme Detection - Grammar -Sentence Completion Filler -Business Vocabulary-Foreign phrases used in English **3**

PROFESSIONAL COMMUNICATION

Telephonic Conversation Skills - Telephonic Interview -Etiquettes - Professional, Dining & Telephone - Employability skills - Importance and Employability level of present Y and Z Generation - Interpersonal Skills - Negotiation Skills - Types, Expressions used in formal and informal negotiations, Stages of Negotiation -Time Management-Pareto principle, Prioritizing tasks, Barriers to time management **7**

THE ART OF SPEAKING

Types of Speaking - Barriers to Speaking - Presentation on a Technical Topic -Speaking on Current Trends in the Industry **5**

NON-VERBAL COMMUNICATION

Interview Skills -Non Verbal Communication - Smiling, Posture, Handshake, Tone of Voice and Eye Contact - GD tips & techniques and Mock GD-Body Language - Grooming. **5**

TOTAL : 20

REFERENCES

1. Kamin, Maxine. *Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders*. Washington, DC: Pfeiffer & Company, 2013.
2. Petes S. J., Francis. *Soft Skills and Professional Communication*. New Delhi: Tata McGraw-Hill Education, 2011.
3. John Hayes. *Interpersonal Skills at Work. Second Edition*. Routledge publication. 2005

19HOC61 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : *Exhibit Corporate Etiquettes with assertiveness and personal effectiveness.*

CO2 : *Build teams and solve problems at workplace.*

CO3 : *Manage conflicts in a professional manner*

CO4 : *Simulate an actual Job Interview scenario to prepare a candidate for a real Interview*

CORPORATE ETIQUETTE

Corporate Etiquette: Dos and Don'ts, -Conversational dos and don'ts - Creating elusive first impression- Assertiveness-Personal Effectiveness **4**

LEADERSHIP AND TEAM MANAGEMENT

Leadership Skills - Understanding Traits and Styles - Team Building: Bonding, Development and Delegation - Adaptability and Work Ethics - Handling Team Dynamics- Giving and Receiving Feedback-Problem Solving Skills **5**

STRESS AND CONFLICT MANAGEMENT

Emotional Intelligence: Recognition, Understanding and Managing - Stress Management: Techniques and Benefits - Conflict Management: Introduction- Handling Conflicts - Conflicts settlement **6**

GROUP DISCUSSION AND INTERVIEW SKILLS

Mock GD - Interview Skills - Answering challenging questions - Common Interview Questions **5**

TOTAL : 20

REFERENCES

1. Barun K Mitra., *Personality Development and Soft Skills. Second Edition. Oxford University Press. 2016*
2. N. Krishnaswamy & Lalitha Krishnaswamy - *Mastering Communication Skills and Soft Skills. New Delhi. Bloomsburry. 2015*
3. Stein, Steven J. & Howard E. Book. *The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.*

OPEN ELECTIVES

19CEOE01 - TOWN PLANNING AND ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : interpret the geometric forms and aesthetic qualities of Architecture

CO2 : integrate the various elements of architecture and orientation of buildings

CO3 : describe the development plans and planning regulations

CO4 : incorporate the development control rules in town and country planning

PRINCIPLES OF TOWN PLANNING

Evaluation of planning - Objects of town planning - principles of town planning- origin of towns - growth of towns - origin - direction - various forms of planning (9)

ELEMENTS OF ARCHITECTURE

Introduction of architecture - definition - Evaluation of geometric forms - function and history - Sphere, Cube, Pyramid, Cylinder and Cone - aesthetic qualities of Architecture - Proportion, Scale, Balance, Symmetry, Rhythm and axis - Contrast in Form - Harmony. (9)

PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS

Factors affecting orientation - Sun-Wind-Rain - Orientation criteria for Indian conditions - Principles governing the theory of planning - Planning of residential buildings. (7)

DEVELOPMENT PLAN

Principles of city planning - levels of planning- scope and contents of regional plan, master plan, detailed development plan and structure plan - preparation and implementation - planning of new towns - slum clearance and urban renewal. (9)

PLANNING LEGISLATION AND DEVELOPMENT CONTROL RULES

Planning legislation and administration - Tamil Nadu Town and Country Planning Act, Tamil Nadu Housing Board Act, Tamil Nadu slum clearance and Improvement Act. Zoning regulations - sub division regulations - building regulations - Floor Space Index - minimum plot sizes - open spaces - minimum standard dimensions (11)

TOTAL : 45

TEXT BOOKS

1. Rangwala S.C., "Town Planning", Charotar Publishing House, Anand, 2013.
2. Francis D.K., Ching, "Architecture Form, Space and Order", Oxford University Press, 2014.

ONLINE RESOURCES

1. <https://nptel.ac.in/courses/124/107/124107001/>
2. <https://nptel.ac.in/content/storage2/courses/109104047/pdf/lecture40.pdf>

19CEOE02 - CLIMATE CHANGE AND ADAPTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

- CO1* : Outline the earth's system which influences the climatic factors of the earth.
- CO2* : Infer the evidences and observed changes in the climate and environment on a global scale and in India.
- CO3* : Analyse the impacts of climate change on various sectors and the uncertainties over the projected impacts of climate change.
- CO4* : Investigate the various adaptation and mitigation options in various sectors and examine the mitigation efforts made in India.
- CO5* : Correlate future clean technology and alternate energy options inferred in clean development mechanism.

EARTH'S CLIMATE SYSTEM

Introduction-Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - The Westerlies - Cloud formation and Monsoon Rains - Storms and Hurricanes - The Hydrological Cycle - Global Ocean Circulation - El Nino and its Effect - Green House Gases and Global Warming - Carbon Cycle. (9)

OBSERVED CLIMATE CHANGE AND ITS CAUSES

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Patterns of Large Scale Variability - Drivers of Climate Change - Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India. (9)

IMPACTS OF CLIMATE CHANGE

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change. (9)

CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones - Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport - Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Mitigation Efforts in India and Adaptation funding. (9)

CLEAN TECHNOLOGY AND ENERGY

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco-friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power. (9)

TOTAL : 45

TEXT BOOKS

1. Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.
2. UNIPCC Fifth Assessment Report, 2014.
3. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.

REFERENCES

1. *Anil Markandya, Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002.*
2. *Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998.*
3. *Jepma, C.J., and Munasinghe, M., Climate Change Policy - Facts, Issues and Analysis, Cambridge University Press, 1998.*
4. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*

ONLINE RESOURCES

1. *"An Inconvenient truth (2006)"- video*
2. <https://climate.nasa.gov>
3. <https://unfccc.int>
4. <https://environment.gov.au>

19CEOE03 - METRO SYSTEMS AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Integrate the basic elements of MRTS, BRTS, LRTS and other transportation systems

CO2 : Illustrate the components of metro rail systems

CO3 : Apply the concepts of ITS in the field of Transportation Engineering

PRINCIPLES OF TRANSPORTATION SYSTEMS

Transportation systems in India - various modes of transport - public transport - Intermediate public transport - types - characteristics - other urban transportation modes - drawbacks- various transit systems (9)

MRTS

Definition - Mass Rapid Transit System - History of MRTS - Need for MRTS - connectivity in Indian conditions - cities having MRTS - infrastructure - operations - fares and ticketing - case study. (8)

BRTS and LRTS

Bus Rapid Transit System - terminology - history -features - performance - cost - drawbacks - Light Rail Transit System - necessity - types - gauge- capacity integration with cycles - comparison to other rail modes (9)

METRO RAIL SYSTEMS

History of Metro trains - Need for Metro rail - connectivity in Indian conditions - cities having Metro - construction techniques adopted in Metro Rail stations - Case study - Delhi Metro (DMRC) - Chennai Metro (CMRL) (10)

ITS

Definition - Intelligent Transport System - Principles - Application of ITS technologies in various countries - smart transportation - case studies (9)

TOTAL : 45

TEXT BOOKS

1. Pradip Kumar Sarkar, Vinay Maltri, G. J. Joshi · "Transportation Planning Principles, Practices and Policies", Prentice Hall India Pvt., Limited 2017
2. D. Johnson Victor, S. Ponnuswamy, "Urban Transportation Planning, Operation and Management" Tata McGraw-Hill Education, 2012
3. Mashrur A. Chowdhury, Adel Wadid Sadek "Fundamentals of Intelligent Transportation Systems Planning" Artech House · 2003
4. Sumit Ghosh, Tony S. Lee, "Intelligent Transportation Systems Smart and Green Infrastructure Design, Second Edition" CRC Press · 2010

ONLINE RESOURCES

1. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf

19CEOE04 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

- CO1 : Infer the current energy scenario and future energy usage in India.
- CO2 : Interpret the concepts of solar energy, wind energy, tidal energy and biomass energy.
- CO3 : Compare the energy utilization from wind energy, solar energy, biomass energy and tidal energy.
- CO4 : Correlate the challenges and problems associated with the use of energy sources.

ENERGY PERSPECTIVES

Conventional and non conventional energies - Energy and sustainable development - Global energy scenario - Energy scenario in India - Energy consumption pattern in rural and urban regions in India - Energy efficiency and economy - Energy losses and its control - Renewable energy potential mapping - Plant load factor (9)

SOLAR ENERGY PERSPECTIVES

Concept of solar energy - Solar energy to light and to thermal conversions - Total energy and necessary infrastructure - Units and measurement of solar radiation - Temperature dependent collecting devices and their efficacies - Design aspects - Typical applications: heating, cooling, lighting, power generation and cooking. (9)

WIND ENERGY PERSPECTIVES

Wind potential in India - Wind turbines and their types - Merits and demerits - Wind power and appropriate coefficient - Efficiency and performance of wind machines - Energy conversion and storage - Synchronous invertors - Various storage aspects: battery, fly wheel, hydrogen and compressed air. (9)

BIOMASS ENERGY PERSPECTIVES

Biomass potential in India - Gobar gas and producer gas - Characteristics of biomass - Operation and design of biogas plants - Objectives, principles and operational aspect of biogassifiers - Pyrolysis and incineration - Power generation from municipal solid waste and industrial Sludges - Application of biodiesel plants - Fuel cells. (9)

TIDAL ENERGY PERSPECTIVES

Tidal aspects in coastal India - Tidal energy conversion system: mechanical to electrical and thermal to electrical - Tidal force calculation and power generation - conceptualization and potential of geothermal energy - Geothermal vents. (9)

TOTAL : 45

TEXT BOOKS

1. Sukathme, S.P, Nayak J.K., "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 2017.
2. Rai, G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2010.
3. P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
4. Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

REFERENCES

1. *Richard A. Dunlap, "Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.*
2. *Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.*
3. *Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.*

ONLINE RESOURCES

1. https://swayam.gov.in/nd1_noc20_ge06/preview
2. https://swayam.gov.in/nd2_nou20_cs09/preview

19CEOE05 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

- CO1 : Identify the components, factors and environmental issues affecting Sustainable development.*
- CO2 : Assess the role of International summits, conventions and Environmental aspects on Sustainable development.*
- CO3 : Interpret the necessity and importance of Indian and International Socio -economical and legal aspects in Sustainability.*
- CO4 : Illustrate the different strategies to achieve Sustainable development.*
- CO5 : Assess the role of Life cycle Assessment, Cleaner Production and Sustainable Chemistry to achieve sustainable development.*

CONCEPTS OF SUSTAINABLE DEVELOPMENT

Sustainable development- Evolution of Environmental awareness and Sustainable development, global Sustainable development goals -components and factors affecting Sustainable development-Demographic dynamics and sustainability- Environmental issues and crisis- ozone layer depletion, global warming and climate change (9)

ENVIRONMENTAL ASPECTS

International Environmental summits, conventions and agreements-Tiwari committee recommendation - Role of Pollution Control Board - Transboundary issues - Ecological indicators- Ecological foot print- Carbon foot print - Basic concept of Environmental impact assessment (9)

SOCIO ECONOMIC AND JUDICIAL ASPECTS

UN Sustainable development policies through trade- World Trade Organization-International monetary fund and World bank - Circular Economy and Sustainable Development - Socio economic policies for sustainable Development- Role of Judiciary in Sustainable Development - Major Environmental Cases in India - Development of Environmental Policies in India - Environment Protection Act, 1986 - EIA notification 2006 - National Conservation Strategy and Policy Statement on Environment and Development, 1992 - Policy Statement for the Abatement of Pollution, 1992 - National Environment Policy, 2006. SDG India Index - Baseline Report 2018 (9)

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth and Sustainable Development - Resource depletion and resource protection- - Internet of things and Sustainable Development - Sustainable Management of Forest, Land, water- Natural Disaster management- case studies. (9)

CLEANER PRODUCTION, LIFE CYCLE ASSESSMENT - GREEN/SUSTAINABLE CHEMISTRY

Cleaner Production, definition, aim, application-Generic process of Cleaner Production Assessment- Life cycle Assessment - definition, necessity and elements- ISO Environmental standards- Environmental Audit -Green Chemistry - twelve Principles of Green Chemistry - case studies. (9)

TOTAL : 45

TEXT BOOKS

1. Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001
2. Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014
3. Bimal N. Patel and Ranita Nagar, "Sustainable Development and India", Oxford University Press, 2018.

REFERENCES

1. Nick Hanley, Jason F. Shogren and Ben White, *"Environmental Economics in Theory and Practice"*, Macmillan Publishers, UK, 1997
2. Tietenberg T. and Lynne Lewis, *"Environmental and Natural Resource Economics"*, Harper Collins, Routledge, 2016
3. Kirkby, J.O., Keefe, P., and Timberlake, *"Sustainable Development"*, Earthsean Pub., London, 2001

ONLINE RESOURCES

1. <https://nptel.ac.in/courses/107/103/107103081/>

19CEOE06 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Identify natural and manmade disasters

CO2 : Explain in detail about causes and effects of natural and manmade disasters.

CO3 : Apply geospatial techniques (including GIS) that can enhance vulnerability assessments

CO4 : Identify and analyse the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans

CO5 : Assess and manage these vulnerabilities through disaster planning and policy-making.

NATURAL DISASTERS

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche. (9)

MAN MADE DISASTERS

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire- Oil fire -accident in Mines. (9)

GEOSPATIAL TECHNOLOGY

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping. (9)

RISK ASSESSMENT AND MITIGATION

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans. (9)

DISASTER MANAGEMENT

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism - Role of Engineers in Disaster Management. (9)

TOTAL : 45

TEXT BOOKS

1. R. Subramanian, "Disaster Management" Vikas Publishing House Pvt. Ltd, New Delhi, 2018.
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.

REFERENCES

1. Disaster Management in India-A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India, 2004.
2. Murthy D. B. N., "Disaster Management : Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.
3. Sundar I. and Sezhiyan T., "Disaster Management", Sarup and Sons, New Delhi, 2007.
4. Singhal J.P. "Disaster Management", Laxmi Publications, 2010.

5. *Khanna BK, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
6. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
7. *Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

19MEOE01 - DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : *Demonstrate the fundamental concepts applied with mathematical knowledge, methodologies to bring knowledge of characterize, analyse and solve a wide range of problems between the purpose of a model and the appropriate level of complexity and accuracy.*
- CO2** : *Plan, design and conduct experimental investigations efficiently and effectively; choose an appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.*
- CO3** : *Analyse the nature of variables, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects using RSM.*

INTRODUCTION

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. (7)

BASIC STATISTICAL CONCEPTS

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples. (9)

EXPERIMENTAL DESIGN

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. (11)

ANALYSIS AND INTERPRETATION METHODS

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples. (9)

EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples. (9)

TOTAL :45

TEXT BOOKS

1. C.F. Jeff Wu & Michael Hamada, "Experiments-Panning, Analysis, and Optimization", 3rd Edition, John Wiley & Sons. Inc., 2021.
2. D.C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley & Sons. Inc. 2019.

REFERENCES

1. T.B. Barker, Andrew Milivojevic, *"Quality by Experimental Design", 4th Edition, CRC Press, 2021*
2. <https://nptel.ac.in/courses/110/105/110105087/>
3. <https://nptel.ac.in/courses/111/104/111104075/>

19MEOE02 - ENGINEERING OPTIMIZATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : Formulate single or multi-variable engineering optimization problems and comply with the appropriate objective functions.
- CO2** : Select the appropriate optimization technique for the specified engineering problems based on number of variables and constraints.
- CO3** : Derive, develop and utilize the possible randomness or any other associated factors that would possibly occur during constrained and unconstrained optimization situations.

INTRODUCTION

Problem formulation - design variables, constraints, constraint surfaces, objective functions, objective function surfaces. Classification of optimization - based on existence of constraints, nature of design variables, structure of the problem, nature of equation involved, permissible value of the design variables, deterministic nature of the variables, separability of the functions and the number of objective functions. Example of engineering optimization problems. (11)

SINGLE VARIABLE OPTIMIZATION

Optimal criteria - bracketing method - exhaustive search method, region elimination method - interval halving, Fibonacci, golden search method, point estimation method - successive quadratic approximation, gradient search method - Newton Raphson's method. (10)

MULTIVARIABLE OPTIMIZATION WITH CONSTRAINTS

Multivariable optimization - semi definite case - saddle point. Multivariable optimization with equality constraints - solution by direct substitution - solution by the method of constrained variation - solution by the method of Lagrange multipliers. Multivariable optimization with inequality constraints - Kuhn-Tucker conditions, constraint qualification. (12)

UNCONSTRAINED OPTIMIZATION

Introduction - classification of unconstrained minimization methods - general approach - rate of convergence - scaling of design variables. Direct Search Methods - random search methods - random walk method with direction exploitation - advantages of random search methods. Indirect Search Methods - gradient of a function - evaluation of the gradient - rate of change of function along a direction - steepest descent (Cauchy) method. (12)

TOTAL : 45

TEXT BOOKS

1. S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.
2. K. Deb, "Optimization for Engineering Design - Algorithms and Examples", 2nd Edition, Prentice Hall India, 2013.

REFERENCES

1. J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.
2. Ashok D. Belegundu & Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering", 3rd Edition, Kindle Edition, Cambridge University Press, 2019.

3. A. Ravindran, K. M. Ragsdell, Reklaitis G.V., "Engineering Optimization: Methods and Applications", John Wiley & Sons, Inc., 2006.
4. <https://nptel.ac.in/courses/112/105/112105235/>
5. <https://nptel.ac.in/courses/105/108/105108127/>
6. <https://nptel.ac.in/courses/112/101/112101298/>

19MEOE03 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1 : Choose manufacturing processes for polymers and PMC materials to obtain required shapes by applying product design considerations*
- CO2 : Find the processes to develop new ceramic and cermet materials for manufacturing of high temperature cutting tools by applying design considerations*
- CO3 : Develop and characterize the Nano-composites, MMCs, CMCs and PMCs for the engineering applications using secondary processing methods*
- CO4 : Synthesize, characterize, compaction and sintering of metal powders for application of P/M parts using powder metallurgy techniques*
- CO5 : Synthesize and characterize the nanostructured materials for fabricating electronic devices, MEMS, magnetic, electronic and optical sensors and fabricating carbon nano structured materials for fuel cell and energy storage applications*

SHAPING PROCESSES FOR PLASTICS

Properties of polymer melts - extrusion - production of sheet and film - fibre and filament production (spinning) - coating processes - injection moulding - compression and transfer moulding - blow moulding and rotational moulding - thermoforming. Casting - polymer foam processing and forming - product design considerations. (8)

RUBBER-PROCESSING TECHNOLOGY

Rubber processing and shaping - manufacture of tyres and other rubber products - product design considerations. (5)

SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES

Materials for PMC - open mold processes - closed mold processes - filament winding - pultrusion process - other PMC shaping processes. (4)

PROCESSING OF CERAMICS AND CERMETS

Processing of traditional ceramics - processing of new ceramics - processing of cermets - product design considerations. (4)

APPLICATION OF COMPOSITES

Composites including Nano-composites for electrical, superconducting and device applications, fabrication of Nano-composites, secondary processing and joining of various composite materials for structural applications and their fracture behavior and safety. (9)

POWDERS

Production and characterization of powders, compaction of metal powders - die compaction, isostatic pressing, powder forging, powder rolling and extrusion, pressure less compaction techniques, hot pressing and hot isostatic pressing, sintering of powder compacts, liquid phase sintering, sintering furnaces, post sintering operations, applications of P/M parts. (7)

INTRODUCTION TO NANOMATERIALS

Nano structured materials, low-dimensional structures: quantum wells, quantum wires, and quantum dots, Nano clusters & Nanocrystals, electronic and optical properties of Nano crystallites, metallic and semiconducting superlattices, synthesis of nanostructured materials, fabrication and characterization of Nano electronic devices and MEMS, basics of synthesis and

characterization of Nano-multi-component systems for sensors (magnetic, electronic and optical) and electrodes, synthesis and fabrication of carbon Nano structures for fuel cell and energy storage applications.

(8)

TOTAL : 45

TEXT BOOKS

1. Mikell P. Groover, *"Fundamentals of Modern Manufacturing Materials, Processes and Systems"*, 4th Edition, John Wiley & sons, Inc. 2015.
2. Ajayan P. M., Schadler L. S., & Braun P. V, *"Nano composite Science and Technology"*, John Wiley & Sons, Inc., 2014.

REFERENCES

1. Charles A. Harper, *"Modern Plastics Handbook"*, McGraw-Hill, 2010.
2. Sperling L.H., *"Introduction to Physical Polymer Science"*, 3rd Edition, John Wiley & Sons, 2011.
3. Chawla K.K., *"Ceramic matrix composites"*, 1st Edition, Chapman & Hall, 2013.
4. Randall M German, *"A-Z of Powder Metallurgy (Metal Powders Technology)"*, Elsevier Science, 2007.
5. Upadhyaya G. S., *"Powder Metallurgy Technology"*, Cambridge International Science Publishing, 2002.

19MEOE04 - INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

- CO1** : *Examine the configuration of a robot and suggest a robot for a particular operation (pick and place, welding, vision, climbing etc.).*
- CO2** : *Calculate the position, velocity and acceleration for a robot manipulator and solve the forward and inverse kinematics.*
- CO3** : *Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.*
- CO4** : *Choose an appropriate vision system for the robot and then extract these images to get the desired output.*
- CO5** : *Write a program to determine path for obstacle avoidance for a specific task and can solve using matrix laboratory software.*

INTRODUCTION

Brief history of robots, robot definitions, today's practical importance of robot applications, challenges faced by robots in industrial situations, future scope of robotics. (3)

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. (5)

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint coordinate system, Euler angles and Euler transformations, Denavit- Hartenberg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse Kinematics, Jacobian of transformation in robotic manipulation. (12)

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. (8)

MOTION CONTROL OF ROBOTIC MANIPULATORS

General arm control system - open and closed loop control systems error controlled robotic dynamics - control structure of amplifier- control of a single axis robotic arm, common control systems for industrial robots, force control of robotic manipulators. (9)

ROBOT SENSING AND ROBOT VISION SYSTEM

Desirable features of sensor- range sensors - proximity sensors - tactile sensors-force sensors, torque sensing detectors - TV cameras - illumination techniques - fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image extraction. Typical vision systems, robot programming languages - characteristics of robot- level languages - characteristics of task level languages, simulation languages. (8)

TOTAL : 45

TEXT BOOK

1. *Fu.K S, Gonzales .R.C., & Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*
2. *Ashitava Ghushal "Robotics : Fundamental Concepts and Analysis", Oxford, 2006.*

REFERENCES

1. *Mikell.P.Groover, Mitchell Weiss, Tooger. N. Nager, & Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*
2. *Richard. D. Klafter, Thomas. A. Chmielewski, & Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*
3. <https://nptel.ac.in/courses/112/105/112105249/>

19MEOE05 - BUSINESS PROCESS REENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Gain knowledge about BPR, Factors affecting BPR operations and design BPR techniques.

CO2 : Use BPR tools, utilize concepts of BPR, analyse cost / Benefit and appreciate the need of IT in BPR.

CO3 : Incorporate changes in the business operation based on market demand and implement the same in the manufacturing system.

CO4 : Select an appropriate practice of the business re-engineering project by taking the practical situations into consideration.

CO5 : Provide the most feasible practical solution to the problem keeping in mind the considerations of business automation, value, processes and risks in launching the business reengineering project.

INTRODUCTION TO BPR

Definition; the paradigm shifts in production; the need for BPR, advantages and benefits of BPR, constraining factors, challenges, the positioning concept; the re-engineering visions; The BPR Life Cycle Methodology, Guidelines for BPR steps, Role of Information Technology in BPR; process Improvement and Process Redesign; BPR Experience in Indian Industry. (9)

METHODOLOGIES AND TOOLS FOR BPR

Process management; dynamic business re-engineering change framework; steps to reengineer the process. Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering. Conceptual Foundation of Business Process Re-engineering; Process Identification and Mapping; Role/Activity Diagrams. (9)

CHANGE MANAGEMENT

Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering. Process Visioning and Benchmarking. Business process Improvement, Business Process Redesign; Man Management for BPR implementation; Re-organizing People and Managing Change. (9)

GOVERNANCE & BPR

Total Quality Management, Risk Management, Organizational Structures, BPR Project Management, The Power of Habit in organizations. The role of eLearning environments. Applications, gaming, BPR facilitation, BPR in Software Development, Basic principles, Relation to BPR. (9)

BEST PRACTICES IN BPR

Research & Practice, Perspectives in BPR, Discussion on research challenges, and practice challenges for industry and governments Case studies: Nissan, Chrysler, Hewlett Packard etc. Workflow systems, Imaging technology, Floware, Business design facility tools, Risk and impact measurement. (9)

TOTAL : 45

TEXT BOOKS

1. Davenport, "Process Innovation: Reengineering work through information technology". Harvard Business School Press, 1993.
2. Hammer & Champy, "Reengineering the Corporation: A Manifesto for Business Revolution" Harper Business Books, 1993.

3. Hammer & Stanton, *"The Reengineering Revolution"* Harper Collins. London, 1995.
4. Henry J Johansson, Patrick McHugh, John Pendlebury & William A. Wheeler, *"Business Process Reengineering: Break Point Strategies for Market Dominance"*, Wiley, New Delhi, 1993.

REFERENCES

1. Harmon, P, *"Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals"*, Elsevier/Morgan Kaufmann Publishers, 2007.
2. R. Anupindi et al., *"Managing Business Process Flows: Principles of Operations Management"*, Pearson Education Inc, 2006.
3. Kock, N.F., *"Process Improvement and Organizational Learning: The Role of Collaboration Technologies"*, Idea Group, 1999.
5. Walford, R.B., *"Business Process Implementation for IT Professionals and Managers"* Artech Business Process Reengineering" Prentice Hall, New Delhi, 1993.

19MEOE06 - ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Analyze the demand and supply and sketch a demand and supply curve.

CO2 : Determine the Breakeven point and find out the strength and weakness of the Market Structure.

CO3 : Sketch the curve for cost behavior for the short run concept.

CO4 : Analyze and specify the causes and provide the solution to each cause.

CO5 : Formulate the steps involved in a recruitment process as a chart and interpret it.

INTRODUCTION

Definition -Nature and Scope-Significance of Economics for Engineers. (5)

BASICS OF MICRO ECONOMICS

Demand Analysis and Supply Analysis - Elasticity of Demand and Supply - Case Study in Demand Forecasting - Cost concepts - Classifications - Short run and Long run cost curves - Break-even Analysis. (8)

MARKET STRUCTURE

Classification of Market - Perfect Competition-Characteristics -Monopoly - Monopolistic Competition - Oligopoly and Duopoly - Price Discrimination under different markets - Price and output determination in short run and long run. (8)

MONEY AND BANKING

Money - Quantity theory of Money -Supply of Money - RBI Measures of Money Supply - Banking - Functions of Commercial Banks and Central Banks- Balance of Payments - Meaning and methods of Exchange control Methods of Foreign Payments - IMF, IBRD, WTO- Agreements of WTO and its Impact on Indian Economy. (9)

NATIONAL INCOME

Meaning - National Income - Concepts -Methods of Calculating and Problems in calculating National Income - Inflation - Causes - Measures -Deflation - Stagflation - Phillips Curve - Unemployment New Environment Policy- Liberalisation -Privatisation - Globalisation. (8)

HUMAN RESOURCE MANAGEMENT

Principles of Management, Evolution of Management, Development of Managerial Skills- Human Resource Management-Importance- Objectives- Job Analysis- Recruitment- Selection and Placement and Training Development. (7)

TOTAL : 45

TEXT BOOKS

1. Dewett. K. K., & Navalur M.H., "Modern Economic Theory", S. Chand and Company Ltd, New Delhi, 2014
2. Lipsey & Chrystal, "Economics", Oxford University Press, 2010
3. V. S. Bagad, "Principles of Management", Technical Publication, Pune

REFERENCES

1. Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.
2. Francis Cherunullem, "International Economics", McGraw Hill Education, 2011.
3. William A McEachern & Smrit Kaur, "Micro Economics", Cengage Learning, 2013.
4. William A McEachern & Indira A., "Macro Economics", Cengage Learning, 2014.
5. Lipsey & Chrystal, "Economics", Oxford University Press, 2010.
6. <https://nptel.ac.in/courses/112/107/112107209/>

19EEOE01 - ENERGY AUDITING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1* : Exhibit Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing
- CO2* : Compute the thermal efficiency of various thermal utilities and use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.
- CO3* : Analyse the cost- benefit of various investment alternatives for meeting the energy needs of productive processes through energy conservation study.
- CO4* : Illustrate the energy saving techniques to reduce power consumption of the non- productive loads
- CO5* : Advocacy of strategic and policy recommendations on energy conservation and energy auditing.

ENERGY AUDIT

Global energy scenario - Heat and Electrical energy - Role of energy managers in industries - Energy auditing -Types of energy audit- Data to be collected in auditing - Needs, methodology and types of energy audits - Simple payback period - Net present value of saving- Energy audit report (9)

ELECTRICAL ENERGY CONSERVATION

Basic Industrial electrical distribution- energy saving and energy efficiency with Transformers, reactive power correction and cable loss reduction- Energy saving in lighting systems -Specific Energy Consumption (SEC) - Load management - Demand Side Management (DSM). (9)

HEAT ENERGY CONSERVATION

Energy Audit - Losses in Boiler - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications- Cogeneration- Heating, ventilation and air conditioning systems (HVAC) :Types - energy conservation in cooling towers and Spray ponds. (9)

BUILDING, TRANSPORT AND UTILITY ENERGY CONSERVATION

Real buildings systems: Consumption - Cost versus lifecycle cost - Building design - Water supply systems Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Energy conservation inpumps, and fan and blowers - Energy efficient motors. (9)

ENERGY AUDIT PLANNING AND MONITORING

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM). (9)

TOTAL : 45

TEXT BOOKS

1. D. P. Sen Gupta, K. R. Padiyar, IndranilSen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.

2. *AmlanChakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2012.*
3. *YP.Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.*
4. *Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2007.*
5. *C.B. Smith, "Energy Management Principles", Pergamon Press, New York, 1981.*

REFERENCES

1. *"General Aspects of Energy Management and Energy Audit-Unit- 1,2,3,4", BEE Guide book, 2010.*
2. *Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & case study", Hemisphere, Washington, 1980.*
3. *Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.*
4. *Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall, May 1984*
5. *Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988.*

19EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Summarize the solar radiation, measurements and characteristics of solar PV cell.

CO2 : Develop the model of a PV system and its applications.

CO3 : Illustrate the basic types, mechanical characteristics and model of wind turbine.

CO4 : Analyse the electrical characteristics and operation of various wind-driven electrical generators.

CO5 : Utilize various power electronic converters used for hybrid system.

SOLAR RADIATION AND SOLAR CELL FUNDAMENTALS

Basic characteristics of sunlight - solar spectrum - insolation specifics- irradiance and irradiation pyranometer - solar energy statistics- Solar PV cell - I-V characteristics -P-V characteristics- fill factor. Modeling of solar cell- maximum power point tracking. (9)

SPV SYSTEM PERFORMANCE AND APPLICATIONS

PV module - blocking diode and by-pass diodes- composite characteristics of PV module - PV array - solar cell array design concepts - Peak power operation-System components. PV- powered fan-PV fan with battery backup - PV-powered pumping system - PV powered lighting systems - grid - connected PV systems. (9)

WIND ENERGY FUNDAMENTALS AND COMPONENTS

Wind source-wind statistics-energy in the wind- Basic principle of wind energy conversion - nature of wind - power in the wind -turbine power characteristics- parts of wind turbines- braking systems-tower-Maximum power operation. (9)

WIND TURBINE TYPES AND CONTROL

Classification of WECS - Generating Systems - DC generator, Synchronous generator, Induction -generator, Doubly fed Induction generator, Direct -driven generator- generator control - load control. (9)

SYSTEM INTEGRATION

Energy storage-Power electronic converters for interfacing wind electric generators - power quality issues- Hybrid system: wind - diesel systems, wind-solar systems. (9)

TOTAL : 45

TEXT BOOKS

1. S N Bhadra, S Banerjee and D Kastha, "Wind Electrical Systems", Oxford University Press, 1st Edition, 2005.
2. Chetan Singh Solanki, "Solar Photovoltaic's: Fundamentals, Technologies and Applications" PHI Learning Publications, 3rd Edition, 2015.

REFERENCES

1. Roger A. Messenger and Jerry Ventre, "Photovoltaic systems engineering", Taylor and Francis Group Publications, 2020.

2. *M. Godoy Simoes and Felix A. Farret, "Alternative Energy Systems: Design and Analysis with Induction Generators", CRC press, 2nd Edition, 2008.*
3. *Ion Boldea, "The electric generators hand book - Variable speed generators", CRC press, 2015.*

19EEOE03 - ELECTRICAL SAFETY PROCEDURES AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify and analyze the precautions and protection of electrical hazards

CO2 : Select and use the suitable personal protective equipment according to the working environment

CO3 : Interpret the safety procedures for the specific work place

CO4 : Analyze and apply the various grounding techniques

CO5 : Infer the electrical safety against low voltage and high voltage and to manage the medical equipments

INTRODUCTION AND HAZARDS OF ELECTRICITY

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only) (9)

ELECTRICAL SAFETY EQUIPMENT

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/ Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials. (9)

SAFETY PROCEDURES

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit. (9)

GROUNDING AND ELECTRICAL MAINTENANCE

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing - Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard. (9)

VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure- Stationary battery safety - Accident prevention - Accident investigation - First aid - Rescue techniques - Electrical safety program structure and development - Safety meetings - Safety audits. (9)

TOTAL : 45

TEXT BOOK

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th edition, Mc Graw Hill, 2012

REFERENCE S

1. *Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013*
2. *Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014*
3. *Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection association, Quincy, 2011*
4. *Electrical Safety booklets issued by Government bodies*

19EEOE04 - ENERGY EFFICIENT ILLUMINATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1* : Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.
- CO2* : Perform the calculation of luminance parameters in various applications.
- CO3* : Identify the criteria for selection of lighting equipment's and control systems in various applications.
- CO4* : Impart design and technology for Interior lighting and Exterior lighting applications
- CO5* : Review the various technologies used in Smart lighting systems.

INTRODUCTION : BASICS OF LIGHTING

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting. (7)

LIGHTING CALCULATIONS AND LIGHT SOURCES

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software.

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps - Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy. (12)

LIGHTING EQUIPMENTS AND STANDARDS

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system. (9)

LIGHTING APPLICATIONS

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles. (8)

SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting. (9)

TOTAL : 45

TEXT BOOKS

1. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.
2. Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008

3. Leon Gaster, John Stewart Dow, *"Modern Illuminants and Illuminating Engineering"*, Nabu Press, Washington DC, 1st Edition, 2010.
4. Philip Gordon., *"Principles and Practices of Lighting Design: The Art of Lighting Composition"*, Blue Matrix Productions, 2011.

REFERENCES

1. *Lighting Engineering: Practical Hand Book, INDALUX 2002*
2. *IES Lighting Handbook, 10th Edition, 2011.*
3. *NPTEL Course: Illumination Engineering*
4. *Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.*

19EEOE05 - ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Apprehend the fundamentals and importance of electric vehicles and its components

CO2 : Select the suitable drive scheme based on the motor and topology for the given specification and applications

CO3 : Design and categorize the battery system for electric vehicles and hybrid electric vehicles

CO4 : Recognize the suitable battery charging scheme for different environments and applications.

CO5 : Describe the significance of E-mobility and its various business opportunities

ELECTRIC VEHICLES

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance - Gradability (9)

ELECTRIC PROPULSION

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives - Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- Matching the electric machine and the internal - combustion engine (ICE), Sizing the propulsion motor, sizing the power - electronics, selecting the energy storage technology, Communications- supporting subsystems (9)

BATTERIES

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices (9)

BATTERY CHARGING

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolated charger topology - Transformer less topologies. (9)

E-MOBILITY

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). (9)

TOTAL : 45

TEXT BOOKS

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition* CRC Press, 2018.
2. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition*, CRC Press, 2021

REFERENCES

1. James Larminie, John Lowry, *Electric Vehicle Technology Explained, 2nd edition*, Wiley, 2012
2. Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.
3. J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd edition, London, UK, 2010.
4. R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.
5. Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.

19EEOE06 - ENERGY EFFICIENCY IN THERMAL AND ELECTRICAL UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Preaudit the energy

CO2 : Analyse the possibility of energy savings

CO3 : Analyze the methods of energy savings

CO4 : Design the solutions

CO5 : Identify and perform appropriate energy management

ENERGY EFFICIENCY IN THERMAL UTILITIES - I

- Fuels and Combustion: Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal, and gas.
- Boilers: Types, combustion in boilers, performance evaluation, analysis of losses, feedwater treatment, blowdown, energy conservation opportunities..
- Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.
- Insulation and Refractories: Insulation-types and application, the economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss.
- FBC boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, Retrofitting FBC system to conventional boilers, saving potential. **(9)**

ENERGY EFFICIENCY IN THERMAL UTILITIES - II

- Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate, and flash steam recovery system, identifying opportunities for energy savings
- Cogeneration: Definition, need, application, advantages, classification and saving potentials.
- Waste Heat Recovery: Classification, advantages, and applications, commercially viable waste heat recovery devices, saving potential.
- Energy Management & Audit: Definition, need and types of an energy audit. Energy management (audit) approach- understanding energy costs, benchmarking, energy performance, matching energy use to the requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.
- Material and Energy balance: Facility as an energy system, methods for preparing process flow, material, and energy balance diagrams. **(9)**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

- Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.
- Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy-saving opportunities with energy- efficient motors.

- Energy-Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy-efficient motors, soft starters with energy savers, variable speed drives, energy-efficient transformers, electronic ballasts, occupancy sensors, energy-efficient lighting controls. (9)

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - I

- Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities
- HVAC and Refrigeration System: Vapor compression refrigeration cycle, refrigerants, the coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.
- Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system, saving potentially
- Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.
- Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. (9)

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - II

- Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy-saving opportunities assessment of cooling towers.
- Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.
- Diesel Generating system: Factors affecting the selection, energy performance assessment of diesel conservation avenues (9)

TOTAL : 45

ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT AND UTILITY SYSTEMS

Open Book examination on the following energy performance assessments for equipment and utility systems:

- Boilers, Furnaces
- Cogeneration, Turbines (gas, steam)
- Heat Exchangers
- Electric Motors, Variable Speed Drives
- Fans and Blowers, Water Pumps, Compressors
- HVAC systems
- Lighting Systems
- Performing Financial Analysis.
- Applications of Non-conventional & Renewable Energy Sources (NRES)
- Waste minimization and resource conservation

TEXT BOOKS

1. Mehmet Kanolu, Yunus A. Çengel, "Energy efficiency and management for engineers", McGraw- Hill Education, 2020
2. Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Handbook", 9th edition, River Publishers, Taylore and Francis Group, 2020
3. Energy Efficiency in Thermal Utilities, Bureau of Energy Efficiency (BEE), Guide books
4. Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency (BEE), Guide books

REFERENCES

1. *Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2017*
2. *Wayne C. Turner, "Energy Management Handbook", Eighth Edition, 2012*
3. *Stephen A. Roosa, Steve Doty, "Energy Management Handbook", 2018*
4. *General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency (BEE), Guide books*
5. *Energy Performance Assistance for Equipment and Utility Systems, Bureau of Energy Efficiency (BEE), Guide books*

19ECEOE01 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

- CO1* : Compute the Discrete Fourier Transform (DFT) of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms and design FIR/IIR Filters
- CO2* : Apply source coding procedure to calculate coding efficiency based on entropy & mutual information and outline different pulse analog modulation techniques
- CO3* : Analyze various equalization techniques and compare its performance
- CO4* : Calculate channel capacity using Shannon's channel capacity theorem and develop channel error control codes
- CO5* : Analyze speech processing methods in time and frequency domain and design codec methods for speech compression techniques

ORTHOGONAL TRANSFORMS AND DIGITAL FILTER STRUCTURES

DFT-DCT-Properties of DFT- Computation of DFT, FFT and structures-Decimation in time-Decimation in frequency - Linear convolution using DFT

Basic FIR/IIR filter structures-FIR/IIR Cascaded lattice structures-Parallel allpass realization of IIR transfer functions- Sine cosine generator - Computational complexity of filter structures (10)

DATA COMPRESSION

Information entropy-Source coding-Huffman algorithm-Delta Modulation-Adaptive Delta Modulation- Continuously Variable Slope Delta Modulation-Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation. (8)

SIGNAL PROCESSING IN COMMUNICATION RECEIVER

Temporal Equalization-Space Time Equalization-Frequency Domain Equalization-Symbol Timing Recovery- Channel Quality Estimation- Automatic Frequency Control-Overall Receiver Block. (9)

ERROR CORRECTING CODES & CHANNEL CODING

Error Correcting codes-Error Correction-Linear Blocks Codes-Cyclic Codes- Bose, Chaudhari and Hocquenghem Codes- Convolution Codes-Viterbi Decoding-Interleaving Codes-Concatenated Codes- Turbo Codes. (9)

SPEECH CODING

Speech Coding-Adaptive Predictive Coding-Sub Band Coding,-Vocoders-Liner Predictive Coding- Image Coding-Joint Photo Graphic Expert Group (JPEG)-Moving Pictures Expert Group (MPEG), the layer-3 of MPEG-1 Algorithms(MP3),Lempel- ZIV Algorithms - Recognition techniques:Speech Recognition and Image recognition. (9)

TOTAL : 45

TEXT BOOKS

1. V. Oppenheim, R. W. Shafer and J.R.Buck, "Discrete-Time Signal Processing", Pearson Education, 3rd Edition, 2011.
2. Simon Haykin, "Digital Communications Systems", 1st Edition, Wiley, 2013.

REFERENCES

1. Sanjit. K. Mitra and Sanjit Kumar Mitra, "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.
2. Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 2005.
3. Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003
4. L.R.Rabiner and R.W.Schaffer "Digital Processing of Speech signals" Prentice Hall 1978
5. Nirmal K. Bose, Calyampudi Radhakrishna Rao, "Signal Processing and Its Applications" North-Holland, 1993

19ECEOE02 - SMART SENSORS AND IoT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the classification ,types,packaging and testing of smart sensors

CO2 : Interpret the construction and working principles of Electronic sensors

CO3 : Exemplify the working of different types of light radiation sensors .

CO4 : Illustrate the key concepts of temperature ,gas and airquality sensors used to measure the parameters.

CO5 : Interpret the characteristics, functional blocks and architecture of IoT to develop an IoT based applications.

SMART SENSORS BASICS

Sensor Classification, Performance and Types, Error Analysis characteristics- Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications-Testing Smart Sensors- HVAC Sensor Chip- Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control-MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. (9)

ELECTRONIC SENSORS

Resistance strain gauge - piezoelectric pressure gauge - characteristics- load cells-torque sensor- Piezo-resistive and capacitive pressure sensor- optoelectronic pressure sensors- vacuum sensors- Capacitor plate sensor, Inductive sensors, LVDT- Hall effect- Doppler detectors- liquid level detectors, flow sensors - ultrasonic sensor- flow sensors. (9)

GHT RADIATION SENSORS

Electronic and Optical properties of semiconductor as sensors - LED - Semiconductor lasers- Fiber optic sensors- Thermal detectors - Photo multipliers- photoconductive detectors- Photo diodes- Avalanche photodiodes - CCDs - Intensity sensor - Interferometers-Phase sensor: Phase detection, Polarization maintaining fibers. (9)

TEMPERATURE, GAS AND AIR QUALITY SENSORS

Bimetallic strip- Bourdon temperature gauge- thermocouples- Resistance thermometers- thermistors- bolometer- Pyroelectric detector-Engine combustion process- Catalytic exhaust after treatment, Emission limits- Exhaust sensors and Engine control - Exhaust sensors for OBD- Hydro-Carbon Sensors- NOx-Sensors-Oxygen Sensors- Measurement of oxides of sulphur,oxides of nitrogen unburnt hydrocarbons, carbonmonoxide, dust mist and fog- smoke sensors. (9)

IoT AND ITS APPLICATIONS

IoT Definition - Characteristics - IoT Functional Blocks -IoT Architecture -Physical design of IoT - Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management. (9)

TOTAL : 45

TEXT BOOKS

1. Jacob Fraden, "Handbook of modern sensors: physics, designs, and applications", 5th Edition, Springer, 2016.
2. Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, Boston, 2011.

REFERENCES

1. Arshdeep Bahga, Vijay Madiseti, "Internet of Things - A hands-on approach", Universities Press, 2015.
2. Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier, 1st Edition, Netherland, 2011.
3. John G Webster, "Measurement, Instrumentation and sensor Handbook", CRC Press, 2nd Edition, Florida, 2017.
4. John P. Bentley, "Principles of Measurement systems", 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.
5. D. Patranabis, "Sensors and Transducers", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.
6. Ernest O Doebelin, Dhanesh N Manik, "Measurement Systems, Application and Design", McGraw Hill, 6th Edition, 2007.

19ECEOE03 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand the various types of microphones and loudspeaker.

CO2 : Explain the principle and working of Monochrome TV.

CO3 : Describe the Colour TV scanning process and camera tube.

CO4 : Illustrate LCD, LED TV, working of cable TV and DTH.

CO5 : Interpret the significant technical considerations using a broad systems perspective.

AUDIO SYSTEMS

Microphones Carbon, moving coil, wireless microphone; Loudspeakers - Direct radiating Electrostatic and horn loudspeaker; Multi-speaker system; Sound Recording - Magnetic Recording, Digital Recording, Optical Recording (CD system and DVD). (9)

MONOCHROME TV

Elements of TV communication system, Scanning process, Scanning methods and Aspect Ratio, Need of synchronizing and blanking pulses, Composite Video Signal, Camera Tube: Vidicon. (9)

COLOUR TELEVISION

Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, Concept of Compatibility with Monochrome Receiver, NTSC, PAL, SECAM. (9)

LCD AND LED TELEVISION

Basic principle and working of LCD & LED TV, Cable Television: Working of Cable TV, DTH (9)

DOMESTIC & CONSUMER APPLIANCES

Operation of Microwave Oven, Automatic Washing Machine, Photostat Machine, Digital Camera, Vacuum cleaner, Food Processors, Scanner. (9)

TOTAL : 45

TEXT BOOKS

1. Bali S.P., "Consumer Electronics" Pearson Education, 2017.
2. Bali R and Bali S.P. "Audio video systems: principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd., 2010.

REFERENCES

1. Gulati R.R., "Modern Television practices" New Age International Publication (P) Ltd.2011.
2. Gupta R.G, "Audio video systems" Tata Mc graw Hill, 2nd Edition, 2010.
3. Whitaker Jerry & Benson Blair, "Standard Handbook of Audio engineering" McGraw-Hill Professional, 3rd Edition, 2010.
4. Amit Dhir, "The Digital Consumer Technology Handbook", Elsevier Science, 2004.

19ECEOE04 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

Upon completion of this course, students will be able to demonstrate an ability to

CO1 : Describe the concepts of robotics, safety measures and homogeneous transformation.

CO2 : Formulate the concepts of mechanical drives and sensors in robotics.

CO3 : Describe the types of sensors and Robotic Vision

CO4 : Develop robotics programming, classifications and its applications.

CO5 : Exemplify the concepts of artificial intelligence.

ROBOT KINEMATICS

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics. (10)

ROBOTIC DRIVERS AND CONTROLS

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism. (9)

SENSORS AND MACHINE VISION

Need for sensing systems- Principles and Applications of the following types of sensors- Position and displacement sensors - Potentiometers, Encoders, Linear Variable Differential Transformer, Force and Torque sensors- Wrist sensor, Joint sensor, Tactile array sensor, Slip sensors- Proximity sensors- Range finders- Imaging sensors- Inductive Proximity switch- Acoustic sensors- Opto-electronic sensors- Lighting Techniques, Robot Vision- Sensing and Digitizing, Image Processing and analysis- Preprocessing, Segmentation, Description, Recognition, Interpretation and Applications of robot vision system (9)

ROBOTIC LANGUAGE AND PROGRAMMING

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language. Applications of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance. (8)

ARTIFICIAL INTELLIGENCE IN ROBOTICS

The history of Artificial Intelligence- Artificial and Natural Intelligence- Artificial Intelligence and Automated manufacturing- The application domains of Artificial Algorithms- Risks and Benefits of AI- Agents and Environments- Knowledge representation. (9)

TOTAL : 45

TEXT BOOKS

1. Satya Ranjan Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, 2nd Edition, 2012.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.

REFERENCES

1. Robin.R.Murphy, "Introduction to AI Robotics", The MIT Press, Cambridge, Massachusetts, London, England, Second Edition, 2019.
2. Jadran Lenarcic, Jean-Pierre Merlet, "Advances in Robot Kinematics 2016", Springer International Publishing AG, 2018.

3. Peter McKinnon, *"Robotics"*, CreateSpace Independent Publishing Platform, 2016.
4. Ritu Tiwari, Anupam Shukla, Rahul Kala, *"Intelligent Planning for Mobile Robotics: Algorithmic Approaches"*, Information science reference, United states of America, 2013.
5. David. L. Pool and Alan. K. Mackworth, *"Artificial Intelligence: Foundations of Computational agents"*, Cambridge University, 2011.

19ECEOE05 - INFORMATION THEORY AND CODING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the information content in a discrete memoryless source through parameters such as entropy and mutual information.

CO2 : Estimate a channel's capacity based on Shannon's channel capacity theorem

CO3 : Analyze various channel encoding and decoding methods

CO4 : Design and develop an error control coding methods for random error and burst error detection and correction techniques

CO5 : Understand different applications in coding techniques

INFORMATION THEORY AND SCHEMES FOR SOURCE CODING

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel

SOURCE CODING : Prefix codes - Necessary conditions for source coding - Kraft Mcmillan Inequality- Huffman Coding- Shannon Fano Coding Efficiency calculations. (9)

MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING

Discrete Memoryless Channel - Channel models - BSC and BEC channels - Cascaded channels - Channel capacity of discrete and analog channels - Channel capacity of a Gaussian channel-Bandwidth-S/N trade-off-Channel coding theorem - Information capacity theorem - Code rate and redundancy-Parity check codes - Rate Distortion Theory. (9)

LINEAR BLOCK CODES AND CYCLIC CODES

Rationale for coding - Types of codes - Matrix description of linear block codes - Syndrome decoding - Minimum distance considerations -Repetition codes - Dual codes- Cyclic codes :Generator polynomial - Parity check polynomial - Encoder of cyclic codes - Calculation of syndrome - Cyclic codes for error correction. (10)

CONVOLUTIONAL CODES

Convolutional codes : Tree codes- Trellis codes- Viterbi decoding of convolutional codes - Catastrophic Error Propagation in Convolutional Codes -Performance Bounds for Convolutional Codes - Coding Gain - Convolutional Code Trade off - Soft Decision Viterbi Decoding -Feedback Decoding - Sequential Decoding (8)

CODING TECHNIQUES IN DATA COMPRESSION

Static and Dynamic Huffman coding - Arithmetic coding - Run length encoding- Lempel-Ziv coding -Image compression techniques -JPEG standard for Lossy and Lossless compression- Video compression standards. (8)

TOTAL : 45

TEXT BOOKS

1. Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.
2. Ranjan Bose, "Information Theory Coding and Cryptography", Tata McGraw Hill, 3rd Edition 2016.

REFERENCES

1. *Richard B. Wells, "Applied Coding and Information Theory for Engineers", Pearson Education, 1st Edition Indian reprint, 2009.*
2. *Khalid Sayood, "Introduction to Data Compression", 4th Edition, Elsevier, 2012.*
3. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*
4. *Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons, 2nd Edition, 2006.*
5. *Reza F M, "An Introduction to Information theory", McGraw Hill, 2000.*
6. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 1st Edition, 2021.*

19ECEOE06 - WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

- CO1 : Outline the challenges & issues in the wireless sensor network and its subsystems and interpret network architecture and its components
- CO2 : Describe the essential principles of the MAC protocols for Wireless Sensor Networks
- CO3 : Elucidate the Routing & localization tracking in Wireless Sensor Networks
- CO4 : Discuss the features of WSN Operating systems
- CO5 : Illustrate the methodologies to provide WSN based solution for various critical issues.

SENSOR NETWORKS - INTRODUCTION & ARCHITECTURES

Challenges for Wireless Sensor Networks-Enabling Technologies for Wireless Sensor Networks- Characteristic requirements for WSN - WSN architecture - Commercially available sensor nodes -Imote, IRIS, Sunspot -Physical layer and transceiver design considerations in WSNs-Single Node Architecture -Energy Consumption of Sensor Nodes- Sensor Network Scenarios- Optimization Goals and Figures of Merit. (9)

DATA LINK LAYER

Fundamentals of MAC protocols- Issues in designing a MAC Protocol for WSN - Low duty cycle protocols and wakeup concepts - Contention based protocols:PAMAS - Schedule-based protocols:LEACH - Sensor MAC - Berkeley MAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4- Link Layer protocols - fundamentals task and requirements, error control, framing, link management, Address and Name Management, Assignment of MAC Addresses, Unique,Content-based and geographical addressing. (10)

ROUTING AND TRACKING

Routing Challenges and Design Issues in Wireless Sensor Networks- Taxonomy :Data-centric routing SPIN - Energy aware routing, Gradient-based routing -Hierarchical Routing LEACH -Location Based Routing GAF, Data aggregation - Various aggregation techniques

A Tracking Scenario - Problem formulation - Distributed representation and inference of states- Tracking multiple objects - Sensor models - Topology control - Clustering - Time synchronization - Localization and Localization Services (10)

EMBEDDED OPERATING SYSTEMS FOR WSNs

Embedded Operating Systems: Operating Systems for WSNs - Introduction - Operating System Design Issues- Introduction to Tiny OS - NesC - Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM. (7)

APPLICATIONS OF WSN

WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications - Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling (9)

TOTAL : 45

TEXT BOOKS

1. *Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, First Edition, 2007.*
2. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.*

REFERENCES

1. *Anna Hac, "Wireless Sensor Network Design", John Wiley & Sons, First Edition, 2003.*
2. *C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer Publication, 2004.*
3. *Paolo Santi, "Topology Control in Wireless Adhoc and Sensor Networks", John Wiley & Sons, 2005.*
4. *Philip Levis, David Gay, "TinyOS Programming", Cambridge University Press, 2009 Contiki - Open Source Operating System for IoT - <http://www.contiki-os.org/>*

19ECEOE07 - AUTOMOTIVE EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Design modules for hybrid vehicle using automotive system components.

CO2 : Design control system in automotives by appropriate choice of Microcontrollers, Sensors and actuators.

CO3 : Examine the communication protocols for real time applications

CO4 : Understand the safety and comfort in Automobiles as per the government test procedures.

CO5 : Understand the communication and diagnostic protocols

AUTOMOTIVE SYSTEMS

Overview of Automotive industry - Tools and Processes - Introduction to modern automotive systems -Spark and Compression Ignition Engines - Automotive Transmissions - Vehicle braking fundamentals -Steering Control - Overview of Hybrid Vehicles - Analog and Digital Systems - Basic measurements systems. (9)

SENSORS AND ACTUATORS

Sensors: Characteristics, response and modeling - Actuators - Microcontroller and Digital Signal Processors used for automotive applications. (9)

EMBEDDED COMMUNICATION

Embedded Automotive Protocols: CAN, LIN, FLEXRAY, MOST (9)

SAFETY SYSTEMS

Active Safety Systems: ABS, TCS, ESP, brake assist - Passive Safety Systems: Airbag systems, Advance Driver Assistance system (ADAS) -Computer vision techniques - Connected cars technology - Trends towards Autonomous vehicles. (9)

FUNDAMENTALS OF DIAGNOSTICS

Basic wiring system and Multiplex wiring system, Self-Diagnostic system - various On board and off board diagnostics in Automobiles - Diagnostics tools - Diagnostics Protocols: KWP20000 and UDS. (9)

TOTAL : 45

TEXT BOOK

Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.

REFERENCES

1. William B. Ribbens, Ph.D, "Understanding Automotive Electronics", Elsevier Publications, 7th Edition, 2012.
2. Tom Denton, "Advance Automotive Diagnosis", 2nd Edition, Elsevier 2006.
3. BOSCH Automotive Handbook, 8th Edition.
4. Denton. T, "Automobile Electrical and Electronics Systems", SAE (Society for Automobile Engineers) International, 3rd Edition, 2004.
5. Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.

19ECEOE08 - 5G TECHNOLOGIES AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : describe the evolution of cellular systems from 2G to 4G

CO2 : explain the motivation, targets of 5G technology and its standardization

CO3 : elaborate the 3GPP releases and 5G radio access network architecture

CO4 : discuss the services offered by 5G deployment and its design approaches

CO5 : understand the role between 5G and emerging next generation wireless technologies

EVOLUTION OF CELLULAR SYSTEMS

Evolution from 2G to 3G and 3G to 4G - Circuit Switch to Packet Switch - ITU Standardization Process- - Evolution of LTE and releases. (9)

INTRODUCTION TO 5G

Motivation for 5G - 5G targets - Technology components - Spectrum - capabilities - The role of 3GPP in standardization - use cases - 5GPPP (Public-Private Partnership) (9)

5G RADIO ACCESS NETWORK

Radio access - 3GPP Releases - 5G New Radio (NR) - Requirements - 3GPP phases for IMT-2020 - NR air interface - 5G RAN architecture (9)

5G SERVICES

Enhanced Mobile Broadband (eMBB) systems - Massive Machine Type Communication (MMTC) system - Ultra Reliable and Low Latency Communication (URLLC) systems - Design approaches (9)

EMERGING TECHNOLOGIES IN 5G

Massive MIMO - Network Function Virtualization - Software Defined Networking - Cognitive radio - Millimetre Wave - Heterogeneous network - Internet of Things (9)

TOTAL : 45

TEXT BOOKS

1. Saad Asif, "5G mobile Communications Concepts and Technologies", CRC Press,2018
2. Biljana Badic, Christian Drewes, Ingolf karls, Markus Mueck, "Rolling out 5G Use cases, Applications and Technology Solutions", Apress, 2016

REFERENCES

1. Antti Toskala, Harri Holma, Takehiro Nakamura, "5G Technology 3GPP New Radio", Wiley & Sons Ltd. 2020.
2. Devaki Chandramouli, Juho Pirskanen, Rainer Liebhart, "5G for the Connected World", Wiley,2019
3. Haesik Kim, "Design and Optimization for 5G Wireless Communications", Wiley, 2020
4. Ramjee Prasad, "5G Outlook Innovations and Applications", River Publications, 2016
5. Anwer Al-Dulaimi, "5G Networks Fundamental Requirements, Enabling Technologies, and Operations Management", Wiley, 2018
6. Mauro Boldi, Olav Queseth, Patrick Marsch, Ömer Bulakci, "5G System Design Architectural and Functional Considerations and Long Term Research", Wiley,2018

19ECEOE09 - VEHICULAR COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand basic principles, technologies, and system architecture of vehicular ad-hoc networks (VANET)

CO2 : Analyze Physical Layer and MAC Layer for signal propagation for vehicular communication

CO3 : Describe the various routing mechanisms and protocols to fulfill vehicular networking requirements.

CO4 : Explain the challenges and issues in establishing cellular V2X connection and mobility management.

CO5 : outline vehicular communication platforms for various emerging applications

INTRODUCTION TO VEHICULAR RADIO NETWORKS

Basic principles and challenges-Mobile Wireless Communications and Networks-Need for Vehicular Communications-VANET activities- Network Architecture for Vehicular Communications. (9)

PHYSICAL LAYER AND MAC LAYER

Signal Propagation-Doppler spread and its impact on OFDM Systems-Proposed MAC approaches and standards, Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC (10)

VANET ROUTING PROTOCOLS

Opportunistic packet forwarding-topology based routing- geographic routing (8)

VEHICULAR MOBILITY MANAGEMENT

Connected Vehicles& Connected Autonomous Vehicles- Dedicated Short Range Communication-flow and traffic models-Standards and Regulations- DSRC Protocol Stack, Cellular V2X (9)

EMERGING VANET APPLICATIONS

Vehicle to Infrastructure Safety Applications-communication paradigms-message coding and composition-data aggregation-Security and Privacy (9)

TOTAL : 45

TEXT BOOKS

1. H. Hartenstein and K. P. Laberteaux, *VANET: Vehicular Applications and Inter-Networking Technologies*, John Wiley & Sons Ltd., 1st Edition 2010.
2. Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy", John Wiley & Sons Ltd 1st Edition 2012.

REFERENCES

1. P. H.-J. Chong, I. W.-H. Ho, *Vehicular Networks: Applications, Performance Analysis and Challenges*, Nova Science Publishers, 2019.
2. C. Sommer, F. Dressler, *Vehicular Networking*, Cambridge University Press, 2015.
3. Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication", Springer, 2010.
4. M. Watfa, *Advances in Vehicular Ad-Hoc Networks: Development and Challenges*, Information Science Reference, 2010.
5. H. Moustafa, Y. Zhang, *Vehicular Networks: Techniques, Standards, and Applications*, CRC Press, 2009.
6. Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015

19ECEOE10 - SENSING FOR AUTOMOTIVE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Acquaint with the basic automotive system components and need for automotive sensors.

CO2 : Discuss the fundamentals of various Power train sensors in automotive systems.

CO3 : Comprehend various sensors for chassis management.

CO4 : Understand the sensors for vehicle management & security systems in Automobiles.

CO5 : Examine the vehicle communication protocols standards in automotive applications.

AUTOMOTIVE SYSTEMS

Introduction to Modern Automotive Systems- Electronics in Automobiles - Combustion Engines- Power-train- braking systems - Transmission- Applications and Challenges in the automotive. (9)

POWERTRAIN AUTOMOTIVE SENSORS

Exhaust temperature sensor - λ sensors - PM sensor - NOx sensor - fuel quality sensor- level sensor- torque sensor-speed sensor- manifold pressure sensor - mass flow sensor. (9)

CHASSIS SENSORS

Wheel speed sensors/direction sensors- steering position sensor (multi turn)- acceleration sensor (inertia measurement)- brake pneumatic pressure sensor- ABS sensor- electronic stability sensor. (9)

SENSORS FOR VEHICLE MANAGEMENT & SECURITY SYSTEMS

Gas sensors (CO₂)- Temperature/humidity sensor- air bag sensor- key less entering sensor- radar sensors. Tire pressure monitoring systems- Two wheeler and Four wheeler security systems. (9)

VEHICLE COMMUNICATION STANDARDS

Automotive Protocols : CAN, LIN, FLEXRAY, MOST (9)

TOTAL : 45

TEXT BOOK

John Turner, Automotive Sensors, 2010, Momentum Press, 1st Edition, New York.

REFERENCES

- 1. Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition, BOSCH.*
- 2. Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.*
- 3. Automotive Sensors Handbook, 8th Edition, 2011, BOSCH*
- 4. Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, Iwao Yokomori, "Sensors for Automotive Technology", 4th Edition, Wiley, New York, 2010.*
- 5. Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.*

19CSOE01 - CUSTOMER RELATIONSHIP MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1 : State the evolution of marketing and define CRM architecture explaining customer acquisition, retention and segmentation.*
- CO2 : Describe the business value, its costs and deploying data mining for CRM.*
- CO3 : Understand the type of collecting and connecting the customer data with proper guidelines for privacy.*
- CO4 : Demonstrate the scoring process and apply the various CRM optimization techniques to optimize the CRM process in order to improve customer profitability.*
- CO5 : Evaluate CRM tools using tool assessment and methodology to choose the appropriate tool for real time applications.*

INTRODUCTION

Most profitable Customer - CRM: Custom centered database, Managing campaigns, Evolution of marketing, Closed loop marketing, CRM architecture - Customer profitability - Customer acquisition - Cross selling - Customer retention - Customer segmentation. (9)

BUILDING THE BUSINESS CASE

Introduction - Uncovering the needs for data mining - Defining the business value - The costs - Deploying Data mining for CRM: Introduction - Define the problem - Define the user - Define the data - Scope the project - Trial - Quality assurance - Education Launch - Continuation. (10)

COLLECTING CUSTOMER DATA

Introduction - Three types of customer data - Collecting customer data - Connecting customer - Customer data and privacy - Privacy and data mining - Guidelines for privacy - Legal issues associated with data mining. (8)

SCORING YOUR CUSTOMER

Introduction - Process - Scoring architectures and configurations - Preparing the data - Integrating scoring with other applications- Optimizing the CRM process: Introduction - Improved customer profitability through optimization - Optimized CRM - Complete loop - Optimal CRM process - Optimization techniques. (8)

OVERVIEW OF DATA MINING AND CRM TOOL MARKETS

Introduction - Data mining market place - Taxonomy of data mining tools - Tool assessment attributes and methodology - Tool evaluation -Data mining tool: WEKA -CRM tools - Next generation for CRM. (10)

TOTAL : 45

TEXT BOOKS

- Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.*
- Ian H. Witten ,Eibe Frank, Mark A.Hall, "Data Mining Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Fourth Edition, 2016*

REFERENCES

1. Francis Buttle, Stan Maklan *"Customer Relationship Management: Concepts and Technologies"*, Routledge, Fourth Edition, 2019.
2. Roger J. Baran, Robert J. Galka, *"CRM: The Foundation of Contemporary Marketing Strategy"*, S.Chand (G/L) & Company Ltd, Second Edition, 2017.

19CSOE02 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1 : Describe the various software life cycle models and choose an appropriate model for a given application.*
- CO2 : Identify the functional requirements, prepare data flow, ER diagrams and Software Requirement Specifications.*
- CO3 : Employ suitable architectural styles, software design methodologies, coding standards and practices in developing practical applications*
- CO4 : Discuss various testing techniques and their application in defect removal.*

INTRODUCTION

The Software Engineering Discipline - Software Development Projects - Software Life Cycle Models: Use of Life Cycle Models - Classical Waterfall Model-Iterative Waterfall Model-Prototype model-Evolutionary Model-Spiral Model (9)

SOFTWARE REQUIREMENTS AND ANALYSIS

Requirements Analysis and Specification - Requirements Gathering and Analysis- Value of good SRS - Requirement process- Requirement Specification - desirable characteristics, components and Structure of requirements document - Functional Specification with use cases - basics - developing Use Cases -DFDs - Data Dictionary - ER Diagrams. (8)

SOFTWARE DESIGN

Design concepts - Cohesion and Coupling- The Open-Closed Principle - Function Oriented Software Design : Structured charts - Structured design methodology - Detailed Design: Logic / Algorithm design - State Modeling of Classes. (10)

CODING

Programming principles and guidelines - Structured programming - Information hiding - Some programming practices - Coding standards - Code inspection - Planning- Self review - Group review meeting. (7)

TESTING

Testing Fundamentals -Black Box Testing: Equivalence Class Partitioning - Boundary Value Analysis - White box Testing: Control Flow based criteria - Data Flow based Testing - Levels of Testing: Unit Testing - Integration Testing - System Testing - Acceptance Testing. (11)

TOTAL : 45

TEXT BOOKS

1. Pankaj Jalote, "Software Engineering A Precise Approach", Wiley India, Third edition 2012.
2. Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Private Limited, Third Edition 2013. (Introduction only)

REFERENCES

1. Roger.S.Pressman "Software Engineering A Practitioner's Approach", McGraw Hill International Edition, Seventh Edition, 2014.
2. Ian Sommerville, "Software Engineering", Dorling Kindersley (India) Private Ltd., Eighth Edition, 2008

19CSOE03 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1* : Gain knowledge in overview of www and web based applications.
- CO2* : Design and develop dynamic and Interactive web page using DHTML.
- CO3* : Design and develop web applications using servlets.
- CO4* : Gain knowledge on E-business models and E-marketing.

BASIC WEB CONCEPTS

Basic Web Concepts - Web based Client/Server model -Web Protocols- Working of web browser - Browser & Server Communication - Review of HTML: Markup Languages, Introduction to HTML- forms - frames - tables. (9)

CLIENT SIDE PROGRAMMING

Client-side Programming (Review of JavaScript): Introduction, Writing Comments, Variables, Operators, Statements, Alert, Confirm, and Prompt Boxes, Functions, Event and Error Handling, Introduction to Built-in Classes, Form Validation, Cookies. (9)

DYNAMIC HTML

Dynamic HTML :Introduction - cascading style sheets-object model and collections - event model - filters and transition - data binding - data control - ActiveX control - handling of multimedia data. (9)

SERVER SIDE PROGRAMMING

Servlets - Deployment of simple servlets - Web server (Java web server / Tomcat / Web logic) - HTTP GET and POST requests - Session tracking - Cookies - JDBC - Simple web applications - Multi-tier applications. (9)

WEB BASED APPLICATIONS AND ITS TECHNOLOGIES

Rails: Overview of Rails-Ajax: Overview of Ajax Rails with Ajax- e-Business Models-e-Marketing-online payments-Security.(9)

TOTAL : 45

TEXT BOOKS

1. Deital & Deital, "Internet and World Wide Web-How to Program", Pearson Education Fifth Edition, 2011.
2. Robert W.Sebesta, "Programming with World Wide Web", Pearson Education, Eighth Edition, 2015.

REFERENCES

1. Scot Johnson, Keith Ballinger, Davis Howard Chapman, "Special Edition Using Active Server Pages", Prentice Hall of India, paperback 1999.
2. Ravi Kalakota and Andrew B Whinston, "Frontiers of e-commerce", Addison Wesley, paperback 1999.
3. Jeffrey C. Jackson, " Web Technologies: A Computer Science Perspective", Pearson Education, Reprint 2011.
4. Elliotte Rusty Harold, "Java Network Programming", O'Reilly Publishers, Fourth Edition 2013.

19CSOE04 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the basic concepts, architecture, data models of database management systems and data warehouse.

CO2 : Demonstrate the multidisciplinary fields of data mining and illustrate the techniques for data preprocessing.

CO3 : Find frequent item set and generate association rules for the given transactions.

CO4 : Analyze different types of data using classification and clustering techniques.

BASIC CONCEPTS OF DATABASE SYSTEM

Purpose of DBMS - Applications - Views of data - Data Abstraction - Instances and Schemas - Data Models - Database Languages - Relational Databases - Database Architecture - Database users and administrators - History of Database systems. (8)

DATA MINING

Data Mining - On What Kind of Data-Data Mining Functionalities - Classification of Data Mining Systems - Data Mining Task Primitives - Integration of a Data Mining System with a Database or Data Warehouse System-Major Issues in Data Mining. (9)

DATA WAREHOUSING

Data Warehouse - Introduction-Multidimensional Data Model-Data Warehouse Architecture -Data Warehouse Implementation from Data Warehousing to Data Mining. (8)

DATA PREPROCESSING AND ASSOCIATION RULES

Data Preprocessing: Needs Preprocessing the Data - Data Cleaning- Data Integration and Transformation-Data Reduction-Discretization and Concept Hierarchy Generation. Association Rules: Basic concepts - Apriori Algorithm - Generation of association rules from frequent item sets - FP Tree Algorithm - Pattern evaluation methods (10)

CLUSTERING AND CLASSIFICATION

Cluster analysis - Partitioning Methods - K-Means and K-Medoid algorithm - CLARA - CLARANS - Hierarchical clustering - BIRCH - Density based clustering - DBSCAN - Decision tree induction. (10)

TOTAL : 45

TEXT BOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Tata McGraw Hill, Sixth Edition, 2013. (Basic Concepts of Database System only)
2. Jiawei Han & Micheline Kamber, "Data Mining-Concepts and Techniques" Morgan Kaufmann Publishers, Third Edition, 2012.

REFERENCES

1. Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.
2. Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.
3. Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh Indian Reprint New Delhi, 2003.
4. George M. Marakas, "Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003
5. Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.

19CSOE05 - INTRODUCTION TO EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1 : Examine the characteristics and challenges in embedded system development*
CO2 : Identify the parameters affecting CPU performance and develop optimized code
CO3 : Demonstrate the scheduling of given set of real-time tasks using the appropriate scheduling algorithm
CO4 : Design embedded system for simple applications

INTRODUCTION

Characteristics of embedded computing applications- Challenges in embedded computing design - Performance in embedded computing. Embedded System Design Process - Computer Architecture Taxonomy - ARM Processor -Assembly Language Programming. (10)

CPU PERFORMANCE

I/O Primitives - Busy -Wait I/O - Interrupts - Memory System Mechanisms: Cache, Memory Management Unit and Address Translation - Pipelining - CPU Power Consumption (8)

DEVELOPMENT AND DEBUGGING

Development environments - Debugging Techniques - Debugging challenges - System Level Performance analysis - Program Level Performance analysis - Program Optimization (9)

SCHEDULING

Scheduling states of a Process-Running Periodic Processes - Preemption - Priorities- Rate Monotonic Scheduling - Earliest Deadline First Scheduling - Priority Inversion - Data dependency. (10)

NETWORKS

Bus Standards: I2C, CAN Bus, Field Bus. CASE STUDY: Alarm Clock, Elevator Controller. (8)

TOTAL : 45

TEXT BOOK

1. Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman, Third Edition, 2012

REFERENCES

1. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education, First Edition, 2009. (For Scheduling)
2. David. E. Simon, "An Embedded Software Primer", Pearson Education, First Edition, 2012
3. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, Third Edition, 2014.

19ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1* : Explain various schemes of number system representations, code conversions and perform arithmetic operations.
- CO2* : Describe Boolean Algebra, formulate and simplify Boolean expressions using K-Maps and illustrate the logic gates realization.
- CO3* : Describe the working of basic combinational circuits and sequential circuits.
- CO4* : Describe the structure and functioning of various memory schemes.

NUMBER SYSTEMS

Binary Numbers, Number Base Conversions, Octal and Hexadecimal Numbers.

Complements of Numbers - Signed Binary Numbers. Binary Codes : Binary-Coded Decimal (BCD) Code, Gray Code, ASCII Character Code, Error Detecting Code. BCD Addition - Decimal Arithmetic. Binary Storage and Registers. (9)

BINARY LOGIC AND BOOLEAN ALGEBRA

Definition of Binary logic. Boolean Algebra - Basic Definitions - Theorems and Properties of Boolean Algebra - Canonical and Standard Forms. Digital Logic Gates : Integrated Circuits. Gate-Level Minimization: Map Method - Four Variable K-Map - Product of Sums Simplification. Realization of Boolean functions using Gates (9)

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers. (10)

SEQUENTIAL CIRCUITS

Storage Elements - Latches, Flip Flops - RS, D, JK and T flip -flops- Triggering of flip -flops - Characteristic Tables - Characteristic Equations. Registers - Shift Registers. Counters: Binary ripple counter - Up down binary counter. (9)

MEMORY AND PROGRAMMABLE LOGIC

Random Access Memory - Memory Decoding - Read Only Memory - Types of ROMs, Programmable Logic Array, Programmable Array Logic (8)

TOTAL : 45

TEXT BOOK

1. M. Morris Mano and Michael D. Ciet, "Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth Edition, 2013.

REFERENCES

1. M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, First Edition, 2008.
2. Thomas L.Floyd, "Digital Fundamentals", Pearson Education, Tenth Edition, 2011.

19ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1* : Describe the fundamental aspects of object oriented programming paradigm.
- CO2* : Develop java programs using features like methods, classes, constructors, overloading and string handling.
- CO3* : Write exception handling routines for practical applications.
- CO4* : Describe multithreading, synchronization and networking features of Java.
- CO5* : Demonstrate use of applets and database connectivity in developing practical Applications.

OBJECT ORIENTED PROGRAMMING

Introduction to object oriented languages - Evolution of object oriented languages - Object oriented programming paradigm - Basic concepts of object oriented programming - Procedural Vs object oriented programming. (6)

INTRODUCTION TO JAVA

Java and Internet - Byte Code - Features of Java - Java Development Environment- Java Programming: Methods and Classes- Constructor - Garbage Collection - Overloading - Inheritance - Overriding - Packages and Interfaces - Java IO systems - String Handling : String and String Buffer. (12)

EXCEPTION HANDLING

Exception Handling: Fundamentals of Exception handling and types - Built in Exceptions - User defined Exceptions. (5)

MULTI THREADS

Multithreaded Programming: Thread Model -Thread properties -Thread priorities - Synchronization- Inter thread communication- Networking :Inet address- Datagrams - Sockets - URL connections. (11)

APPLET AND DATABASE CONNECTIVITY

Introduction to Abstract Window Tool kit - Applet class - HTML applet tags - Parameter passing - Audio clip interface - Event class: Keyboard and Mouse events handling. (11)

TOTAL : 45

TEXT BOOK

1. Herbert Schilt : "Java 2 - Complete references ", Tata McGraw Hill, fifth Edition, McGraw Hill Education, 2014.

REFERENCE

1. Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.

19ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1* : Describe the database system concepts and explain the key features of Relational data models.
- CO2* : Describe the features of Entity Relationship diagram and draw Entity Relationship diagram for the given real world application
- CO3* : Design a normalized database system and carry out data retrieval using SQL.
- CO4* : Demonstrate various transaction concepts and various concurrency control mechanisms

DATABASE SYSTEMS

Data Vs Information-Introducing the database and DBMS- Importance of Database Design- Files and File systems-Problems with File System Data Management, Database Systems. Relational Database Model: Logical view of Data- Keys- Integrity Rules- Relational Set Operators- Data Dictionary and the system catalog -Codd's relational database rules. (10)

RELATIONAL MODEL

Entity Relationship Model: Entities-Attributes-Relationship-Connectivity and cardinality- Existence Dependence-Relationship Strength-Weak Entities-Relationship participation- Relationship Degree-Recursive Relationship-Developing an ER Diagram. (8)

STRUCTURED QUERY LANGUAGE

Introduction to SQL- Data Definition Commands- Data Manipulation Commands-Advanced Data Definition and SELECT Commands - Virtual Tables -Creating Views- Joining Database Tables. (8)

DATABASE DESIGN

Database Tables and Normalization- Need for Normalization- Normalization Process- Improving the Design-Surrogate Key Considerations, High level Normal Forms, Normalization and Database Design-Denormalization. (10)

TRANSACTION MANAGEMENT

Transaction Concepts: Transaction Properties- Transaction Concurrent Executions. Concurrency control with Locking Methods: Lock Granularity-Lock Types-Two-Phase Locking to Ensure Serializability-Deadlocks-Database Recovery Management-RAID. (9)

TOTAL : 45

TEXT BOOK

1. Peter Rob, Coras M.Colonel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth Edition, 2012.

REFERENCES

1. Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.
2. Ramez Elmasri, Shamkant B. Uvathe, "Fundamentals of Database Systems", Pearson Education, Sixth Edition, 2013.
3. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw Hill Education, Third Edition, 2014.
4. Thomas M.Connolly and Carolyn E.Begg, "A Practical Approach to Design, Implementation and Management", Pearson, 6th Edition, 2004.

19ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1 : Understanding the client- server, distributed collaborative and cloud computing architecture along with cloud storage and services.*
- CO2 : Classify the different virtualization environments and techniques.*
- CO3 : Illustrate various services deployed from a cloud architecture supported by different providers.*
- CO4 : Analyze the major security challenges and privacy problems in the cloud and virtual environment.*

INTRODUCTION

Understanding Cloud Computing- history of cloud computing: Client/Server computing, Peer to peer computing, Distributed computing and Collaborative computing.- Understanding cloud architecture, cloud storage and services-Pros and cons of cloud computing. (9)

VIRTUALIZATION

Introduction-Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization - Technology Examples (9)

CLOUD COMPUTING ARCHITECTURE

Cloud reference model: Architecture, Infrastructure / Hardware as a service, Platform as a service-Software as a service, Types of cloud: Public clouds, Private clouds, Hybrid Cloud, Community Clouds. (9)

CLOUD SERVICES

Discovering Cloud services Development services and tools: Amazon, Google App Engine, IBM, Salesforce.com, Other Cloud Services development tool (9)

CLOUD SECURITY

Security Overview - Cloud SecurityChallenges - Software as a Service Security - Security Governance - Risk Management - Security Monitoring - Security Architecture Design - Data Security - Application Security - Virtual Machine Security. (9)

TOTAL : 45

TEXT BOOKS

1. Michael Miller "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", 1st Edition, Pearson Education, New Delhi, 2009.
2. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013. (Virtualization, Cloud Computing Architecture)
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010. (Cloud Security)

REFERENCES

1. *Toby Velt, Anthony Velt, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.*
2. *Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2002.*
3. *Kai Hwang, Geoffrey C Fox, Jack GDongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2002.*

19ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Identify and analyze the security threats and attacks and apply device suitable security policies and standards.

CO2 : Assess the risks and apply suitable risk control strategies.

CO3 : Employ appropriate intrusion detection and prevention systems to ensure information security.

CO4 : Discuss various national and international laws of information security and its framework.

INTRODUCTION, NEED FOR SECURITY

Introduction to Information Security - The History of Information Security- Critical Characteristics of Information - NISTISSC Security Model - Components of an Information System - Securing Components - Balancing Information Security and Access - The Systems Development Life Cycle - The Security Systems Development Life Cycle. The Need for Security: Introduction Business Needs First -Threats -Attacks. (9)

RISK MANAGEMENT AND INFORMATION SECURITY

Introduction - An Overview of Risk Management - Risk Identification -Risk Assessment - Risk Control Strategies - Selecting a Risk Control Strategy - Risk Management Discussion Points - Recommended Practices in Controlling Risk. (9)

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001 and its controls, NIST Security Models, Design of Security Architecture - Security Education, Training and Awareness Program - Continuity Strategies. (6)

SECURITY TECHNOLOGY

Introduction - Intrusion Detection and Prevention Systems: IDPS Terminology, Use of IDPS, Strengths and Limitations of IDPS - Honey Pots, Honey Nets, and Padded Cell Systems - Scanning and Analysis Tools, Access Control Devices (6)

BIOMETRIC CONTROLS

Biometrics - Nature of Biometrics Identification/Authentication Techniques - Biometric Techniques - Matching and Enrollment Process in Biometrics - Benefits Over Traditional Authentication Methods. (6)

SECURITY OF WIRELESS NETWORKS

Attacks on Wireless Networks: Other Security Risks in Wireless Networks, Management and Mitigations for Wireless Networks Attacks. (7)

LAWS AND LEGAL FRAMEWORK

Introduction - Information Security and the Law: The Rising Need -Understanding the Laws for Information Security:A Conceptual Framework - The Indian IT Act - Laws for Intellectual Property Rights (IPR) -Health Insurance Portability and Accountability Act (HIPAA) - Building Security into Software/System Development Life Cycle. (7)

TOTAL : 45

TEXT BOOKS

1. Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Course Technology, New Delhi, Fourth Edition, 2012 Reprint.

2. *Nina Godbole, "Information Systems Security-Security Management, Metrics, Frameworks and Best Practices", Wiley India Pvt. Ltd., New Delhi, First Edition, 2009.(Biometric Controls, Security of Wireless Networks, Laws and Legal Framework)*

REFERENCES

1. *Thomas R.Pettier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.*
2. *Vicki Krause and Harold F.Tipton, "information Security Management Handbook", Auerbach Publications, Sixth Edition,2008.*
3. *Mark Merkow and Jim Breithaupt,"Information Security - Principles & Practices", Second Edition, Pearson Education, 2014.*

19ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1* : Describe the importance and need for effective user friendly Graphical User Interfaces (GUI).
- CO2* : Choose suitable interactions devices/tools to meet application specific requirements.
- CO3* : Design Graphical User Interfaces(GUI) using apt components and apply the design guidelines for user-friendly navigation and presentation.
- CO4* : Asses graphical user interfaces for compliance against the screen design guidelines.

INTRODUCTION

Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design (9)

THE GRAPHICAL USER INTERFACE & DESIGN PROCESS

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface.

Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions. (9)

SCREEN DESIGNING

Design Goals - Screen Planning and Purpose - Organizing Screen Elements - Ordering of Screen Data and Content - Screen Navigation and Flow - Visually Pleasing Composition - Amount of Information - Focus and Emphasis - Presenting Information Simply and Meaningfully - Information retrieval on web - Statistical Analysis - Technological considerations in Interface Design. (9)

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of DevicesBased on Screen Based Controls. Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. (11)

SOFTWARE TOOLS AND INTERACTION DEVICES

Specification Methods - Interface Building Tools - Keyboard and Function Keys - Pointing Devices Speech Recognition. (7)

TOTAL : 45

TEXT BOOKS

1. Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.
2. Ben Shneidermann, "Designing the User Interface", Fifth edition, Pearson Education Asia, 2013. (Software Tools and Interaction Devices)

REFERENCE

1. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition

19ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

- CO1 : Describe the operational aspects of ERP system and its related technologies.*
- CO2 : Demonstrate the steps required for ERP Project management and implementation process by choosing the right vendors/consultants, employee training and monitoring.*
- CO3 : Categorize the business modules of an ERP package in order to define the functionality of various departments in a company.*
- CO4 : Analyze the ERP market place and its vendors, and assess how Enterprise Application Integration (EAI), e-business help the company use ERP to its utmost benefit.*

INTRODUCTION

Enterprise - An Overview - Introduction to ERP - Benefits Of ERP - ERP and Related Technologies - Business Process Reengineering (BPR) - Data Warehousing - Data Mining - OLAP--SCM. (9)

ERP IMPLEMENTATION

ERP Implementation Lifecycle - Implementation Methodologies - ERP deployment methods - Package Selection - Process Definition - Vendors and Consultants - Contract with Vendors, Consultants and Employees - Training and education- Project Management and Monitoring. (10)

THE ERP BUSINESS MODULES

Business modules of an ERP Package - Finance - Manufacturing - Human Resources - Plant Maintenance - Materials Management - Quality Management - Sales and Distribution. (9)

THE ERP MARKET & ERP - PRESENT AND FUTURE

ERP Marketplace and Marketplace Dynamics - ERP Vendors - SAP AG, Oracle Corporation, Microsoft Dynamics, EPICOR, QAD, RAMCO Systems - Enterprise Application Integration (EAI)- ERP and E-Business- Future Directions and Trends in ERP. (9)

SAP

Gateway to SAP: Architecture of SAP R/3 -SAP Integrated-Three Tier Architecture - SAP Easy Access - Understanding ABAP Workbench (8)

TOTAL : 45

TEXT BOOKS

1. Alexis Leon, "ERP Demystified", Tata McGraw Hill, New Delhi, Third Edition, 2014.
2. Dreamtech Press, "SAP R/3, Black Book", Dreamtech Software Team, 2006. (SAP)

REFERENCES

1. Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2011.
2. Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.

19CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

- CO1** : *Practice the safety norms and inspect turning machines, boring machines, milling machine, planning machine, grinding machines, CNC machines and wood working machinery to create risk free working environment.*
- CO2** : *Assess the adequacy of machinery guarding to eliminate or reduce the hazards from the point operation, flying chips and sparks and moving parts.*
- CO3** : *Apply the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes, etc.,*
- CO4** : *Predict, identify and evaluate, hazardous conditions and practices safety rules in in cold forming and hot working of metals*
- CO5** : *Employ the safety rules in inspection and testing process and take plan the preventive measures in health and welfare of workers' aspects in engineering industry.*

SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. (9)

PRINCIPLES OF MACHINE GUARDING

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS - guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entry to hazardous installations-benefits of good guarding systems (9)

SAFETY IN WELDING AND GAS CUTTING

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipment and instruments - safety in generation, distribution and handling of industrial gases-colour coding - flashback arrestor - leak detection-pipeline safety-storage and handling of gas cylinders. (9)

SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. (9)

SAFETY IN FINISHING, INSPECTION AND TESTING

Heat treatment operations, electro plating, paint shops, sand and shotblasting, safety in inspection and testing, dynamic balancing, hydrotesting, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal

monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal (9)

TOTAL : 45

TEXT BOOKS

1. Wells G.L.,R.M.C. *Seagrave-Flow sheeting for safety*, Indian Institute of Chemical Engineering, London U.K,1977.
2. TrevurKletz Butterworth, *Learning from accidents*, - London, 1988.
3. John Barton and Richard Rogers, *Chemical reaction Hazards - A guide to safety*, Institution of Chemical Engineering London, 1997.
4. Philip Hagan "*Accident Prevention Manual for Business and Industry*", N.S.C.Chicago, 13th edition 2009.

REFERENCES

1. Rohatgi A.K, *Safety handling of Hazardous Chemicals Enterprises*, Bombay, 1986.
2. Shukla S.K., *Envirohazards and Techno Legal aspects*, Shashi Publications, Jaipur India, 1993.
3. John V.Grimaldi and Rollin H.Simonds," *Safety Management*", Richard D Irwin, 1994.
4. Krishnan N.V. "*Safety Management in Industry*" Jaico Publishing House, Bombay, 1997.
5. "*The Indian boilers act 1923 with amendments*", Law Publishers (India) Pvt. Ltd., Allahabad.
6. "*Health and Safety in welding and Allied processes*", Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
7. "*Safe use of wood working machinery*", HSE,UK,2005.

19CHOE02 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Identify individual hazards in a process and deduce the associated risks.

CO2 : Identify radiation intensity and effects of explosion

CO3 : Perform risk analysis of various types of problems

CO4 : Evaluate effect about key hazard identification techniques

CO5 : Apply risk analysis techniques and Hazop study

INTRODUCTION AND DISPERSION MODELS

Risk analysis introduction, quantitative risk assessment, rapid risk analysis - Comprehensive risk analysis - Emission and dispersion - Leak rate calculation. Single and two-phase flow - Dispersion model for dense gas - Flash fire - Plume dispersion - Toxic dispersion model - Evaluation of risk. (9)

RADIATION INTENSITY

Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people and property radiation VCVCE - Explosion due to over pressure - Effects of explosion, risk contour -Effects, explosion, BLEVE - Jet fire - Fire ball.(9)

RISK ANALYSIS

Overall risk analysis - Generation of meteorological data - Ignition data - Population data - Consequences analysis and total risk analysis - Overall risk contours for different failure scenarios - Disaster management plan - Emergency planning - On site and off site emergency planning, risk management ISO 14000, EMS models case studies - Marketing terminal, gas processing complex, refinery. (9)

HAZARD ANALYSIS

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough - Mexico - Madras - Vizag - Bopal analysis (9)

CASE STUDIES

Hazop - Guide words, parameters, derivation - Causes - Consequences - Recommendation - Coarse Hazop study - Case studies - Pumping system - Reactor - Mass transfer system. (9)

TOTAL : 45

TEXT BOOKS

1. Ragavan K.V., Khan A.A., *Methodologies in Hazard identification and assessment -Manual, CLRI publication, 1990.*
2. Marcel.V.C., *Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.*
3. Skeleton B., *Process Safety Analysis, Institution of chemical Engineers, U.K., 1997.*

REFERENCE

1. Daniel A Crowl., Louvar J.F., *Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

19CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Outline the green technology concepts and relevance in twenty first century requirements.

CO2 : Defend the environmental and sustainability issues, role of CSR and CER and Indian corporate structure and environment.

CO3 : Recall the indicators of sustainability and their use and can also find the alternate theories.

CO4 : Criticize the environmental reporting, ISO 14001, ISO 14064, financial initiative by UNEP, etc.

CO5 : Analyse the green tax incentives and rebates, business redesign and its models.

INTRODUCTION

The concept of green technology; evolution; nature, scope, importance and types; developing a theory; green technology in India; relevance in twenty first century. (9)

SUSTAINABILITY & ENVIRONMENT

Organizational environment; internal and external environment; Indian corporate structure and environment; how to go green; spreading the concept in organization; environmental and sustainability issues for the production of high-tech components and materials, life cycle analysis of materials, sustainable production and its role in corporate social responsibility (CSR) and corporate environmental responsibility (CER). (9)

ECOSYSTEM APPROACHES

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories (9)

ACTS OF GREEN TECHNOLOGY

Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy technology; green product technology. (9)

GREEN ECONOMICS

Definition; green techniques and methods; green tax incentives and rebates (to green projects and companies); green project technology in action; business redesign; eco-commerce models. (9)

TOTAL : 45

REFERENCES

1. *Green Technology and Green Technologies: Exploring the Causal Relationship* by Jazmin Seijas Nogarida, 2008.
2. *Green Marketing and Technology: A global Perspective* by John F. Whaik, 2005.
3. *The Green Energy Technology Book* by Leo A. Meyer.
4. *Green Project Technology* by Richard Maltzman and David Shiden.
5. *Green Marketing* by JacquelinOttman.
6. *Green and World* by Andrew S. Winston.

19CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

- CO1 : Classify the types of corrosion and theories and also relate the various controlled corrosion process.
- CO2 : Examine the factors involved in the corrosion and control methods of various corrosion.
- CO3 : Analyse the mechanism of corrosion and evaluate the effects like pH, temperature, flow rate on corrosion.
- CO4 : Design and develop the corrosion control methods like cathodic protection, sacrificial anode and impressed current anodes and anodic protection.
- CO5 : Predict the different corrosion testing, monitoring and inspection tests by surface analytical studies.

INTRODUCTION

Introduction, classification, economics and cost of corrosion. emf series, galvanic series, corrosion theories derivation of potential Current relations of activities controlled and diffusion controlled corrosion process. Potential - pH diagram, Fe-H₂O system, application and limitation. Passivation - Definition, anodic passivation theory of passivation, oxidation laws, effects of oxygen and alloying on oxidation rates. (9)

CORROSION CONTROL METHODS

Forms of corrosion - Definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, fretting corrosion, hydrogen embitterment, corrosion processes and control methods in fertilizers, petrochemical, chemical building industries (9)

MECHANISM OF CORROSION

Environmental aspects, atmospheric corrosion - Classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature, and flows rates on corrosion, marine corrosion, underground corrosion. Biological corrosion, definition, mechanism of corrosion, control of bio-corrosion. (9)

CORROSION PREVENTION

Corrosion control aspects, electrochemical methods of protection-theory of cathodic protection design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - Boiler water system. Organic coating, surface preparation, natural, synthetic resin, paint, formulation and application. Design aspects in corrosion prevention, corrosion resistant materials. (9)

CORROSION TEST

Corrosion testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion processes, inspection methods by NDT. Surface analytical techniques such as AES, ESCA, SEM. Evaluation of paints by conventional and electrochemical methods. (9)

TOTAL : 45

TEXT BOOKS

1. *Roberge P. R., Corrosion Engineering, McGraw Hill, New York, 2008.*
2. *Fontana M.G., Greene N.D., Corrosion Engineering, Third Edition, McGraw Hill, NewYork, 2005.*
3. *Uhling H. H., Revie R.W., Corrosion and Corrosion Control, John Wiley and Sons, Inc, 1985.*

REFERENCE

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

19CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Express the fundamentals of chemical engineering and to solve problems.

CO2 : Ability to develop basic fluid concepts, transfer and separation operations.

CO3 : Design equipment for transport and separation processes.

CO4 : Apply material and Energy balance to precisely calculate material required for a process.

CO5 : Apply steady state balances to develop process flow sheets.

OVERVIEW OF CHEMICAL ENGINEERING

Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry-scope, features & characteristics. Flow sheets, and symbols for various operations. (9)

MATERIAL AND ENERGY BALANCE CALCULATIONS

Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances, combustion reactions. (9)

BASIC FLUID CONCEPTS

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics. pipe flow, Pumps, Agitation and Mixing, Compressors. (9)

HEAT TRANSFER OPERATIONS

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, natural and forced convection, correlations; Radiation; Heat exchangers- Fundamental principles and classification of heat exchangers, Evaporators. (9)

MASS TRANSFER OPERATIONS

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process. Energy and Mass Conservation in process systems and industries. Introduction to chemical reactors. (9)

TOTAL : 45

REFERENCES

1. G.T. Austin, R.N. Shreve, *Chemical Process Industries, 5th Ed., McGraw Hill, 1984.*
2. W.L. McCabe, J.C. Smith and P. Harriott, *Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill, 2001.*
3. R. M. Felder and R.W. Rousseau, *Elementary Principles of Chemical Processes, 3rd Ed., John Wiley, New York, 2004.*
4. L.B. Anderson and L.A. Wenzel, *Introduction to Chemical Engineering, McGraw Hill, 1961.*
5. H.S. Fogler, *Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.*

19CHOE06 - NANOMATERIAL SYNTHESIS AND CHARACTERIZATION LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : To synthesize several nanomaterials in different methods in lab scale.

CO2 : To understand and operate the instruments for material characterization.

CO3 : To interpret the properties of synthesized nanomaterials by analyzing the results

EXPERIMENTS

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol.
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge.
3. Synthesis of ceria nanofibres by Solvothermal method.
4. Synthesis of silica nanoparticles using Stober method.
5. Synthesis of Au nanoparticles by simple chemical method.
6. Synthesis of Fe₃O₄ nanoparticles by simple reduction method.
7. Effect of reducing agent on the synthesis of metal nanoparticles.
8. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption.
9. Effect of concentration on the synthesis of silver nanoparticles.
10. Effect of reducing agent on gold nanoparticles.
11. Fabrication of silver nanofilms.
12. Synthesis of polyvinyl alcohol fibres by electrospinning method.
13. Synthesis of Au and Ag nanoparticles at aqueous-organic liquid interface; UV-visible spectroscopy of the colloidal film; comparison with the corresponding colloidal sol.
14. Sol gel synthesis of ZnO/TiO₂/CdO nanoparticles.
15. A bioroute to Au nanoparticles.
16. Sol-gel spin coating route to SnO₂ nanorods: surface roughness measurement by AFM.
17. Hydrothermal synthesis of ZnS Nanorods: Nanorods formation by SEM analysis.
18. Fabrication and wettability characterization of nanostructured soft polymer surfaces.
19. Preparation of nanofluids.
20. Determination of viscosity of nanofluids.
21. Evaporation studies of nanofluids.
22. Measurement of stability of nanofluids.
23. Optical properties of nanofluids.
24. Measurement of onset of natural convection in nanofluids.
25. Thermal conductivity measurement of nanofluids.

TOTAL : 60

REFERENCES

1. Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, *Nanofluids: Science and Technology*, Wiley, 2007.
2. Vincenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai, *Heat Transfer Enhancement with Nanofluids*, CRC Press, 2017.
3. Amy S., *Thermal Energy Storage Using Phase Change Materials: Fundamentals and Applications* Fleischer, Springer, 2015.
4. Mohsen Sheikholeslami and Davood Domairry Ganji, *Applications of Nanofluid for Heat Transfer Enhancement*, Elsevier, 2017.
5. S.M. Sohel Murshed, Carlos Nieto de Castro, *Nanofluids: Synthesis, Properties and Applications*, Nova Science Publishers, 2014.
6. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*. Tata McGraw-Hill Education, 2003.
7. P.R. Chandran, M. Naseer, N. Udupa, N. Sandhyarani. Size controlled synthesis of biocompatible gold nanoparticles and their activity in the oxidation of NADH. *Nanotechnology*. 8, 23(1), 2011.
8. I.A. Ibrahim, A.A. Zikry, M.A. Sharaf. Preparation of spherical silica nanoparticles: Stober silica. *J. Am. Sci.* 6(11), 985-9, 2010.
9. X. Chen, S.S. Mao. Titanium dioxide nanomaterials: synthesis, properties, modifications, and applications. *Chemical reviews*. 11, 107(7), 2891-959, 2007.
10. Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, *Nanofluids: Science and Technology*, Wiley, 2007.

19CHOE07 - MULTIVARIATE STATISTICS LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Design experiments to obtain statistical principles of Univariate examples.

CO2 : Apply the concepts of statistics to draw conclusions from data

CO3 : Assess practical knowledge to carry out meaningful interpretation of data from real life

CO4 : Conduct experiments to solve complex engineering problems effectively as an individual or team work.

CO5 : Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.

LIST OF EXPERIMENTS

1. Point and Interval Estimation for Normal and Chi-Square Distribution using Excel and R.
2. Point and Interval Estimation for T-Distribution and F-Distribution using Excel and R.
3. K-means Clustering.
4. One-way ANOVA Model in Excel and R.
5. Linear Regression
6. Logistic Regression
7. Naive Bayesian Classifier
8. Decision Trees
9. Simulation of Principal component analysis using Excel and R.
10. Simulation of Fischer Discriminant Analysis using Excel and R.
11. Modeling the Change by Differential Equations using R and Excel.
12. Modeling the Change by Difference Equations using R and Excel.
13. Multivariate Normal & Hotelling's T₂ Distribution.
14. Multivariate Analysis of Variance (MANOVA).
15. Correspondence Analysis using R.

TOTAL : 60

REFERENCES

1. *Apostol T.M. (1985) Mathematical Analysis, Narosa, Indian Ed.*
2. *Courant R. And John F. (1965) Introduction to Calculus and Analysis, Wiley.*
3. *Miller K.S. (1957) Advanced Real Calculus, Harper, New York.*
4. *Rudin, Walter (1976) Principles of Mathematical Analysis, McGraw Hill.*
5. *Malik S.C. (2005) Principles of Real Analysis, New Age International (p)Ltd.*
6. *Bartle R.G. (1976) Elements of Real Analysis*

19MOE01 - GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

- CO1* : The students will be able to understand the idea of graph theory and to solve the real time problem.
- CO2* : To relate the Graph theory Algorithms' in their field of engineering and apply the same in the irrespective mainstream.
- CO3* : To become familiar with Special graphs for modeling the networks.
- CO4* : Able to design and solve Coloring concepts for defined problems.
- CO5* : Model the networks using graph theory.

GRAPHS AND SUB GRAPHS

Graph-Standard Concepts in Graphs - Sub graphs - Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix-Walk, Trail and Path - Bipartite Graph - Connectedness - The Shortest Path Problem - Dijkstra's Algorithm (9)

TREES

Trees- Characterization - Blocks - Block Graphs - Cayley's Formula - Spanning Trees - Spanning Tree Algorithms - Kruskal's and Prim's Algorithm (9)

EULERIAN AND HAMILTONIAN GRAPHS

Eulerian graphs - Euler's theorem - Hamiltonian graphs - Dirac's and Ore's theorems - Closure of a graph - Bondy - Chvatal theorem - Traveling salesman problem - The Chinese Postman Problem - Fleury's Algorithm. (9)

COVERING AND COLORING

Covering - Independent Sets - Matching - Perfect Matching- Applications - The Personal Assignment Problem - Coloring - Chromatic Number - Four Color Problem - Chromatic Polynomials - Application. (9)

DIRECTED GRAPHS

Digraph - orientation - strongly, weakly and unilaterally connected digraphs - directed acyclic graph - adjacency matrix and incidence matrix of graph - Network Flows - Transport Networks - Max - Flow Min-Cut Theorem - Activity Network (9)

TOTAL : 45

TEXT BOOKS

1. Gary Chartrand and Ping Zhang, *Introduction to Graph Theory*, Mc Graw Hill Education (India), 2017.
2. Narsingh Deo, *"Graph Theory with Applications to Engineering and Computer Science"*, Prentice Hall of India Private Limited, 2004.

REFERENCES

1. Douglas B. West, *"Introduction to Graph Theory"* Second Edition, Prentice Hall of India Private Limited, 2001.
2. Balakrishnan. R, Ranganathan. K , *"A Text book of Graph Theory"*, Second Edition, Springer Newyork, 2012.
3. Clark. J. and Holton. D.A, *"A First Look at Graph Theory"*, Allied Publishers, 1995.
4. Frank Harary, *Graph Theory*, 10th Edition, Narosa Publishing House, 2001.

19MOE02 - METHODS OF APPLIED MATHEMATICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

- CO1* : The students will be able to understand the idea of integral equations and to solve the real time problems.
- CO2* : To familiarize the students with basic concept of ordinary differential equations, special functions and solve problems associated with engineering applications.
- CO3* : To achieve an understanding of the basic concepts of boundary value problems and characteristic function representations and method of solving them.
- CO4* : Able to construct and solve a mathematical model for heat flow problems in real life situation
- CO5* : Able to use the concepts of Calculus of variations and basic concepts for solving equations involving functional

INTEGRAL EQUATIONS

Relation between integral and differential equations - Green's function. Fredholm's equation with separable Kernels Hilbert Schmidt theory, interactive methods for solving equations of second kind. (9)

SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS

Singular points, Series solutions and the methods of Frobenius, Bessel Equation, Bessel Functions, modified Bessel functions and their properties, Ber and Bei functions. (9)

BOUNDARY PROBLEMS AND CHARACTERISTIC FUNCTION REPRESENTATIONS

Sturm - Liouville problems. Orthogonal functions and expansions in series of Orthogonal functions. Stodola and Vianello method for Sturm - Liouville problems, Fourier - Bessel and Legendre Series (9)

PARTIAL DIFFERENTIAL EQUATIONS

Linear and quasi - linear equations of the first and second order. Characteristics of first and second order linear equations. Heat flow equations. Problems in one, two and three dimensions - Fourier method. (9)

INTEGRAL TRANSFORM METHODS

Calculus of variations - Variational notation, Constraints and Lagrangian multipliers, variable and points, Rayleigh - Ritz method. (9)

TOTAL : 45

TEXT BOOKS

1. *M.K. Venkatraman, Higher Mathematics for Engineering and Science, Third Edition, The National Publishing Company, 2014.*
2. *F.B. Hildebrand: Advanced Calculus for applications second Edition (EEE).Prentice Hall of India P.Ltd., 2014.*

REFERENCES

1. *F.B. Hildebrand - Methods of Applied Mathematics, Second Edition. Prentice Hall of India P.Ltd., 2012.*
2. *David Borthwick : An introduction to partial differential equation Springer International Publishing 2017.*
3. *Mattias Blennow: Mathematical methods in Physics and Engineering, CRC Press, 2018.*

19MOE03 - LINEAR AND NON - LINEAR PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

- CO1* : The students will be able to understand the idea of linear Programming problems and to solve the real time problems.
- CO2* : To familiarize the students with basic concept of Transportation models and solve problems associated with engineering applications.
- CO3* : To achieve an understanding of the basic concepts of Assignment problems and method of solving them.
- CO4* : Able to construct and solve a Game theory models in real life situation
- CO5* : Able to use the concepts of Non-linear Programming problems for solving Constrained and unconstrained equations.

LINEAR PROGRAMMING

Formulation of LPP - Graphical methods for two variables - The Simplex method - Artificial Variables Techniques - Big M - method - The Two Phase method - Dual Simplex Method (9)

TRANSPORTATION MODEL

Mathematical formulation of a Transportation problem - Methods for finding initial basic feasible solution - North West corner rule - Least cost method - Vogel's Approximation method - Modified distribution method - Degeneracy in Transportation problems. (9)

ASSIGNMENT PROBLEM

Mathematical formulation of an Assignment problem - Hungarian Method - Unbalanced Assignment Models -Maximization case in Assignment Problems - Restrictions in Assignments - Travelling Sales man Problem. (9)

GAME THEORY

Two person zero - sum Games - The Maxmini - Minimax Principle - Saddle Point and value of the game -Games without saddle points, Mixed Strategies - Matrix Oddment method for $n \times n$ games - Dominance Property - Graphical Method of $2 \times n$ or $m \times 2$ games. (9)

NON - LINEAR PROGRAMMING

Non - linear Programming Algorithm - Unconstrained Non - linear Algorithms - Constrained Non -linear Lagrange multipliers, Kuhn - Tucker optimality conditions. (9)

TOTAL : 45

TEXT BOOKS

1. *Operations Research An Introduction, Eight Edition, Hamdy A .TAHA, Pearson Prentice Hall 2016, New Delhi.*
2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016, A.R Publications, Chennai.*

REFERENCES

1. *Kanti Swarup, P.K. Gupta and Man Mohan, " Operations Research", Sultan Chand & Sons, Educational publishers, New Delhi. 20th Edition, 2019.*
2. *Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", Mc Graw Hill, (India) Private Limited, India, 11th Edition, 2021.*

19MOE04 - PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

- CO1* : The students will be able to understand the basic probability problems and to solve the real time problems.
- CO2* : To familiarize the students with basic concept of probability distributions and solve problems associated with engineering applications.
- CO3* : To achieve an understanding of the basic concepts of Correlation and regression and method of solving them.
- CO4* : Able to solve a signal processing problems by using random process concepts.
- CO5* : Able to use the concepts of Correlation functions and Power spectral densities for solving Electrical and electronics problem.

THEORY OF PROBABILITY

Sample Space, Events, Axioms of probability, Conditional probability, Independent events, Theorem of total probability, Baye's Theorem. (9)

PROBABILITY DISTRIBUTIONS

Definition of Discrete and Continuous random Variables

Discrete distributions : Binomial, Poisson and Geometric - Properties and Simple problems

Continuous distributions : Normal, Uniform Exponential - Properties and Simple problems. (9)

CORRELATION AND REGRESSION

Correlation -Meaning and scope of Correlation - Scatter diagram, Karl Pearson's co-efficient of Correlation, Spearman's Rank Correlation, Multiple Correlation and partial correlation - simple problems.

Regression Analysis - Meaning and Scope of regression - Regression in two variables - Uses of Regression. (9)

RANDOM PROCESSES

Classification - Stationary process - Markov process - Poisson process - Random telegraph process. (9)

CORRELATION FUNCTIONS AND POWER SPECTRAL DENSITIES

Auto Correlation functions - Cross Correlation functions - Properties - Power spectral density - Cross spectral density - Properties. (9)

TOTAL : 45

TEXT BOOKS

1. S.C. Gupta and V.K. Kapoor, *Fundamental of Mathematical Statistics, Tenth Revised Edition, 2020.*
2. T. Veerarajan, *Probability, Statistics and Random Processes, Second Edition, Tata Mc Graw - Hill 2017.*

REFERENCES

1. Robert Hogg & Joseph McKean: *Introduction to Mathematical Statistics, Pearson 8th Edition 2018.*
2. Bhat, B. R.: *Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International 2015.*

3. Cochran, W.G: *Sampling Techniques*, Wiley Eastern Private Limited, 2007.
4. Sukhatme, P.V. and Sukhatme, B.V.(1977) : *Sampling Theory of Survey with Applications*, Asia publishing House.
5. Rakesh Dube, "Higher mathematics for Engineering and Science" Manakin Press, 2018.
6. Ibe, O.C., "Fundamentals of Applied Probability and Random processes", 2nd Edition, Elsevier, 2019.
7. Peyton Peebles, "Probability Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, NewDelhi, 2017.

19POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1* : Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2 : Understand the different classes of nanomaterials.
CO3 : Identify the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.
CO4 : Outline the applications of nanotechnology and develop an ability to critically evaluate the promise of a nanotechnology device.

BASICS OF NANOTECHNOLOGY

Introduction - Time and length scale in structures - Definition of a nanosystem - Dimensionality and size dependent phenomena - Surface to volume ratio - Fraction of surface atoms - Surface energy and surface stress- surface defects - Effect of nanoscale on various properties - Structural, thermal, mechanical, magnetic, optical and electronic properties. (9)

DIFFERENT CLASSES OF NANOMATERIALS

Classification based on dimensionality - Quantum Dots, Wells and Wires - Carbon based nano materials (buckyballs, nanotubes, graphene) - Metal based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites - Nanopolymers - Nano ceramics - Biological nanomaterials. (9)

SYNTHESIS OF NANOMATERIALS

Chemical Methods: Metal Nanocrystals by Reduction - Sol - gel processing - Solvothermal Synthesis - Photochemical Synthesis - Chemical Vapor Deposition (CVD) - Metal Oxide - Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling - Electrodeposition - Spray Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE). (9)

CHARACTERIZATION OF NANOSTRUCTURES

Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM) - Energy Dispersive X-ray analysis (EDAX) - Transmission Electron Microscope (TEM) - Scanning Tunneling Microscope (STM) - Atomic force microscopy (AFM), UV-vis spectroscopy (liquid and solid state) - Raman spectroscopy - X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy(AES). (9)

APPLICATIONS

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics - Polymers with a special architecture - Liquid crystalline systems - Applications in displays and other devices - Nanomaterials for data storage - Photonics, Plasmonics - Chemical and biosensors - Nanomedicine and Nanobiotechnology. (9)

TOTAL : 45

TEXT BOOKS

1. *Nano technology: Basic Science and Emerging technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)*
2. *A Text book of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw Hill Education Pvt. Ltd., 2012.*
3. *Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, 2002.*
4. *Introduction to Nanotechnology, Charles P.Poole, Frank J.Owens, Wiley Interscience (2003)*

5. *Textbook of Nanoscience and Nanotechnology*, B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Springer Science & Business Media, 2013.

REFERENCES

1. *Nanotechnology: A gentle introduction to the next Big idea*, Mark A. Ratner, Daniel Ratner, Mark Ratne, Prentice Hall P7R:1st Edition (2002)
2. *Fundamental properties of nanostructured materials* Ed D. Fioran, G.Sberveglie, World Scientific 1994
3. Dupas C., Houdy P., Lahmani M., *Nanoscience: Nanotechnologies and Nanophysics*, Springer-Verlag Berlin Heidelberg, 2007

19POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Recognize the fundamental growth and material parameters of thin films.

CO2 : Evaluate and use models for nucleation and growth of thin films.

CO3 : Asses the relation between deposition technique, film structure and film properties.

CO4 : Identify modern techniques for the characterization of thin films

CO5 : Demonstrate the applications of thin films

Preparation of thin films : Preparation methods: electrolytic deposition, cathodic and anodic films, thermal evaporation, cathodic sputtering, chemical vapour deposition. Molecular beam epitaxy and laser ablation methods. Thickness measurement and monitoring: electrical, mechanical, optical interference, microbalance, quartz crystal methods. (9)

Growth Kinetics of Thin Films : General features.- nucleation theories - energy formation of a nucleus - critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped) Effect of electron bombardment on film structure. Post-nucleation growth, epitaxial films and growth. (9)

Analytical techniques of characterization : X-ray diffraction - Photoluminescence - UV-Vis-IR spectrophotometer - Atomic Force Microscope - Scanning Electron Microscope - Hall effect - Vibrational Sample Magnetometer - Secondary Ion Mass Spectrometry - X-ray Photoemission Spectroscopy - Auger emission spectroscopy. (9)

Properties of Thin films : Dielectric properties - experimental technique for the determination of dielectric properties - optical properties - experimental technique for the determination of optical constants - mechanical properties - experimental technique for the determination of mechanical properties of thin films - magnetic and superconducting properties. (9)

Applications : Optoelectronic devices : LED, LASER and Solar cell - Micro Electromechanical Systems (MEMS) - Fabrication of thin film capacitor - application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) - sensors - fabrication and characterization of thin film transistor and FET. (9)

TOTAL : 45

TEXT BOOKS

1. A. Goswami, *Thin Film Fundamentals*, New Age international (P) Ltd. Publishers, New Delhi, 2006.
2. L.I. Maissel and Glang (Eds.), *Handbook of Thin film Technology*, McGraw-Hill, 1970.
3. K.L. Chopra, *Thin Film Phenomena*, McGraw-Hill (1983)

REFERENCES

1. *Thin-Film Deposition : Principles and Practice*, Smith Donald Donald L Smith Smith, McGraw-Hill Professional Pub, 1995
2. J.C. Anderson, *The Use of Thin Films in Physical Investigation*, Academic Press 1966.
3. J.J. Coutts, *Active and Passive Thin Film Devices*, Academic Press 1978.
4. George Hass, *Physics of Thin Films: Volumes 1.:12*, Academic Press 1963.
5. Kiyotaka Wasa, Makoto Kitabatake, Hideaki Adachi, *Thin Films Material Technology*, Springer-Verlag Berlin Heidelberg, 2004.

19POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Demonstrate the knowledge about photovoltaics.

CO2 : Gain knowledge about principle of operation of solar cells

CO3 : Realization about semiconducting materials used in the manufacture of PV cells

CO4 : Outline the various advanced solar cell technologies, their current status and future technological challenges

EVOLUTION OF SOLAR CELLS

Historical development; present and future global issues- commercialization/economic factors- basic components of PV systems - The solar spectrum - terrestrial and space spectra; air mass (AM0, AM1.5) - Introduction to 1st, 2nd and 3rd generation photovoltaics. (9)

SOLAR CELL FUNDAMENTALS

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell - light absorption- creating charge carriers forming the electric field - driving the charge carriers - solar cell parameters- electrical characteristics - the ideal solar cell, solar cell in practice, the quantum efficiency and spectral response, optical properties - basics of solar cell device design. (9)

SEMICONDUCTOR PROPERTIES

Overview of semiconductor properties relevant to solar cell operations- semiconductor band structure, carrier statistics in semiconductors, the transport equations, carrier mobility, carrier generation by optical absorption - band to band transitions, free-carrier absorption, recombination- bulk recombination processes, surface recombination, minority carrier life time. (9)

SILICON AND THIN FILM SOLAR CELLS

Si photovoltaics - single crystal silicon cells - semicrystalline and polycrystalline silicon cells - overview of various thin film solar cells: gallium arsenide solar cells - fabrication techniques, InP & cadmium telluride based solar cells - copper indium diselenide solar cells - multijunction cells - environmental and health aspects. (9)

ADVANCED SOLAR CELLS

Advanced solar cell concepts - organic (polymer) photovoltaics - new concepts - quantum dots, wires, intermediate band, multiple exciton generation - Dye sensitized solar cells - perovskite solar cells - challenges in materials and device design - current and future research trends in PV. (9)

TOTAL : 45

TEXT BOOKS

1. Fonash S. J., "Solar Cell Device Physics", Academic, 2010.
2. Goetzberger, J. Knobloch, and B. Voss "Crystalline Silicon Solar Cells" Wiley, 1998.
3. Green M. A. "Third Generation Photovoltaics: Advanced Solar Energy Conversion" Springer, 2006 .

REFERENCES

1. Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt. Ltd., 2009.
2. Jha A.R., "Solar Cell Technology and Applications", CRC Press, 2010.

19POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

- CO1** : Recognize the criteria for material selection based on properties of materials and to choose the required material for a specified application.
- CO2** : Understand various metallurgical forming processes such as casting, rolling extrusion, drawing, development of grain structure and processing of different composite types.
- CO3** : Demonstrate knowledge about powder metallurgy, ceramic and polymer processing methods.
- CO4** : Identify and choose the required surface treatment technique for coating formation on account of enhancing the surface properties of the mechanical components for engineering applications.
- CO5** : Understand the applicable joining and machining techniques and their limitations

INTRODUCTION AND SELECTION OF MATERIALS

Motivation for selection - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability, corrosion and wear resistance - Relationship between materials selection and processing - Case studies - aero, auto, marine, machinery and nuclear applications. High and low temperature materials, superconductors, supramagnetic materials, high entropy alloys, nanomaterials and biomaterials. (9)

METALLURGICAL FORMING AND PROCESSING OF COMPOSITES

Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties. Processing of composites: lay up methods, press/ autoclave / resin transfer moulding, Reinforced Reaction Injection Molding (RRIM), obtrusion and filament winding. (9)

POWDER METALLURGY, CERAMIC AND POLYMER PROCESSING

Powder metallurgy and ceramic processing: green fabrication methods, sintering, hot pressing, Hot Isostatic Pressing (HIP), spark plasma sintering, development of microstructure in powder processed materials. Polymer processing: extrusion, injection moulding, blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers. (9)

COATING METHODS

Introduction to surface Engineering, Differences between surface and bulk properties, Properties of surfaces-wear, wettability. Chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes. Principle of various coating processes, process parameters, controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. (10)

JOINING AND MACHINING

Joining: fusion welding, solid state welding, adhesive bonding, mechanical joining and recent advancements in welding. machining: Electromachining (electrochemical and electro-discharge), mechanical machining and recent advancements. (8)

TOTAL : 45

TEXT BOOKS

1. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials", 3rd Edition, Butterworth-Heinemann, 1977.
2. Betzalel Avitzu, "Metal Forming- Processes and Analysis", Tata McGraw Hill, 1977.

3. *William F Hasford, Robert M Caddell "Metal Forming: Mechanics and Metallurgy" Cambridge University Press P. Ltd, 2007.*
4. *Angelo P C and Subramanian R" Powder Metallurgy Science, Technology and Applications", Prentice Hall of India, New Delhi, 2012.*

REFERENCES

1. *Michael Barsoum, "Fundamentals of Ceramics", Mc Graw Hill Publishing Co., INC, 1997*
2. *Gowariker V R, Viswanathan N V, Jayadev Sreedhar, "Polymer Science", New Age International P Ltd., 2005.*
3. *David S. Rickerby, Allan Matthews "Advanced surface coatings: a handbook of surface engineering", Blackie, 1991.*
4. *Parmar, R.S, "Welding Engineering and Technology", Khanna Publishers, 2003.*

19COE01 - MEDICAL NANO TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : Understand the essential features of nanomedicine

CO2 : Identify the medical based nanotools

CO3 : Assess health effects due to nanoparticle exposure

ASSESSING NANOTECHNOLOGY HEALTH

Nanomaterials : The Current State of Nanotechnology Application - Nanotechnology Risks - Risk Analysis - Hazard Identification - Exposure Assessment for Nanomaterials - Risk Characterization - Risk Management - Best Practices for Nanomaterials in the Workplace - Safety Research - Needs for Engineered Nanoscale Materials (9)

RISK ASSESSMENT AND ENVIRONMENTAL PROTECTION

Context for Technological Risk - Need for Risk Assessment for Nanotechnology - Adaptive Risk Assessment for Nanomaterials - Origins and Development of Risk Assessment - Risk Assessment Used in Environmental Decision Making - Issues in Applying the Four Steps of Risk Assessment to Nanotechnology - Hazard Assessment - Exposure Assessment - Dose - Response Evaluation (9)

SUSTAINABLE NANOTECHNOLOGY DEVELOPMENT

Necessity of Risk Assessment in Nanotechnology - The Pace of Nanotechnology Development and the Paucity of Information - Potential for Wide Dispersion in the Environment Amid Uncertainty - Few Standards or Guidelines - Environmental Risk Issues - Carbon Nanotubes - Defining the Toxic Dose - Environmentally Friendly Nanotechnology - Life Cycle Analysis for Sustainable Nanotechnology (9)

HUMAN HEALTH, TOXICOLOGY, AND NANOTECHNOLOGY RISK

Mechanisms of Toxicity - Types of Toxicological Studies - Pulmonary Toxicity Studies - Gastro intestinal Toxicity - In Vitro Studies - Dermal - In Vitro Toxicity Studies (4)

ENVIRONMENTAL RISKS

Antimicrobial Properties of Nanoscale Silver - Buckyballs, Titanium Dioxide - Short-term Toxicity Tests - Daphnia LC50 Assays - Studies of Nanomaterial Toxicity to Fish - Buckyballs and Bass-TiO₂ in Arsenic - Field Studies - Environmental Exposures - Nanoscale Zerovalent Iron (9)

NANOELECTRONIC DEVICES

Resonant tunneling diodes - Field effect transistors - Single electron transfer devices - Potential effect transistors - Light emitting diodes and lasers - Nanoelectromechanical system devices - Quantum dot cellular automata (5)

TOTAL : 45

TEXT BOOKS

1. George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007
2. Vladimir V. Mithin et.al, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications" Cambridge University Press, 2012

REFERENCES

1. Mithin.V, Kochelap.V and Stroschio.M, "Introduction to Nanoelectronics", Cambridge University Press, 2008
2. Karl Gosar et.al, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005.

19COE02 - ADVANCED DRUG DELIVERY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to know the fundamentals of Nanoscience and their applications in pharamacological industries

CO2 : The students will able to describe polymeric drug delivery systems and their encapsulation methodology to study targeted drug delivery with different polymeric systems

CO3 : The students will able to identify lipids-nanocarriers and their application in biological system

CO4 : The students will able to study site specific drug delivery for gene therapy

THEORY OF ADVANCED DRUG DELIVERY

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models. (10)

POLYMERS Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscaffold systems Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA. (8)

LIPID BASED NANOCARRIERS

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes. (9)

MICROBES AND ANTIBODY BASED NANOCARRIERS

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibodybioconjugates. (9)

SITE SPECIFIC DRUG DELIVERY

Concepts and mechanism of Site specific drug delivery- Microneedles, Micropumps, microvalves. Implantable microchips. (9)

TOTAL : 45

REFERENCES

1. *Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman, Oxford University Press, 2001.*
2. *Drug Delivery and Targeting, A.M. Hillery, CRC Press, 2002.*
3. *Drug Delivery: Principles and Applications, B. Wang, Wiley Interscience, 2005.*
4. *Nanoparticle Technology for Drug Delivery, Ram B. Gupta, Uday B. Kompella Taylor & Francis, 2006.*

19COE03 - BIOSENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will able to understand protein based biosensors and their enzyme reactivity, stability and their application in protein based nano crystalline thin film processing

CO2 : The students will able to describe DNA based biosensors to study the presence of heavy metals in the food products

CO3 : The students will able to understand fluorescence, UV-Vis and electrochemical applications of biosensors

CO4 : The students will able to study about the fabrication of biosensors and its application as nanochip analyzer

PROTEIN BASED BIOSENSORS

Nano structure for enzyme stabilization - Single enzyme nano particles - Nanotubes microporous silica - Protein based nano crystalline Diamond thin film for processing (9)

DNA BASED BIOSENSOR

Heavy metal complexing with DNA and its determination, water and food samples - DNA zymo biosensors (9)

ELECTRO CHEMICAL APPLICATION

Detection in biosensors - Fluorescence - Absorption - Electrochemical. Integration of various techniques - Fibre optic biosensors (9)

FABRICATION OF BIOSENSORS

Techniques used for microfabrication - Microfabrication of electrodes - On chip analysis (9)

BIOSENSORS IN RESEARCH

Future direction in biosensor research - Designed protein pores-as components of biosensors - Molecular design - Bionanotechnology for cellular biosensing - Biosensors for drug discovery - Nanoscale biosensors (9)

TOTAL : 45

REFERENCES

1. *Biosensors: A Practical Approach*, J. Cooper & C. Tass, Oxford University Press, 2004
2. *Nanomaterials for Biosensors*, Cs. Kumar, Willey - VCH, 2007
3. *Smart Biosensor Technology*, G.K. Knoff, A.S. Bassi, CRC Press, 2006.

19COE04 - NANOCOMPOSITES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

- CO1 : Study the different synthesis techniques of metal ceramic nanocomposites and their functionality
- CO2 : Describe the processing techniques for heterometallic nanocomposites and to study their electromagnetical property
- CO3 : Understand the design of super hard nanocomposites with improved mechanical properties
- CO4 : Study the polymer based carbon nanotube composites, to study their mechanical properties and their industrial applications

NANO CERAMICS

Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. (9)

METAL BASED NANOCOMPOSITES

Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties. (9)

DESIGN OF SUPER HARD MATERIALS

Super hard nanocomposites, its designing and improvements of mechanical properties. (9)

NEW KIND OF NANOCOMPOSITES

Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites. (9)

POLYMER BASED NANOCOMPOSITES

Preparation and characterization of diblock Copolymer based nanocomposites; Polymercarbon nanotubes based composites, their mechanical properties, and industrial possibilities. (9)

TOTAL : 45

REFERENCES

1. *Nanocomposites Science and Technology* - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
2. *Physical Properties of Carbon Nanotubes*- R. Saito 1998.
3. *Carbon Nanotubes (Carbon, Vol 33)* - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
4. *The search for novel, superhard materials*- Stan Veprek (Review Article) *JVSTA*, 1999
5. *Electromagnetic and magnetic properties of multi component metal oxides, hetero*
6. *Nanometer versus micrometer-sized particles*-Christian Brosseau, Jamal Ben, Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) *J. Appl. Phys*, Vol 93, 2003
7. *Diblock Copolymer*, - Aviram (Review Article), *Nature*, 2002

19COE05 - BIOREFINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : Understand various renewable feedstocks for biofuels production

CO2 : Understand the broad concept of second and third generation biofuel products from biomass and other low-cost agri-residues and biowastes.

CO3 : Analyze the design processes for biofuel production

CHEMISTRY & BIOCHEMISTRY OF BIOMASS

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; trichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch. (9)

BIODIESEL

Sources and processing of biodiesel, nature of lipids, fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel, (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. (9)

BIOMETHANE OR BIOGAS

Hydrolysis; anaerobic digestion; methanogenesis (acetoclastic, hydrogenotrophic), rates of methane formation; and one and two stage fermentation. Thermal depolymerization. Use of exhaust gases (e.g. CO₂, H₂S and H₂) from geothermal power plants and industrial operations (e.g. coal and oil refineries) as an energy sources (methane and hydrogen) (9)

GASIFICATION & PYROLYSIS TECHNOLOGIES

Gasification processes and the main types of gasifier designs; production of electricity by combining a gasifier with a gas turbine or fuel cell. Combined- cycle electricity generation with gas and steam turbines, and generation of heat and steam for district heating systems or CHP, including kalina Cycle. Production of synthesis gas (i.e. CO, H₂, H₂O, CO₂) tar vapor and ash particles) for subsequent conversion to hydrogen and transport fuels; advanced gas cleaning technologies for biomass. Biological conversion of syngas into liquid biofuels. Fast pyrolysis technology to produce a range of fuels, chemicals, and fertilizers; biorefineries, and new uses for glycerine in biorefineries. (9)

POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY

Analysis of both current and future EU regulations and directives on biofuels and bioenergy. Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. (9)

TOTAL : 45

TEXT BOOKS

1. Robert C. Brown, "Biorenewable Resources: Engineering", New Products from Agriculture, Wiley- Blackwell Publishing, 2003.
2. Samir K. Khanal, "Anaerobic Biotechnology for Bioenergy Production: Principles and Application", Wiley- Blackwell Publishing 2008.

REFERENCES

1. Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery", Springer Publishing, 2008.

19HOE01 - PRINCIPLES OF MANAGEMENT

COURSE OUTCOMES

CO1 : Design the Management function for a given organization

CO2 : Design and develop a strategic approach for the completion of the project

CO3 : Analyze the behavior of individuals and groups in organizations in terms of the key factors

CO4 : Formulate the procedure for recruitment, selection, training of staff to establish an organization

Unit I - Introduction to Management: Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought (9)

Unit II - Management Concepts: Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma (9)

Unit III - Organizational Behavior: Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work (9)

Unit IV - Business Process Reengineering: Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity (8)

Unit V - Human Resource Management: Evolution of Management- Development of Managerial skills-Human Resource Management - Objectives -Job analysis -Recruitment -Selection and Placement and Training Development (10)

TOTAL : 45

TEXT BOOKS

1. Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, "Principles of Management" Tata Mcgraw Hill, New Delhi, 2013.
2. Mamoria, CB, "Personnel Management", Sultan Chand and Sons, New Delhi, 2013.

REFERENCES

1. Robbin Finchanm and Peter Rhodes, "Principles of Organizational Behavior" Oxford University Press, 2010.
2. CB Gupta "Management Theory and Practice" Sultan Chand and Sons, New Delhi, 2009.
3. VSP Rao "Management Text and Cases" Excel Books, New Delhi, 2009.
4. Fred Luthans "Organizational Behavior" Mc-Graw hill, New York, 2005.
5. Knanna OP "Industrial Engineering and Management", Dhanpat Rai publications, New Delhi, 2003.

19HOE02 : CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

- CO1* : Outline the structure of our Indian Economic System
- CO2* : Access the role of industrial sector in Indian economy
- CO3* : Interpret the demographic trends for the current scenario
- CO4* : Analyze the role of two tier for the achievement of common national goals

Unit - 1 National Income and Agriculture Sector: Economics Development-Meaning-National Income and Per capita Income in India- Indian Planning-Agricultural Development of India: Major crops- Production-Productivity-Contribution to GDP and Exports
(8)

Unit - II Industrial Sector: India's industrial development-Industrial policies of 1948, 1956 and 1991-Liberalisation-Public sector-Privatization-Disinvestment policy-Role and importance of large scale industries and small scale industries-Special economic zones-Contribution to GDP-Growth rate
(8)

Unit - III Population: Growth and policy issues-Demographic trends-Vital statistics-India's population: size and growth rate-Demographic dividend-HDI-Population policy-Issues of Unemployment, Poverty and inequality in India
(10)

Unit - IV Service sector: Service sector in India-Banking-Insurance-Telecommunication-IT sector-Software exports-BPO-Contribution to GDP
(9)

Unit - V Federal System and Foreign Trade: Federal setup in India-Taxes: Direct and Indirect Tax-Value added Tax-Foreign direct investment-Merits and Demerits-India's imports and exports: Composition and direction-Foreign exchange reserve position-MNC's in India
(10)

TOTAL : 45

TEXT BOOKS

1. Ruddar Datt and Sundaram, *KPM, Indian Economy, S.Chand and company, New Delhi-2015*
2. Ramesh Singh *Indian Economy, McGraw hill Education 7th edition, 2015*

References: www.jagranjosh.com

19H0E03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Evaluate the monetary measures formulated through static and dynamic role of money

CO2 : Design the driving force of circular flow of money

CO3 : Analyse how quantity theory of money fluctuate the price level

CO4 : Estimate the demand and supply of money based on the Interest rate

Unit I Nature and significance of Money: Definition of Money-Functions of Money-Static and Dynamic role of Money-Circular flow of Money-Monetary standards-Gold standard-Paper currency standard-Principles of Note issue-Measures of Money supply (9)

Unit II Quantity Theory of Money: Fisher's quantity theory of Money-Assumptions-Cash Balance Approach (Cambridge Equations)- Equation of Marshall, Pigou and Keynes-Similarities and dissimilarities of cash balance and cash transaction approaches-Income and expenditure theory-Superiority of Income and expenditure theory-Demand for Money: Classical and Keynesian liquidity preference theory approach (9)

Unit III Inflation and Deflation: Meaning-Types-Causes of Inflation-Demand Pull and Cost push inflation -Inflationary Gap-Phillips Curve-Effects of Inflation-Deflation-Causes-Measures to control Inflation and Deflation-Stagflation (9)

Unit IV Commercial Banking and Financial Markets: Functions of Commercial Banks-Credit Creation-Meaning and constitute of Money Markets-Capital Market-Institutional structure of Capital Market-Primary Market-Secondary Market-Indian capital Market-Non-Banking financial intermediaries (9)

Unit V Central Banking and Monetary Policy: Central Banking-Functions-Organization-Instruments of Credit control-Monetary Policy: Meaning, Objectives, and Recent policy changes in RBI-Monetary Policy in a developing economy (9)

TOTAL : 45

TEXT BOOK

1. *Jhinghan ML "Monetary Economics:" Vrinda Publications, New Delhi, 2013.*

REFERENCES

1. *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi, 1996.*

2. *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai, 2013.*

19HOE04 - ENGLISH FOR ACADEMIC PURPOSE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

- CO1 : Write a description and apply grammatical rules.*
CO2 : Analyse a passage and enhance vocabulary.
CO3 : Formulate a research paper
CO4 : Listen to a lecture and prepare a summary.
CO5 : Construct dialogues using appropriate expressions.

FOCUS ON LANGUAGE

Sentence construction- types of clauses- sequence- co ordination- subordination- paragraphing information - describing a system & procedure (9)

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and megacities - To identify and outline main ideas in a passage - Skim a reading passage for main ideas - Summarize texts and images - Using a dictionary to obtain lexical, phonological and orthographical information - Identify and use target vocabulary words - Highlight important parts and texts. (13)

WRITING

Achieving appropriate tone and style in academic writing - writing a Research article - Types of Research Designs - Choosing a Research Problem- The Abstract - The Introduction - The Literature Review - 6. The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proofreading.

LISTENING

Listening to conversation - lectures - topics - discussions - listening comprehension on specific topics - listening to recognize formal and informal spoken English (11)

SPEAKING

Seminar skills - Engage in verbal role playing in Formal and Informal situation. - Express advice and personal opinions with supporting information - Paraphrase stories and information - Expressing requests - Suggestions - Complaints - Apology - Giving and Accepting compliments - Making invitations - Refusing invitations (12)

TOTAL : 45

REFERENCES

1. *Wisniewska, I., Riggerbach, H., & Samuda, V. (2007). Grammar dimensions*
2. *Form, meaning, and use (4th Ed.). Boston, MA: Heinle Cengage Learning Longman Introductory Course for the TOFEL Test*
3. *Original publications and web- based resources will be reviewed as necessary.*

19HOE05 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Listen to TOEFL exercises and formulate appropriate answers.

CO2 : Speak using right grammar and appropriate pronunciation on general and academic topics.

CO3 : Analyze the passage and answer the question.

CO4 : Generate and organize ideas on a given topic

LISTENING

Listening to conversation - Narration - Suggestion - Assumptions - Predictions - Implications - Problems - Academic conversations
- Discussions - Lectures (11)

SPEAKING

Independent speaking - Integrated speaking - Speaking about a personal experience - Preferences - Report the speakers opinion - Explain a problem and solution - Give a summary of a academic lecture. (13)

READING

Read and understand short passages - Integrated reading tasks - Read the passage and choose the right summary of the passage - Reading for main ideas - Scanning the passage for synonyms - Making inferences - Identifying exceptions - Locating references. (12)

WRITING

Independent writing - Integrated writing - Writing short essays - Writing dialogues - Articles - Sentence construction (9)

TOTAL : 45

REFERENCES

1. Sharpe J.Pamela. *Barron's How to prepare for the TOEFL Test of English as a foreign Language. 11th Edition, Galgotia Publications Pvt. Ltd: New Delhi, 2004.*
2. Sharpe J.Pamela. *Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*

19HOE06 - LIFE AND LITERATURE

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COURSE OUTCOMES

- CO1 : Compose an essay on the prose piece
CO2 : Analyse the poem and write a critical appreciation of it
CO3 : Read the story and find the moral values implied in the stories
CO4 : Write a review the fiction

Unit - 1 : Prose

- The Postmaster by Rabindranath Tagore
Snapshot of a Dog by J G Thurber
On the Rule of the Road by A.G. Gardiner
The Village Schoolmaster by Oliver Goldsmith
Incident of the French Camp by Robert Browning (13)

Unit - 2 : Poems

- Stopping By Woods on a Snowy Evening by Robert Frost
The Ballad of Father Gilligan by W.B. Yeats (9)

Unit - 3 : Short stories

- The Model Millionaire by Oscar Wilde
The Ant and the Grasshopper by W. Somerset Maugham
The Doll's House by Katherine Mansfield, Biography
Albert Einstein and Steve Jobs (11)

Unit - 4 : Fiction

- The Old Man and the Sea by Ernest Hemmingway
The Scarlet Pimpernel by Baroness Emma Orczy
Practice in creative writing, review writing (13)

TOTAL : 45

REFERENCES

1. Xavier. ed. *An Anthology of Popular Essays and Poems*. Macmillan: New Delhi, 2009.
2. Kumara Pillai. ed. *A Book of Modern Short Stories*. Macmillan: New Delhi, 2009.
3. Colleen and Darius Krishnaraj. ed. *Convergence , A Book of Short Stories*. Macmillan: New Delhi, 2009.
4. Ernest Hemmingway. *The Old Man and the Sea*. Arrow: Warwickshire, 2000.
5. Baroness Emma Orczy, *The Scarlet Pimpernel*. Hutchinson : 1995.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Autonomous Institution affiliated to Anna University Chennai)

COIMBATORE - 641 014

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(1956 - 2016)



**DEPARTMENT OF ELECTRICAL AND
ELECTRONICS ENGINEERING**

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

Under Choice Based Credit System

(For the students admitted during 2019 - 2020 and onwards)

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