SENGUNTHAR ENGINEERING COLLEGE
(AUTONOMOUS)
(Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai)
Recognized Under Section 2(f) & 12(B) of the UGC Act, 1956
NAAC Accredited with 'A' Grade
TIRUCHENGODE - 637 205 NAMAKKAL (Dt) TAMILNADU
ESTD 2001
ISO 9001 REGISTERED

REGULATIONS, CURRICULAM & SYLLABI

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

(CHOICE BASED CREDIT SYSTEM)

REGULATIONS – 2019

(Revised)

SENGUNTHAR
Shrine 2 Success

SENGUNTHAR ENGINEERING COLLEGE
(AUTONOMOUS)
(Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai)
Recognized Under Section 2(f) & 12(B) of the UGC Act, 1956
NAAC Accredited with 'A' Grade
TIRUCHENGODE - 637 205 NAMAKKAL (Dt) TAMILNADU
ESTD 2001
ISO 9001 REGISTERED

REGULATIONS, CURRICULAM & SYLLABI

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

(CHOICE BASED CREDIT SYSTEM)

REGULATIONS – 2019

(Revised)

Note: The regulations hereunder are subject to amendments as may be decided by the Academic Council of the Sengunthar Engineering College from time to time. Any or all such amendments will be effective from such date and to such batches of candidates (including those already undergoing the program) as may be decided by the Academic Council.

SENGUNTHAR
Shrine 2 Success

INDEX

REGULATIONS

UG Regulations -2019

SENGUNTHAR
Shrine 2 Success

SCHEME FOR CURRICULUM

B.E. –Electrical and Electronics Engineering

SENGUNTHAR
Shrine 2 Success

SCHEME FOR SYLLABI

B.E. –Electrical and Electronics Engineering

SCHEME FOR EEC & MC

List of Courses

SENGUNTHAR
Shrine 2 Success

SCHEME

Credit Summary

SENGUNTHAR
Shrine 2 Success

MINOR DEGREE / HONOURS

CURRICULUM AND SYLLABI FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2019-2020 onwards)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program Outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities

and norms of the engineering practice.

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

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

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

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

Program Specific Outcome (PSO)

1. Ability to understand the fundamental concepts, analyze, design, develop, implement using mathematicalfoundations and domain knowledge for providing solutions to new ideas and innovations in Electrical Systems.
2. Ability to work and communicate effectively in a team environment and foster the professional skills towardsindustrial and societal needs.
3. Ability to grasp the advancements in Electrical Systems and creating a career path to become an entrepreneur,lifelong learner with moral values and ethics.

CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2019-2020 onwards)

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - FIRST SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19HST101	Communicative Techno English - I	HS	3	0	0	3	40	60	100
19MAT101	Engineering Mathematics - I	BS	3	1	0	4	40	60	100
19CYE101	Engineering Chemistry	BS	3	0	2	4	40	60	100
19PHE101	Engineering Physics	BS	3	0	2	4	40	60	100
19GET101	Engineering Graphics	ES	3	0	0	3	40	60	100
19GEE101	Computer Fundamentals and Python Programming	ES	3	0	2	4	40	60	100
19EEC101	Life Skills for Engineers	EEC	0	0	2	0	100	-	100
19MDC101	Induction Program (2 Weeks)	MC	-	-	-	-	-	-	-
TOTAL CREDITS IN SEMESTER - I			22						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - SECOND SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19HST201	Communicative Techno English - II	HS	3	0	0	3	40	60	100
19CYT201	Environmental Science and Engineering	HS	3	0	0	3	40	60	100
19MAT201	Engineering Mathematics - II	BS	3	1	0	4	40	60	100
19PHT202	Solid State Physics And Nano Electronic Devices	BS	3	0	0	3	40	60	100
19GET203	Basic Civil and Mechanical Engineering	ES	3	0	0	3	40	60	100
19EEE201	Circuit Theory	PC	3	0	2	4	40	60	100
19EEC203	Technical Skill (Hands on training in Electrical & Electronics)	EEC	0	0	2	0	100	-	100
19MDC201	NSS / YRC / RRC	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - II			20						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - THIRD SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19MAT301	Transforms and Partial Differential Equations	BS	3	1	0	4	40	60	100
19EET301	Electromagnetic Theory	PC	3	1	0	4	40	60	100
19EET302	Linear Integrated Circuits	PC	3	0	0	3	40	60	100
19EEE301	Analog Electronics and Circuits	PC	3	0	2	4	40	60	100
19ECE301	Digital Electronics	PC	3	0	2	4	40	60	100
19CSE302	Programming in C and C++	ES	3	0	2	4	40	60	100
19EEC301	Communication Skills	EEC	0	0	2	0	100	-	100
19MDC301	Leadership Enhancement Programme	MC	1	0	0	0	100	-	100
TOTAL CREDITS IN SEMESTER - III			23						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - FOURTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19MAT403	Numerical Methods	BS	3	1	0	4	40	60	100
19EET401	Electrical and Electronic Measurements	PC	3	0	0	3	40	60	100
19EET402	Generation, Transmission andDistribution	PC	3	0	0	3	40	60	100
19ECT404	Discrete Time System andSignal Processing	PC	3	1	0	4	40	60	100
19EEE401	DC Machines and Transformers	PC	3	0	2	4	40	60	100
19EEE402	Control Systems Engineering	PC	3	0	2	4	40	60	100
19EEC302	Entrepreneurship DevelopmentActivity	EEC	0	0	2	0	100	-	100
19MDC401	Value Added Course - I	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - IV			22						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - FIFTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19EET501	Microprocessors and Microcontrollers	PC	3	1	0	4	40	60	100
19EET502	Power System Analysis	PC	3	1	0	4	40	60	100
19EEE501	Power Electronics and Applications	PC	3	0	2	4	40	60	100
19EEE502	Induction and Synchronous Machines	PC	3	0	2	4	40	60	100
	Professional Elective - I	PE	3	0	0	3	40	60	100
	Open Elective - I	OE	3	0	0	3	40	60	100
19EEC501	Quantitative Aptitude Learning	EEC	0	2	0	0	100	-	100
19MDC501	Value Added Course - II	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - V			22						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - SIXTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19EET601	Protection and Switchgear	PC	3	0	0	3	40	60	100
19EET602	Electrical Drives	PC	3	1	0	4	40	60	100
19EEE601	Embedded Controllers and Real Time Operating Systems	PC	3	0	2	4	40	60	100
19EEE602	Power System Operation and Control	PC	3	0	2	4	40	60	100
	Professional Elective - II	PE	3	0	0	3	40	60	100
	Professional Elective - III	PE	3	0	0	3	40	60	100
19EEC604	Mini Project	EEC	0	0	2	1	40	60	100
19MDC601	Constitutions of India	MC	3	0	0	0	100	-	100
TOTAL CREDITS IN SEMESTER - VI			22						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - SEVENTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19EET701	Electric Vehicles	PC	3	0	0	3	40	60	100
19EEE701	Renewable Energy Systems	PC	3	0	2	4	40	60	100
	Professional Elective - IV	PE	3	0	0	3	40	60	100
	Open Elective - II	OE	3	0	0	3	40	60	100
19EEJ701	Project Phase - I	EEC	0	0	2	1	40	60	100
TOTAL CREDITS IN SEMESTER - VII			14						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING - EIGHTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
	Professional Elective - V	PE	3	0	0	3	40	60	100
	Professional Elective - VI	PE	3	0	0	3	40	60	100
19EEJ801	Project Phase - II	EEC	0	0	20	10	40	60	100
TOTAL CREDITS IN SEMESTER - VIII			16						

HS : Humanities and Social Sciences
BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

LIST OF PROFESSIONAL CORE (PC) COURSES

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19EEE201	Circuit Theory	PC	3	0	2	4	40	60	100
19EET301	Electromagnetic Theory	PC	3	1	0	4	40	60	100
19EET302	Linear Integrated Circuits	PC	3	0	0	3	40	60	100
19EEE301	Analog Electronics and Circuits	PC	3	0	2	4	40	60	100
19ECE301	Digital Electronics	PC	3	0	2	4	40	60	100
19EET401	Electrical and Electronic Measurements	PC	3	0	0	3	40	60	100
19EET402	Generation, Transmission and Distribution	PC	3	0	0	3	40	60	100
19ECT404	Discrete Time System and Signal Processing	PC	3	1	0	4	40	60	100
19EEE401	DC Machines and Transformers	PC	3	0	2	4	40	60	100
19EEE402	Control Systems Engineering	PC	3	0	2	4	40	60	100
19EET501	Microprocessors and Microcontrollers	PC	3	1	0	4	40	60	100
19EET502	Power System Analysis	PC	3	1	0	4	40	60	100
19EEE501	Power Electronics and Applications	PC	3	0	2	4	40	60	100
19EEE502	Induction and Synchronous Machines	PC	3	0	2	4	40	60	100
19EET601	Protection and Switchgear	PC	3	0	0	3	40	60	100
19EET602	Electrical Drives	PC	3	1	0	4	40	60	100
19EEE601	Embedded Controllers and Real Time Operating Systems	PC	3	0	2	4	40	60	100
19EEE602	Power System Operation and Control	PC	3	0	2	4	40	60	100
19EET701	Electric Vehicles	PC	3	0	0	3	40	60	100
19EEE701	Renewable Energy Systems	PC	3	0	2	4	40	60	100

LIST OF PROFESSIONAL ELECTIVE (PE) COURSES

Course Code	Name of the Subject	Category	Hours / Week			Credi	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – I									
19EEPX01	Advanced Control System	PE	3	0	0	3	40	60	100
19EEPX02	Design of Electrical Apparatus	PE	3	0	0	3	40	60	100
19EEPX03	High Voltage Direct Current Transmission	PE	3	0	0	3	40	60	100
19EEPX04	Power Quality	PE	3	0	0	3	40	60	100
19EEPX05	Total Quality Management	PE	3	0	0	3	40	60	100
19EEPX31	Automotive Electronics	PE	3	0	0	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Credi**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
Professional Elective – II									
19EEPX06	Principles of Robotics	PE	3	0	0	3	40	60	100
19EEPX07	Communication Engineering	PE	3	0	0	3	40	60	100
19EEPX08	EHVAC Transmission	PE	3	0	0	3	40	60	100
19EEPX09	Special Electrical Machines	PE	3	0	0	3	40	60	100
19EEPX10	VLSI Design	PE	3	0	0	3	40	60	100
19EEPX32	Introduction to Internet of things	PE	3	0	0	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Credi**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
Professional Elective – III									
19EEPX11	Computer Architecture	PE	3	0	0	3	40	60	100
19EEPX12	Digital Control Systems	PE	3	0	0	3	40	60	100
19EEPX13	Artificial Neural Networks	PE	3	0	0	3	40	60	100
19EEPX14	Fibre Optics and Laser Instrumentation	PE	3	0	0	3	40	60	100
19EEPX15	Digital Design with VHDL	PE	3	0	0	3	40	60	100
19EEPX33	Industrial Electrical Systems	PE	3	0	0	3	40	60	100

Course Code	Name of the Subject	Category	Hours / Week			Credi	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – IV									
19EEPX16	Power Systems Transients	PE	3	0	0	3	40	60	100
19EEPX17	Computer methods in Power systems	PE	3	0	0	3	40	60	100
19EEPX18	Utilization of Electrical Energy	PE	3	0	0	3	40	60	100
19EEPX19	Adaptive Control	PE	3	0	0	3	40	60	100
19EEPX20	Energy Auditing and Conservation Techniques	PE	3	0	0	3	40	60	100
19EEPX34	Energy Storage Devices	PE	3	0	0	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Cred**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
Professional Elective – V									
19EEPX21	Power Systems Dynamics	PE	3	0	0	3	40	60	100
19EEPX22	Microcontroller Based System Design	PE	3	0	0	3	40	60	100
19EEPX23	Biomedical Instrumentation	PE	3	0	0	3	40	60	100
19EEPX24	Smart Grid	PE	3	0	0	3	40	60	100
19EEPX25	High Voltage Engineering	PE	3	0	0	3	40	60	100
19EEPX35	Electrical CAD	PE	3	0	0	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Credi**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
Professional Elective – VI									
19EEPX26	Computer Aided Design of Electrical Apparatus	PE	3	0	0	3	40	60	100
19EEPX27	Dynamic Modeling and Analysis of Electrical Machines	PE	3	0	0	3	40	60	100
19EEPX28	Power Electronics for Renewable Energy systems	PE	3	0	0	3	40	60	100
19EEPX29	Modern Power Converters	PE	3	0	0	3	40	60	100
19EEPX30	Micro Electro Mechanical Systems	PE	3	0	0	3	40	60	100
19EEPX36	Wearable Technologies	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVE (OE) COURSES FOR OTHER BRANCHES

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
OPEN ELECTIVE – I									
19EEOX01	Flexible AC Transmission Systems	OE	3	0	0	3	40	60	100
19EEOX02	Electrical Energy Auditing and Conversation techniques	OE	3	0	0	3	40	60	100
19EEOX03	Advanced Electric Drives	OE	3	0	0	3	40	60	100
19EEOX04	Digital Control Systems	OE	3	0	0	3	40	60	100
19EEOX05	Power System Dynamics and Control	OE	3	0	0	3	40	60	100
19NCCL01	NCC Air Force Level-1	OE	2	0	2	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
OPEN ELECTIVE – II									
19EEOX06	Industrial Electrical Systems	OE	3	0	0	3	40	60	100
19EEOX07	Power Quality and FACTS	OE	3	0	0	3	40	60	100
19EEOX08	Wind Energy and Solar Energy Systems	OE	3	0	0	3	40	60	100
19EEOX09	Microprocessors	OE	3	0	0	3	40	60	100
19EEOX10	SMPS and UPS	OE	3	0	0	3	40	60	100
19NCCL02	NCC Air Force Level -2	OE	2	0	2	3	40	60	100

SEMESTER I

19HST101 **COMMUNICATIVE TECHNO ENGLISH - I** **L T P C**
(Common to Civil, CSE, ECE, EEE & Mechanical) **3 0 0 3**

OBJECTIVES

The main objective of this course is to:

- Understand the basics of the English Language in a graded manner.
- Enrich vocabulary for the development of all the four language skills (LSRW).
- Develop speaking skills through self introduction and delivering speeches.
- Write e-mails, informal letters.
- Improve writing skills to express thoughts freely.

UNIT I: VOCABULARY **8**

Synonyms and Antonyms - Single Word Substitutes - Use of Abbreviations and Acronyms - Homonyms and Homophones - Business Vocabulary - Commonly Confused Words - Collocation - British and American Vocabulary - Word formation.

Activity: Grammar worksheets on the given topics.

UNIT II: GRAMMAR **10**

Parts of speech - Comparative Adjectives - Numerical Adjectives - Be, Have and Do verbs - modal verbs - Types of Questions - Tenses - Impersonal Passive Voice - Direct and Indirect Speech - Gerunds and Infinitives - Same Word Used as Different Parts of Speech.

Activity: Grammar worksheets on the given topics.

UNIT III: INFORMAL WRITING **9**

Letter Writing - Informal Letters - e-mail Writing - Informal Dialogues - Essay Writing - Informal Essays - Movie Reviews - Writing Instructions.

Activity: Giving topic and ask the students to write informal letters, e-mail.

UNIT IV: LANGUAGE ENHANCEMENT THROUGH SPEAKING **9**

Self Introduction - (exchanging personal information) personal information, hobbies, strengths and weaknesses, likes and dislikes, special features of home town. Narrating Personal Experiences and Incidents - Two minute talk - Debate discussion.

Activity: Ask the students to speak about the above given topics.

UNIT V: READING SKILLS **9**

Reading Comprehension - reading techniques, pre-reading, post-reading, comprehension questions (multiple choice questions or short questions) - Short comprehension passages, practice skimming - scanning and predicting - Reading the passage and taking (Note making) Notes - Scan and understand main contents of the passage.

Activity: Giving topic and ask the students to find out answers for given passage

TOTAL: 45 PERIODS

OUTCOMES

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

- Learn to acquire usage of English.
- Use a wide range of vocabulary in oral and written communication.
- Give short informal presentations and participate in classroom discussions.
- Write informal letters and other communications.
- Frame grammatically correct sentences.

TEXT BOOKS

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

REFERENCES

1. Department of English, Anna University, "Mindscapes: English for Technologists and Engineers", 1st Edition, Orient Black Swan, Chennai. 2012.
2. Title: Developing Communication Skills. Publisher: MacMillan. Author: Krishna Mohan, Meera Banerji. Edition: Paperback 2019.

E-RESOURCES

1. https://nptel.ac.in/courses/109/106/109106094/ - (Introduction to Vocabulory)
2. https://nptel.ac.in/courses/109/106/109106129/ - (Reading Comprehension)

19MAT101	ENGINEERING MATHEMATICS - I (Common to Civil, CSE, ECE, EEE & Mechanical)	LT P C 3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Develop the use of matrix algebra techniques that are needed by engineers for practical applications.
- Familiarize the students with differential calculus.
- Describe the student with functions of several variables.
- Explore the students understand various techniques of integration.
- Acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I: MATRICES **9+3**

Eigen values and Eigenvectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigenvectors - Cayley-Hamilton theorem - Diagonalization of matrices - Reduction of a quadratic form to canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT II: DIFFERENTIAL CALCULUS **9+3**

Representation of function - Limit of a function - Continuity -- Derivatives - Differentiation rule - Maximum and Minimum values - Absolute Maximum and Minimum - Local Maximum and Minimum.

UNIT III: FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial differentiation - Homogeneous functions and Euler„s theorem - Total derivative - Jacobians -Taylor„s series for functions of two variables - Maxima and minima of functions of two variables - Lagrange„s method ofundetermined multipliers.

UNIT IV: INTEGRAL CALCULUS **9+3**

Definite and Indefinite integral - Substitution rule - Integration by parts - Trigonometric substitutions - Integration of rational function by partial fraction - Improper integrals - Bernoulli‟s formula.

UNIT V: MULTIPLE INTEGRALS **9+3**

Double integrals - Change of order of integration - Double integrals in polar coordinates - Area enclosed by plane curves - Triple integrals - Volume of solids - Change of variables in double and triple integrals.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Classify the matrix algebra methods for solving practical problems.
- Discover differential calculus tools in solving various application problems.
- Develop differential calculus ideas on several variable functions.
- Compare different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS

1. Grewal B.S., - Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

REFERENCES

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., ¯ Advanced Engineering Mathematics, Narosa Publications, NewDelhi, 3rd Edition, 2007.

E-RESOURCES

1. https://nptel.ac.in/courses/111105121
2. https://nptel.ac.in/courses/111107112

19CYE101	ENGINEERING CHEMISTRY (Lab Embedded Theory Course) (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 3 0 2 4

OBJECTIVES

The main objective of this course is to:

- Classify the impurities of water and know the treatment and the conditioning methods for domestic and industrial uses.
- Develop an understanding about fundamentals of polymers.
- Be familiar with the types of corrosion and control measures and working of batteries.
- Gain knowledge about the phase rule and its applications to engineering field.
- Explain the basics of Nanochemistry, synthesis, properties and applications of Nano materials.
- Acquire practical skills in the determination of water quality parameters, molecular weight of polymer, rate corrosion through volumetric and instrumental analysis.

UNIT I: WATER TECHNOLOGY **9**

Introduction - Characteristics - Hardness - Estimation of hardness by EDTA method - Alkalinity and its estimation - Boiler feed water - Requirements - Boilers troubles (Scale and Sludge) - Internal conditioning (colloidal - Phosphate - Calgon and carbonate conditioning methods) - External conditioning - Zeolite process, demineralization process - Desalination of brackish water by reverse osmosis - Municipality water treatment - Break point chlorination.

UNIT II: POLYMER CHEMISTRY **9**

Introduction - Classification of polymers - Natural and synthetic; Thermoplastic and Thermosetting. Functionality - Degree of polymerization. Types of polymerization: Addition condensation and copolymerization, Properties of polymers: Tg, Tacticity, Molecular weight - Weight average, number average and polydispersity index. Preparation, properties and uses of PVC, Nylon 6,6, Polyethylene - Rubbers - Types - Vulcanization of rubber - Plastics - Moulding constituents of plastics - Moulding of plastics - compression, injection and blow moulding - Biodegradable polymers-Conducting polymers.

UNIT III: CORROSION AND BATTERY TECHNOLOGY **9**

Corrosion - Types - Chemical Corrosion - Electrochemical Corrosion (galvanic and Differential aeration) - Factors influencing corrosion - Material selection and design aspects-control methods of corrosion -Sacrificial anodic and impressed current cathodic protection - Protective coatings - Paints - Constituents and their functions - Electroplating of Copper - Electroless plating of Nickel.

Batteries: Definition, Types - example, Lead acid battery, Lithium ion battery - H2 - O2 fuel cell-solar cell.

UNIT IV: PHASE RULE AND ALLOYS **9**

Phase rule - Explanation of terms involved - One component system - Water system - Condensed phase rule - Construction of phase diagram by thermal analysis - Simple eutectic systems (lead - silver system only).

Alloys: Introduction - Definition - Properties of alloys - Significance of alloying, functions and effect of alloying elements - Ferrous alloys - Nichrome and stainless steel - Heat treatment of steel, non-ferrous alloys - Brass and bronze.

UNIT V: CHEMISTRY OF NANO MATERIALS **9**

Nano chemistry - Basics (Surface area to volume ratio - Quantum confinement - (0D, 1D, 2D & 3D) - Distinction between Molecules, Nanoparticles and Bulk Materials - Characterisation of nano materials using XRD and SEM. Synthesis of nano materials: Top down approach - Ball milling - Bottom up approach - Sol-gel method, Chemical vapour deposition - Properties of nanomaterials and Applications of Nanomaterials (Nano products of today).

LIST OF EXPERIMENTS

(Any Eight Experiments to be conducted)

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
3. Determination of DO content of water sample by Winkler"s method.
4. Determination of chloride content of water sample by Argentometric method.
5. Determination of strength of given hydrochloric acid using pH meter.
6. Estimation of sodium and potassium present in water using flame photometer.
7. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
8. Conductometric titration of strong acid vs strong base.
9. Corrosion experiment-weight loss method.
10. Estimation of copper content in the brass by Iodometry.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Identify the method of removal of impurities from water for domestic and industrial purpose.
- Identify the different types of polymers, polymerisation processes and some special properties and applications of polymers.
- Analyze the causes of corrosion and discuss the control measures and discuss the functions of batteries.
- Apply of phase rule to alloy making for various engineering applications.

- Discuss the fundamentals of the nano materials and nano products of today.
- Outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TEXT BOOKS

1. Jain P.C and Monika Jain, "Engineering Chemistry", Dhanpet Rai Publishing Company (P) Ltd.,New Delhi, 2013.
2. Viswanathan B, "Nanomaterials" Alpha Science International Ltd, 2009.

REFERENCES

1. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, NewDelhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.

E-RESOURCES

1. https://nptel.ac.in/downloads/122101001/ - (Corrosion)
2. https://nptel.ac.in/courses/122/101/122101001/ - (Atomic Structure)

19PHE101 **ENGINEERING PHYSICS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**
(Common to Civil, CSE, ECE, EEE & Mechanical)

OBJECTIVES

The main objective of this course is to:

- Recognize different lattices and crystal structures.
- Be aware of the basic concepts of stress and strain
- Know the basics of photonics and its applications
- Make known the principles of quantum theory
- Understand the applications of acoustics and ultrasonics in industry
- Demonstrate experiments to understand basic of Engineering Physics concepts to be applied in optics, thermal physics, properties of matter and liquids.

UNIT I: STRUCTURE OF SOLIDS **9**

Lattice - Unit cell - Bravais lattice - Lattice planes - Miller indices - d -Spacing in Cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - Coordination number - Packing factor for SC, BCC, FCC and HCP structures - Crystal Growth Techniques - Solution, melt (Bridgman and Czochralski) and Vapour growth techniques(qualitative).

UNIT II: ELASTICITY **9**

Elasticity - Stress-Strain diagram and its uses - Factors affecting elastic modulus and tensile strength - Torsional stress and deformations -Twisting couple - Torsion pendulum: theory and experiment - Bending of beams :Bending moment - Cantilever: Theory and Experiment - Uniform and Non-uniform bending: Theory and experiment - I- Shaped girders.

UNIT III: PHOTONICS **9**

Introduction to interaction of radiation with matter - Spontaneous and Stimulated emission - Population Inversion - Derivation of Einstein‟s A and B coefficients - Principle and working of Laser - Nd:YAG laser - Direct bandgap and indirect bandgap semiconductors - Semiconductor diode Laser- Principle and propagation light in optical fibres - Derivation of Numerical aperture and Acceptance angle - Fibre optic communication system.

UNIT IV: QUANTUM PHYSICS **9**

Black body radiation - Planck‟s theory (derivation) - Compton effect: theory and experimental verification - Wave particle duality - Electron diffraction - Concept of wave function and its Physical significance - Schrödinger‟s wave equation: Time independent and time dependent equations - Particle in a one-dimensional rigid box - Qunatum Tunnelling - Tunnelling Electron Microscope.

UNIT V: ACOUSTICS AND ULTRASONICS **9**

Classification of sound - decibel - Weber - Fechner law - Sabine‟s formula - Derivation using growth and decay method - Absorption Coefficient and its determination - Factors affecting acoustics of buildings and their remedies Introduction- Classification of Sound waves - Production of Ultrasonic‟s by magnetostriction and piezoelectric methods - Acoustic grating - Cavitation - Applications of Ultrasonics.

LIST OF EXPERIMENTS

(Any Eight Experiments to be Conducted)

1. Laser : Determination of wavelength of laser and particle Size.
2. Fiber Optics : Determination of Numerical Aperture and Acceptance angle.
3. Determination of bandgap of semiconductor.
4. Determination of wavelength of mercury spectrum- Spectrometer.
5. Determination of Youngs modulus - Non- Uniform bending.
6. Determination of Youngs modulus - Uniform bending.
7. Torsional Pendulum : Determination of moment of inertia and rigidity modulus.
8. Determination of velocity of ultrasonic in liquid.
9. Determination of Thickness of a thin wire - Air Wedge
10. Determination of Viscosity of a liquid -Poiseulle‟s Method

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Apply these basic principles of structures of engineering materials.
- Make use of materials properties using the knowledge of Elasticity.
- Acquire the concepts of light propagation and its applications in lasers and fibre optics.
- Realize advanced physics concepts of quantum theory and its applications.
- Incorporate the Acoustics and ultrasound applications
- Apply principles of elasticity, optics and acoustic properties in engineering applications.

TEXT BOOKS

1. Avadhanulu M.N & Kshirsagar P.G “Text Book of Engineering Physics”. S.Chand, 2006.
2. P.Mani, “Engineering Physics Practicals”, Dhanam Publications, 2019.

REFERENCES

1. Raghavan V, "Materials Science and Engineering", A First Course, PHI Publications, 2015.
2. Rajendran V. "Engineering Physics". Tata McGraw Hill Publications, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/122107035/ (Polarization)
2. https://ocw.mit.edu/courses/physics/ (Introduction)

19GET101	ENGINEERING GRAPHICS (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the principles in graphic skill to communicate the concepts, ideas and design of engineering components.
- Learn projections of points, lines, planes viewed in different positions.
- Learn the projection of solids viewed in different positions.
- Gain the knowledge about the section of solids and development of surfaces of the given solids.
- Expose the international standards of technical drawing.

UNIT I: GENERAL PRINCIPLES OF ORTHOGRAPHIC PROJECTION **9**

Graphics significance in engineering applications - Study of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Principle of Letter writing and dimensioning.

Projections of points, lines and planes - Principles of orthographic projection - First angle projection only - Layout of views - Projection of points located in all quadrant - Projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT II: PROJECTION OF SOLIDS **9**

Projections of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT III: SECTION OF SIMPLE SOLIDS **9**

Section of solids - prisms, pyramids, cylinder and cone - Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

UNIT IV: DEVELOPMENT OF SURFACES **9**

Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones with cutout, perpendicular and inclined to the horizontal axis.

UNIT V: ISOMETRIC AND PERSPECTIVE PROJECTIONS **9**

Principles of isometric projection - isometric scale - isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones. Conversion of isometric projection into orthographic projection. Perspe ctive projection of prisms, pyramids and cylinders by visual ray method.

TOTAL: 45 PERIODS

OUTCOMES

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

- Sketch multiple views of engineering components.
- Prepare pictorial drawings as per the standards.

- Develop the projection of solids.
- Draw the section of solids drawings and development of surfaces of given objects.
- Apply free hand sketching and concept of isometric in engineering practice.

TEXT BOOKS

1. Venugopal K. and Prabhu Raja V., - "Engineering Graphics", 15th Edition, New Age International (P) Limited, New Delhi, 2018.
2. Natarajan K.V., "Engineering Graphics", 32nd Edition, Dhanalakshmi Publishers, Chennai, 2019.

REFERENCES

1. K.R. Gopalakrishna, "Engineering Drawing Volume 1 & 2", 55th Edition Subhas Publications, Bangalore, 2017.
2. T.Jeyapoovan., "Engineering Graphics using Auto CAD" 3rd Edition vikas publishing house Pvt Ltd, New Delhi, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/112/103/112103019/ - (Geometric Constructions)
2. https://nptel.ac.in/courses/105/104/105104148/ - (Projections)

19GEE101 COMPUTER FUNDAMENTALS AND PYTHON PROGRAMMING **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**
(Common to Civil, CSE, ECE, EEE & Mechanical)

OBJECTIVES

The main objective of this course is to:

- Enable the student to learn the major components of a computer system and software.
- Know the basics of algorithmic problem solving and fundamentals of python programming.
- Develop simple python programs.
- Define controls and functions in python.
- Use python data structures - lists, tuples and dictionaries.

UNIT I: INTRODUCTION **9**

Introduction, Characteristics of Computers, Generation and Classifications of Computers, Basic Computer Organization, Computer Software, Types of Software, Software Development Steps, Internet, Getting connected to Internet Applications

UNIT II: PROBLEM SOLVING AND PYTHON FUNDAMENTALS **9**

Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Introduction to Python: Basics of Python and history of Python - Unique features of Python, interpreter and interactive mode - values and types: int, float, boolean, string, and list; variables.

UNIT III: EXPRESSIONS AND STATEMENTS **9**

Expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT IV: CONTROL FLOW AND FUNCTIONS **9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions, Strings, Lists as arrays. Illustrative programs: square root, gcd, Tower of Hanoi, exponentiation, sum an array of numbers, linear search, binary search.

UNIT V: LISTS, TUPLES AND DICTIONARIES **9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension.

LIST OF EXPERIMENTS

(Any Eight to be conducted)

1. Document Creation, Table Creation and Flow chart
2. Spread sheet- Chart, Formula, Sorting
3. Compute the GCD of two numbers.
4. Find the square root of a number (Newton„s method)
5. Exponentiation (power of a number)
6. Find the maximum of a list of numbers
7. Linear search and Binary search
8. First n prime numbers
9. Multiplication of two matrices
10. Simulate elliptical orbits in Pygame

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Know the Computer basics, Components and softwares.
- Develop algorithmic solutions to simple computational problems and Read, write, execute by handsimple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, and dictionaries.

TEXT BOOKS

1. Ashok.N.Kamthane,“ Computer Programming”, Pearson Education (India),(2015).
2. Allen B. Downey, „“Think Python: How to Think Like a Computer Scientist””, 2nd Edition, Updated for Python 3, Shroff/O“Reilly Publishers, 2016. (http://greenteapress.com/wp/think- python/)

REFERENCES

1. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python „“- Revised and updated for Python 3.2, Network Theory Ltd., 2011.
2. Charles Dierbach, “Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/106/106/106106145/ - (Introduction to Algorithms)
2. https://nptel.ac.in/courses/106/106/106106182/ - (Joy of Computing)

19EEC101	LIFE SKILLS FOR ENGINEERS (Employability Enhancement Course) (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 0 0 2 0

OBJECTIVES

The main objective of this course is to:

- Develop communication competence for engineers and enable them to convey thoughts and ideas with clarity and focus.
- Inculcate critical thinking process on problem solving.
- Have an overview on career skills required in their profession.
- Learn professional Ethics and Moral values.
- Lead a team with more responsibilities to be succeed in their endeavour.

UNIT I: COMMUNICATION SKILL **6**

Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication- Technical Presentation

UNIT II: CRITICAL THINKING & PROBLEM SOLVING **6**

Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Mind Mapping & Analytical Thinking.

UNITIII: CAREER SKILLS **6**

Introduction to Employability and Career Skills - Developing a long - Term career plan - Making career changes -Time Management - General awareness of Current Affairs - Stress management - Leadership straits - Team work - Career planning.

UNIT IV: ETHICS MORAL & PROFESSIONAL VALUES **6**

Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues.

UNIT V: LEADERSHIP SKILLS **6**

Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

TOTAL: 30 PERIODS

OUTCOMES

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

- Communicate effectively and make effective presentations.
- Write different types of reports.

- Face interview & group discussion.
- Critically think on a particular problem.
- Get success in all aspects and develop public skills.

TEXT BOOKS

1. Life Skills for Engineers, McGraw Hill Education (India) Private Ltd., 2016
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015

REFERENCES

1. Barun K. Mitra; (2011), "Personality Development & Soft Skills", 1st Edition; Oxford Publishers.
2. Kalyana; (2015) "Soft Skill for Managers"; 1st Edition; Wiley Publishing Ltd.

SEMESTER II

19HST201	COMMUNICATIVE TECHNO ENGLISH - II (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Acquire usage of grammar in English language.
- Enhance the reading skill to comprehend technical writing.
- Improve business writing skills.
- Develop presentation skills in analytical view.
- Help learners to develop their speaking skills and speak fluently in real contexts.

UNIT I: GRAMMAR **9**

Compound words - Prepositions - Articles - Conditionals - Direct and indirect speeches - Subject verb agreement - Active and passive voice.

Activity: **Grammar worksheets on the given topics.**

UNIT II: LANGUAGE ENHANCEMENT THROUGH LISTENING & READING **9**

Syllabification - Sentence stress - Intonation - Listening to You Tube Documentaries - Reading Vocabulary - Reading News Papers - Reading short stories.

Activity: **Playing video & TED and identifying stress and intonation.**

UNIT III: BUSINESS WRITING **9**

Writing Recommendations - Checklist- Business Letters - Calling for Quotations, Placing Orders, Letter of Complaint, Letter of Clarification - Cover Letter with Résumé - Report Writing - Accident Report, Industrial Visit Report - Survey Report and Feasibility Report.

Activity: **Giving topic and ask the students to prepare checklist and complaint.**

UNIT IV: WRITING **9**

Transcoding Graphics - Bar Chart, Flow Chart, Pie Chart and Tables - Tour Itinerary - Process Description - Agenda and Minutes of meeting.

Activity: **Giving charts to the students and ask them to transcode.**

UNIT V: SPEAKING **9**

Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging - suggesting - comparing and contrasting - Expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words.

TOTAL: 45 PERIODS

OUTCOMES

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

- Acquire advanced level grammatical knowledge.
- Improve their language usage in LSRW skills.
- Speak fluently using a wide range of vocabulary.
- Acquire the ability to understand different written texts.
- Enhance the writing skills to express the ideas in the business contexts.

TEXT BOOKS

1. Title: Technical English II Author: S. Sumant Maven Learning.
2. Communicative English by KN Shoba ,Lourdes Joavani Rayen Publised by Cambridge university, 2017.

REFERENCES

1. Dr K Elango, Dr. Veena Selvam, Dr. Sujatha Priyadarshini, "Resonance English for Engineers and Technologists". Cambridge University Press, 1st Edition, Foundation Books, New Delhi, 2013.
2. Seely, John. Oxford Guide to Effective Writing and Speaking. Indian ed. New Delhi: Oxford University Press. 2005.

E-RESOURCES

1. https://nptel.ac.in/courses/109/104/109104031/ - (Verbal and Non Verbal Communication)
2. https://nptel.ac.in/courses/109/106/109106094/ - (Technical English for Engineers)

19CYT201	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the importance of the environment and interrelationship between living organism and environment.
- Understand the various kinds of pollutions.
- Gain knowledge about natural resources and resource management.
- Be familiar with the social issues to improve the quality of environment.
- Gain knowledge about biodiversity, waste management and population explosion.

UNIT I: ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY **11**

Definition, scope and importance of environment - Need for public awareness - Concept of an ecosystem - structure and function of an ecosystem - Producers, consumers and decomposers - Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, rivers, oceans) - Introduction to biodiversity definition: genetic, species and ecosystem diversity - bio geographical classification of India - Value of biodiversity - India as a mega-diversity nation - Hot-spots of biodiversity - threats to biodiversity - Endangered and endemic species of India - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Activity: Biodiversity in and around the campus and report submission.

UNIT II: ENVIRONMENTAL POLLUTION **9**

Definition - Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards - Solid waste management: causes, effects and control measures of municipal solid wastes - e-waste - Role of an individual in prevention of pollution - Pollution case studies - Disaster management: floods, earthquake and cyclone.

Activity: Local Pollution Case Study and report submission.

UNIT III: NATURAL RESOURCES **10**

Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people - Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies - Food resources: World food problems, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies - Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies - Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification - Role of an individual in conservation of natural resources.

Activity: Waste to wealth.

UNIT IV: SOCIAL ISSUES AND THE ENVIRONMENT **9**

From unsustainable to sustainable development - Water conservation, rain water harvesting, watershed management - Resettlement and rehabilitation of people; its problems and concerns, case studies - environmental ethics: Issues and possible solutions - climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. - Wasteland reclamation - Green Chemistry and principles - environment production act - Air (Prevention and Control of Pollution) act - Water (Prevention and control of Pollution) act - Wildlife protection act - Forest conservation act - Public awareness.

Activity: Creating Environmental Awareness.

UNIT V: HUMAN POPULATION AND THE ENVIRONMENT **6**

Population growth, variation among nations - Population explosion - Family welfare programme - Environment and human health - Human rights - Value education - HIV / AIDS - women and child welfare - Role of information technology in environment and human health - Case studies.

Activity: Visit to local primary health center.

OUTCOMES

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

- Find scientific, technological, economic and political solutions to environmental problems.
- Invent innovative solutions for pollutions to improve the quality of environment.
- Participate the conservation of natural resources to save earth.
- Promote sustainable development and understand the concept of green chemistry.
- Analyse the effects of human population and issues related to the environment and human health.

TEXT BOOKS

1. Benny Joseph, „Environmental Science and Engineering„, Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, „Introduction to Environmental Engineering and Science„, 2nd Edition, Pearson Education, 2004.

REFERENCES

1. Erach Bharucha, „Textbook of Environmental Studies", Universities Press(I) Pvt Ltd, Hydrabad, 2015.
2. Dharmendra S. Sengar, „Environmental law„, Prentice hall of India Pvt Ltd, New Delhi, 2007

E-RESOURCES

1. https://nptel.ac.in/courses/122102006/ - (Nature of Environment)
2. https://nptel.ac.in/courses/127/105/127105018/ - (Sustainability Concepts)

19MAT201 **ENGINEERING MATHEMATICS - II** **L T P C**
(Common to Civil, CSE, ECE, EEE & Mechanical) **3 1 0 4**

OBJECTIVES

The main objective of this course is to:

- Acquire sound knowledge of techniques in solving ordinary differential equations obtained from engineering problems.
- Acquaint the student with the concepts of vector calculus that is needed for problems in engineering disciplines.
- Develop the fundamental concepts in analytic functions, conformal mapping and Bilinear transformations.
- Extend the standard techniques of complex integration.
- Compose the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I: DIFFERENTIAL EQUATIONS **9+3**

Higher order linear differential equations with constant coefficients - Method of variation of parameters - Homogenous equation of Euler„s and Legendre„s type - System of simultaneous linear differential equations with constant coefficients.

UNIT II: VECTOR CALCULUS **9+3**

Gradient and directional derivative - Divergence and curl - Line integral over a plane curve - Surface integral - Area of a curved surface - Volume integral - Green‟s, Gauss divergence and Stoke‟s theorems - Verification and application in evaluating line, surface and volume integrals.

UNIT III: ANALYTIC FUNCTIONS **9+3**

Analytic functions - Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties - Harmonic conjugates - Construction of analytic function - Conformal mapping - Mapping by function $W = \frac{1}{z}$ - Bilinear transformation.

UNIT IV: COMPLEX INTEGRATION **9+3**

Cauchy‟s integral theorem - Cauchy‟s integral formula - Laurent‟s series - Application of residue theorem for evaluation of real integrals - Use of circular contour and semicircular contour.

UNITV: LAPLACE TRANSFORMS **9+3**

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

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Apply various techniques in solving differential equations which arises in Engineering problems.
- Solve engineering problems using the concept of vector calculus.
- Develop the concept of analytic functions, conformal mapping and Bilinear transformations.
- Evaluate integrals using Cauchy's integral formula and residue theorem.
- Build the Laplace transforms techniques in solving differential equations.

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

REFERENCES

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, Delhi, 10th Edition, New Delhi , 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi,3rd Edition, 2007.

E-RESOURCES

1. https://nptel.ac.in/courses/111105134
2. https://nptel.ac.in/courses/111106139

19PHT202 **SOLID STATE PHYSICS AND NANOELECTRONIC DEVICES** **L T P C**

(Common to CSE, ECE and EEE Branches) **3 0 0 3**

OBJECTIVES

The main objective of this course is to:

- Learn the basic conduction process in conducting materials
- Understand the fundamentals of semiconducting materials.
- Develop the knowledge in Superconducting and Dielectric materials
- Aware of the propagation of light phenomenon in optical materials
- Comprehend the concept of Nano Electronic Devices.

UNIT I: CONDUCTING MATERIALS **9**

Conductors - Classical free electron theory of metals - Electrical and thermal conductivity - Wiedemann - Franz law , Lorentz number - Draw backs of classical theory - Ohm's law verification - Fermi Dirac distribution function - Effect of temperature on Fermi Function - Density of energy states - Carrier concentration in metal - Average energy of an electron - Effective mass of electron and Concept of hole.

UNIT II: SEMICONDUCTING MATERIALS **9**

Elemental and compound semiconductors - Intrinsic semiconductor - Carrier concentration derivation - Fermi level - Derivation of carrier concentration in n-type and p-type semiconductor - Hall effect and applications - Working of PN junction diode - Schottky diode - Ohmic contacts - Tunnel diode.

UNIT III: SUPERCONDUCTING AND DIELECTRIC MATERIALS **9**

Superconductivity: Properties - Type I and Type II superconductors - BCS theory of superconductivity - High Tc superconductors - General applications of superconductors - Cryotron and Magnetic levitation.

Dielectric Materials: Electrical susceptibility - Dielectric constant - Electronic, ionic, orientation and space charge polarization - Internal filed and Clausius-Mosotti Relation - Ferro electricity and applications

UNIT IV: OPTICAL MATERIALS **9**

Introduction - optical materials - Carrier generation and recombination processes - Solar cell - Photo detectors - PIN diode - Light Emitting Diode (LED) - Organic Light Emitting Diode (OLED) Laser diode - Liquid Crystal Display (LCD) - Excitons - Optical data storage techniques - Plasmonics.

UNIT V: NANO ELECTRONIC DEVICES **9**

Introduction - Quantum confinement - Quantum well, quantum wire and quantum dot structure - Tunneling: single electron phenomena and single electron transistor (SET) - Quantum dot laser- quantum bits (qubits) - quantum computing - Carbon Nano Tubes (CNT) structure, properties and applications. Concepts of Molecular Transisitor - Graphene Transistor - Carbon nano tube transistor - Applications of Nano devices and Nano sensors.

TOTAL: 45 PERIODS

OUTCOMES

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

- Gain knowledge on classical and quantum electron theories, and energy band structures.
- Acquire knowledge on basics of semiconductor physics and its applications in various devices.
- Get knowledge on superconducting and dielectric properties of materials.
- Understand the function of optical materials for optoelectronics.
- Expand the knowledge on quantum structures and their applications in spintronics and Nano electronics.

TEXT BOOKS

1. Kasap, S.O. "Principles of Electronic Materials and Devices", McGraw-Hill Education, 2007.
2. Rajendran V. "Engineering Physics". Tata McGraw Hill Publications, 2012.

REFERENCES

1. Garcia, N. & Damask, A. "Physics for Computer Science Students". Springer-Verlag, 2012.
2. Hanson, G.W. "Fundamentals of Nanoelectronics". Pearson Education, 2009.

E-RESOURCES

1. https://nptel.ac.in/downloads/122101002/ - (Introduction of nano materials)
2. https://swayam.gov.in/nd1_noc19_ph14/preview - (semiconductor devices)

19GET203	BASIC CIVIL AND MECHANICAL ENGINEERING (Common to CSE, ECE and EEE Branches)	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Familiarize the materials and measurements used in Civil Engineering.
- Provide the exposure on the fundamental elements of civil engineering structures.
- Enable the students to distinguish the components and working principle of power plant and pumps.
- Enable the students to distinguish the components and working principle of IC engines and various sources of energy.
- Understand refrigeration and air condition system, manufacturing and fabrication techniques.

UNIT I: CIVIL ENGINEERING MATERIALS AND SURVEYING **9**

Role of civil engineering for the welfare of Society - Introduction - Bricks - Stones - Sand - Cement - Concrete - Necessity of special Concrete - Steel - Timber - Modern materials - Surveying : Objects - Classification - Principles - Measurement of Distances - Angles - Levelling - Determination of Areas - Contours - Examples.

UNIT II: BUILDING COMPONENTS AND STRUCTURES **9**

Foundations: Soil - General types of soil -Types of foundations - Bearing capacity and settlement - Factors affecting bearing capacity - Requirement of good foundations - Causes of failure of foundations. Civil Engineering Structures: Super structure: Brick masonry - Stone masonry - Beams - Columns - Lintels - Roofing - Flooring - Plastering - Types of Bridges and Dams - Floor area, carpet area - Classification and purposes governing selection of site - Water supply - Sources and quality of water - Rain water harvesting.

UNIT III: POWER PLANT ENGINEERING **9**

Introduction, Classification of Power Plants - Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants - Merits and Demerits - Pumps - Working principle of Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Turbines - Working principle of Impulse and reaction turbine.

UNIT IV: IC ENGINES AND ALTERNATE SOURCES OF ENERGY **9**

Internal combustion engines - Working principle of Petrol and Diesel Engines - Four stroke and two stroke cycles - Comparison of four stroke and two stroke engines - Automobile - important components and its functions. Alternate Energy sources - Solar energy, Wind energy, Tidal and Geothermal energy.

UNIT V: AIR CONDITIONING AND MANUFACTURING TECHNOLOGY **9**

Terminology of Refrigeration and Air Conditioning - Principle of vapour compression - Layout of typical domestic refrigerator - Window and Split type room Air conditioner - Principle and applications of Metal forming process - Foundry, Forging and Metal joining process - Welding.

TOTAL: 45 PERIODS

OUTCOMES

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

- Know the various functions of Civil Engineer and to identify the suitable construction materials.
- Demonstrate the various elements of sub-structure and super-structure.
- Understand the basic concepts in thermal engineering and fluid mechanics.
- Display the IC engine working principles of various energy sources.
- Exhibit an understanding of principles and applications of mechanical power transmission components and basic manufacturing process.

TEXT BOOKS

1. K.Venugopal, V.Praburaja, G,.Sreekanjana "Basic Civil and Mechanical Engineering" , Anuradha Publications, Chennai, 2001.
2. Shanmugam.G and Palanichamy.MS, "Basic Civil and Mechanical Engineering", Tata McGraw Hill PublishingCo., NewDelhi, 2018.

REFERENCES

1. Dr.B.C.Punmic, Ashoke K.Jain, Arun K.Jain, "Basic Civil Engineering" , Laxmi publications (P) LTD, New Delhi, 2008.
2. Shantha Kumar S R J., "Basic Mechanical Engineering", Hi-tech Publications, Mayil

E-RESOURCES

1. National Programme on Technology Enhanced Learning (NPTEL) on basic civil and mechanical engineering - (Introduction of basic civil and mechanical engineering)
2. https://acedemicearth.org/mechanical-engineering/ - (power plant engineering)

19EEE201	CIRCUIT THEORY	L T P C 3 0 2 4

OBJECTIVES

The main objective of this course is to:

- Introduce electric circuits and its analysis.
- Impart knowledge on solving circuit equations using network theorems.
- Introduce the phenomenon of resonance and coupled circuits.
- Educate on obtaining the transient response of circuits.
- Introduce Phasor diagrams and analysis of three phase circuits.
- Simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab and Gain Practical experience on electric circuits and Verification of Theorem.

UNIT I: BASIC CIRCUITS ANALYSIS **9**

Ohm's Law - Kirchhoff's laws - DC and AC Circuits - Resistors in series and parallel circuits - Mesh current and node voltage method of analysis for D.C and A.C. circuits.

UNIT II: NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS **9**

Network reduction: Voltage and current division, source transformation - Star delta conversion - Thevenin's and Norton"s Theorem - Superposition Theorem - Maximum power transfer theorem - Reciprocity Theorem - Millman's Theorem.

UNIT III: RESONANCE AND COUPLED CIRCUITS **9**

Series and parallel resonance - Frequency response - Quality factor and Bandwidth - Self and mutual inductance - Dot rule - Coefficient of coupling - Tuned circuits - Single tuned and double tuned circuits.

UNIT IV: TRANSIENT ANALYSIS **9**

Natural response - Forced response - Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input - Characterization of two port networks in terms of Z, Y, h and ABCD parameters.

UNIT V: THREE PHASE CIRCUITS **9**

Average and RMS value - Phasor diagram - Power, power factor and Energy - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - Phasor diagram of voltages and currents - Power and power factor measurements in three phase circuits.

LIST OF EXPERIMENTS

1. Simulation and Experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Simulation and Experimental verification of electrical circuit problems using Thevenin's theorem and Norton's theorem.
3. Simulation and Experimental verification of electric circuit problem using superposition theorem.
4. Simulation and Experimental verification of Maximum Power transfer Theorem.
5. Measurement of self-inductance of a coil.
6. Simulation and Experimental validation of R-C electric circuit transients
7. Simulation and Experimental validation of frequency response of RLC electric circuit.
8. Design and Simulation of series and parallel resonance circuit.
9. Simulation of three phase balanced and unbalanced star, delta networks circuits.
10. Calibration of single phase energy meter.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Learn the basic concepts of DC and AC electrical circuits.
- Understand and apply the knowledge of circuit theorems.
- Acquire knowledge about resonance and coupled circuits.
- Apply the concepts in transients.
- Analyze the three phase circuits.
- Understand and apply circuit theorems and concepts in engineering applications.

TEXT BOOKS

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 9th Edition, New Delhi, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill, 6th Edition, 2019.

REFERENCES

1. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, 3rd Edition, 2018.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 5th Edition, 2017.

E - RESOURCES

1. https://nptel.ac.in/courses/108102042/ - (Resonance and coupled circuits)
2. https://www.my-mooc.com/en/mooc/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0/ - (Three phase circuits)

19EEC203 HANDS ON TRAINING IN ELECTRICAL AND ELECTRONICS ENGINEERING **L T P C**
(Employability Enhancement Course) **0 0 2 0**
(For EEE and ECE Branches)

OBJECTIVES

The main objective of this course is to:

- Gain practical experience on Electrical Appliances.
- Create awareness on non-conventional energy.

LIST OF EXPERIMENTS:

1. Maintenance of UPS and Battery.
2. Earthing of Power Devices.
3. Repair &Maintenance of Home Appliances.
4. Change of Fuse Links.
5. Repair &Maintenance of Air Compressor.
6. Repair &Maintenance of RO System (filter, pump moter)
7. Study of Electronic Devices.
8. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
9. Fluorescent lamp wiring.
10. Stair case wiring.
11. Soldering practice-components devices and circuits-using general purpose PCB.
12. Study of simple home based LAN connection.

TOTAL: 20 PERIODS

OUTCOMES

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

- Repair and service the home based electrical appliances.
- Establish home based LAN connection.

SEMESTER III

19MAT301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
(Common to Civil, CSE, ECE, EEE & Mechanical) **3 1 0 4**

OBJECTIVES:

The main objective of this course is to:

- Discover the basic concepts of Partial differential equation for solving standard partial differential equations.
- Apply the Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- Acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- Explain Fourier transform techniques used in wide variety of situations.
- Utilize the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I: PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

UNIT II: FOURIER SERIES 9+3

Dirichlet‟s conditions - General Fourier series - Odd and even functions - Half range Sine and Cosine series - Parseval‟s identity - Harmonic analysis.

UNIT III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of partial differential equations - Method of separation of variables - Fourier Series Solutions of one dimensional wave equation - One dimensional equation of heat conduction - Steady state solution of two dimensional equation of heat conduction.

UNIT IV: FOURIER TRANSFORMS 9+3

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

UNIT V: Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

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

TOTAL: 45+15= 60 PERIODS

OUTCOMES

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

- Use the standard types of partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Relate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Analyze some of the physical problems of engineering by Fourier transforms.
- Apply Z transforms techniques in solving difference equation.

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES

1. N.P. Bali and Manish Goyal, "A Textbook of Engineering Mathematics" 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
2. Erwin Kreyszig, "Advanced Engineering Mathematics",10th Edition, John Wiley,India,2016.

E-RESOURCES

1. https://nptel.ac.in/courses/111/105/111105035/ - (Review Groups, Fields and Matrices)
2. https://nptel.ac.in/courses/111105035/27 - (Complex Variables)

19EET301 **ELECTROMAGNETIC THEORY** **L T P C**
3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Introduce the basic mathematical concepts related to electromagnetic vector fields.
- Impart knowledge on the concepts of Electrostatic fields, energy density.
- Magneto static fields, magnetic flux density, vector potential and its applications.
- Different methods of EMF generation and Maxwell's equation.
- Communicate knowledge on the concepts of electromagnetic.

UNIT I: ELECTROSTATICS - I **9+3**

Sources and effects of electromagnetic fields - Coordinate Systems - Vector fields -Gradient, Divergence, Curl - theorems and applications - Coulomb's Law - Electric field intensity - Field due to discrete and continuous charges - Gauss's law and applications.

UNIT II: ELECTROSTATICS - II **9+3**

Electric potential - Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor - Electric field in free space, conductors, dielectrics - Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics - Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

UNIT III: MAGNETOSTATICS **9+3**

Lorentz force, magnetic field intensity (H) - Biot-Savart's Law - Ampere's Circuit Law - H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) - B in free space, conductor, magnetic materials -Magnetization, Magnetic field in multiple media - Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density- about Finite Element Method Magnetics (FEMM) Simulation tool - Applications.

UNIT IV: ELECTRODYNAMIC FIELDS **9+3**

Magnetic Circuits - Faraday's law - Transformer and motional EMF - Displacement current - Maxwell's equations (differential and integral form) - Relation between field theory and circuit theory - Applications.

UNIT V: ELECTROMAGNETIC WAVES **9+3**

Electromagnetic wave generation and equations - Wave parameters; velocity, intrinsic impedance, propagation constant - Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector- Plane wave reflection and refraction.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Describe the basic mathematical concepts related to electromagnetic vector fields.
- Explain the electric and magnetic fields for simple configurations under static conditions.
- Analysis time varying electric and magnetic fields.
- Apply the Maxwell's equations in different forms and different media.
- Outline the knowledge in Electromagnetic waves.

TEXT BOOKS

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc.Asian Edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian Edition, 2014.

REFERENCES

1. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010
2. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; 8th Reprint: 2015.

E-RESOURCES

1. https://nptel.ac.in
2. https://swayam.gov.in/nd1_noc19_ma22/preview

19EET302 **LINEAR INTEGRATED CIRCUITS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the IC fabrication process of active and passive components.
- Impact the DC and AC characteristics of op-amp and its effect on output.
- Explicate and design filters and generate waveforms using op-amp circuits.
- Analyze and compare the multivibrators using special application.
- Acquire the various specific ICs such as voltage regulators and isolation amplifier.

UNIT I: IC FABRICATION **9**

IC classification - Fundamentals of monolithic IC technology - Basic planner process - Epitaxial growth, masking and etching - Realization of monolithic ICs and packaging - Fabrication of active and passive components (R, C, diodes, transistors, FETs) in ICs.

UNIT II: CHARACTERISTICS OF OPAMP **9**

Ideal op-amp characteristics - DC characteristics - AC characteristics - Differential mode - Common mode - CMRR - Voltage follower - basic applications of op-amp - Differentiator and integrator - V/I & I/V converters - Power amplifier in op-amps - Classification of power amplifier.

UNIT III: APPLICATIONS OF OPAMP **9**

Summing amplifier – Adder – Subtractor - Low pass and high pass filters – Comparators – Multivibrators - Waveform generators – Clippers – Clampers - Peak detector - S/H circuit - D/A converter (R- 2R ladder and weighted resistor types) - A/D converters using op-amps.

UNIT IV: SPECIAL ICs **9**

555 timer circuit - Functional block and its applications - Monostable multivibrator - Astable multivibrator - 565 phase locked loop - Functional blocks - Capture range - Lock range and its applications - Frequency multiplier – FSK - AM detection - FM demodulator - 566 voltage controlled oscillator circuit - Voltage to frequency conversion factor - RC Phase Shift and Wien bridge oscillator using P-spice model.

UNIT V: APPLICATION ICs **9**

AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators - LM78XX, LM79XX; fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators - Switching regulator - SMPS - Opto-coupler - Opto-electronic ICs.

TOTAL: 45 PERIODS

OUTCOMES

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

- Interpret the knowledge in IC fabrication procedure.
- Describe the DC and AC characteristics of op-amp and its effect on output.
- Elucidate and design filters and generate waveforms using op-amp circuits.
- Analyze the applications of special ICs like Timers, PLL circuits.
- Acquire the knowledge on the Applications of Op-amp.

TEXT BOOKS

1. D.Roy Choudhry, ShailJain, "Linear Integrated Circuits", New Age International Pvt.Ltd, 4th Edition, 2016.
2. Ramakant A.Gayakwad, "Op-amp and Linear ICs", Prentice Hall, 4th Edition, 2015.

REFERENCES

1. S.Salivahanan & V.S. Kanchana Bhaskaran,"Linear Integrated Circuits", TMH,2018.
2. Jacob Millman, Christos C.Halkias,"Integrated Electronics - Analog and Digital Circuit System", Tata McGraw Hill,2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108/106/108106068/# - (Basic building blocks in Analog circuits)
2. https://nptel.ac.in/courses/108/106/108106068/# - (Cascode amplifier)

19EEE301	ANALOG ELECTRONICS AND CIRCUITS (Lab Embedded Theory Course)	L T P C 3 0 2 4

OBJECTIVES

The main objective of this course is to:

- Understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- Familiarize the operation and applications of transistor like BJT and FET.
- Explore the characteristics of differential amplifier gain and operation of various Multivibrators.
- Learn the required functionality of positive and negative feedback systems.
- Provide practical knowledge on the behaviour of semiconductor devices and Integrated ICs

UNIT I: PN JUNCTION DIODE AND ITS APPLICATIONS **9**

Semiconductor Device Modeling and Simulation for Electronic Circuit Design - PN junction diode - Structure, operation and V-I characteristics - Rectifiers : Half Wave and Full Wave Rectifier - Display devices : LED, Laserdiodes - Zener diode: Characteristics , Zener Reverse characteristics , Zener as regulator - Switched mode power supply.

UNIT II: TRANSISTORS AND THYRISTORS **9**

BJT, JFET, MOSFET- Structure, operation, characteristics and Biasing UJT - Thyristors and IGBT : Structure and characteristics.

UNIT III: AMPLIFIERS **9**

BJT small signal model - Analysis of CE, CB, CC amplifiers - Gain and frequency response - MOSFET small signal model - Analysis of CS and Source follower - Gain and frequency response - High frequency analysis.

UNIT IV: DIFFERENTIAL AMPLIFIER AND SWITCHING CIRCUITS **9**

BIMOS cascade amplifier, Differential amplifier - Common mode and Difference mode analysis - Switching circuits: Multivibrators: Astable, Monostable, Bistable Multivibrator - Schmitt Trigger.

UNIT V: FEEDBACK AMPLIFIERS AND OSCILLATORS **9**

Advantages of negative feedback - Voltage / current, series, Shunt feedback - Positive feedback - Condition for oscillations, Phase shift-Wien bridge, Hartley, Colpitts and Crystal oscillators.

LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode and Zener diode.
2. Characteristics of a NPN Transistor under common emitter, common collector and common

base configurations.

3. Characteristics of JFET (Draw the equivalent circuit).
4. Characteristics of photo diode & photo transistor, Study of light activated relay circuit.
5. Design and testing of RC phase shift and LC oscillators.
6. Single Phase half-wave and full wave rectifiers with inductive and capacitive filters.
7. Inverting and Non-Inverting amplifier using op-amp.
8. Integrator and Differentiator using op-amp.
9. Instrumentation amplifier using op-amp.
10. Astable, Monostable Multivibrator using IC 555 Timer.
11. PLL characteristics and Frequency multiplier using PLL.
12. Voltage to Frequency Characteristics of NE/SE 566 IC.

TOTAL: 45+15=60PERIODS

OUTCOMES

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

- Explain the structure and working operation of basic electronic devices.
- Identify and differentiate both active and passive elements.
- Analyze the characteristics of different electronic devices such as diodes and transistors.
- Choose and adapt the required components to construct an amplifier circuit and analyze the various switching circuits with its waveforms.
- Employ the acquired knowledge in design and analysis of oscillators.
- Understand and analyse the practical electronics circuits.

TEXT BOOKS

1. David A.Bell."Electronic devices and circuits",Oxford University higher education, 5th Edition, 2018.
2. S.Salivahanan, N.Sureshkumar, "Electronic devices and circuits", McGrawhill Education, 4th Edition, 2017.

REFERENCES

1. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall,10th Edition, 2018.
2. V.K.Mehta, Rohit Mehta, "Principles of Electronics" , S.Chand Publishing, 12th Edition, 2020.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102095/ - (Analog Electronic Circuits)
2. https://nptel.ac.in/courses/108/102/108102097/ - (Introduction to Electronic Circuits)

19ECE301 **DIGITAL ELECTRONICS** **L T P C**
3 0 2 4

OBJECTIVES

The main objective of this course is to:

- Introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions
- Establish the methods for simplifying Boolean expressions
- Outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
- The concept of memories and programmable logic devices.
- Illustrate the concept of synchronous and asynchronous sequential circuits.

UNIT I: DIGITAL FUNDAMENTALS **9**

Number Systems - Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes - Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Min terms and Max terms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT II: COMBINATIONAL CIRCUIT DESIGN **9**

Design of Half and Full Adders, Half and Full Sub tractors, Binary Parallel Adder - Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Verilog HDL for combinational circuits.

UNIT III: SYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Flip flops - SR, JK, T, D, Master/Slave FF - operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits - Design - Moore/Mealy models, state minimization, state assignment, circuit implementation - Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

UNIT IV: ASYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits, ASM chart.

UNIT V: MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS **9**

Basic memory structure - ROM - PROM - EPROM - EEPROM - EAPROM, RAM - Static and dynamic RAM - Programmable Logic Devices - Programmable Logic Array (PLA) Programmable Array Logic (PAL) - Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL.

LIST OF EXPERIMENTS

1. Verification of Boolean theorems using digital logic gates.
2. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters, etc.
3. Design and implementation of 4-bit binary adder / subtractor using basic gates and MSI devices.
4. Design and implementation of parity generator / checker using basic gates and MSI devices.
5. Design and implementation of magnitude comparator.
6. Design and implementation of application using multiplexers/ Demultiplexers.
7. Design and implementation of Shift registers.
8. Design and implementation of Synchronous and Asynchronous counters
9. Simulation of combinational circuits and sequential circuits using Hardware Description Language (VHDL/Verilog HDL software required)
10. Design and implementation of a simple digital system (Mini Project).

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Analyze different methods used for simplification of Boolean expressions.
- Design and implement Combinational circuits.
- Design and implement synchronous and asynchronous sequential circuits.
- Write simple HDL codes for the circuits.
- Use the semiconductor memories and related technology.

TEXT BOOK

1. M. Morris R. Mano, Michael D. Ciletti, ¯Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog‖, 6th Edition, Pearson Education, 2017.

REFERENCES

1. G. K. Kharate, Digital Electronics, Oxford University Press, 2010
2. John F. Wakerly, Digital Design Principles and Practices, 5th Edition, Pearson Education, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/117/106/117106086/ - (Introduction to digital circuits)
2. https://nptel.ac.in/courses/108/105/108105132/ - (Introduction as sequential circuits)

19CSE302 **PROGRAMMING IN C AND C++** **L T P C**
3 0 2 4

OBJECTIVES:

The main objective of this course is to:

- Understand the basic of c program.
- Build the C programs using arrays and strings.
- Develop applications in C using functions, pointers and structures.
- Aware of the Oops design technique in C++.
- Understand the benefits of Oops and develop the programs.
- Implement the applications using C and C++

UNIT I: BASICS OF C PROGRAMMING **9**

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

UNIT II: ARRAYS AND STRINGS **9**

Arrays - Initialization - Declaration -One dimensional and Two dimensional arrays. String- String operations - String Arrays. Simple programs: sorting- searching - matrix operations.

UNIT III: FUNCTIONS AND POINTERS **9**

Function - definition of function - Declaration of function - Pass by value - Pass by reference - Recursion - Pointers - Definition -Initialization - Pointers arithmetic -Pointers and arrays- sample programs.

UNIT IV: PRINCIPLES OF OBJECT ORIENTED PROGRAMMING **9**

Introduction - Object Oriented Programming Paradigm - Basic Concepts of Object Oriented Programming - Benefits of Object Oriented Programming - Applications of Object Oriented Programming - Tokens - Keywords - Identifiers and Constants - Data Types - Type Compatibility - Variables - Operators - Operator Precedence - Control Structures - Classes and Objects.

UNIT V: CONSTRUCTORS & DESTRUCTORS, OPERATOR OVERLOADING, INHERITANCE **9**

Constructors - Parameterized Constructors - Copy Constructors - Dynamic Constructors - Destructors - Defining Operator Overloading - Overloading Operators - Rules for Overloading Operators - Type Conversions - Virtual Functions.

LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions.
2. Programs using decision-making constructs.
3. Write a program to find whether the given year is leap year or Not.
4. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and

square of a number.

5. Check whether a given number is Armstrong number or not?
6. Populate an array with height of persons and find how many persons are above the average height.
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
8. Sort the list of numbers using pass by reference.
9. Program for Classes and Objects.
10. Program for operator overloading and constructors.
11. Program for Virtual Functions.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Illustrate the basic concept of C programming.
- Design and implement applications using arrays and strings.
- Evaluate using functions, pointer and structure.
- Apply the concept of object oriented programming.
- Describe the process of data file manipulated using C++.
- Develop C and C++ program for simple applications using C and Oops concept.

TEXT BOOKS

1. Kernighan, B.W and Ritchie,D.M, - The C Programming language, 2nd Edition, Pearson Education, 2006.
2. Bjarne Stroustrup,"The C++Programming Language",4th Edition , Addison Wesley, 2013.

REFERENCES

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Herbert Schildt, "C++: The Complete Reference", 5th Edition, McGraw Hill, 2015.

E-RESOURCES

1. http://www2.cs.uregina.ca/~hilder/cs833/Other%20Reference%20Materials/The%20C%20Programming%20Language.pdf - (Fundamentals of Programming in C)
2. https://www.ebookphp.com/object-oriented-programming-in-c-epub-pdf/ - (Functions and pointers)

19EEC301 **COMMUNICATION SKILLS** **L T P C**
0 0 2 0

OBJECTIVES

The main objective of this course is to:

- Improve fluency in English through well developed vocabulary.
- Improve the oral communication skills.
- Focus the effective reading of general and technical text.
- Improve writing skill.
- Communicate ideas in group discussion and interviews.

UNIT I: VOCABULARY **6**

Vocabulary building - articulate ideas and thoughts; usage of palindromes, greetings, wishes, festival related words - homophones and homonyms- connotation - vocabulary words with sentences. - Idiomatic Expressions - One- word Substitutes.

Activities: Learn a word a week, Use newspaper to write unfamiliar words, Word association games.

UNIT II: LISTENING **6**

Listening Skill- Its importance - Purpose- Process- Types- Barriers- Effective Listening strategies- Listening and note - taking - Listening to telephonic conversations -Ted talks - Watching Inspiring Speech videos on You tube - Listening native speaker's videos for pronunciation.

Activities: Listen and draw the different scenes in a story, Secret Message games, watching videos and listing difficult words.

UNIT III: SPEAKING **6**

JAM Talk - Role play - Debate - Conversational skills (formal and informal) - Conversation practice - group discussion and interview skills - Introducing oneself and others - Presentation skills -Making presentations (individual and group) through seminars / PPTs.

Activities: Picture Description, Giving Directions and Guidelines, Making a short speech- Extempore.

UNIT IV: READING **6**

Strategies for effective reading (Guessing meanings from contexts -Scanning, skimming, inferring meaning and critical reading) - Read and recognize different text types ranging from newspaper articles, magazines, books, Technical articles and Reading autobiographies.

Activities: Reading online sources like e-books, e-journals and e-newspapers, cloze exercises, Reading and answering questions.

UNIT V: WRITING **6**

Develop a paragraph: topic sentence, supporting sentences, concluding sentence - Writing simple Essays - argument, descriptive and comparative essays- Creative writing.

Activities: Write Essays with sub titles, Write a story that uses as many clichés and idioms, Write Paragraph.

TOTAL: 30 PERIODS

The following Practice Session will be conducted for the Communication Skills (CS) Lab sessions:

- Activities on Presentations Skills- Students make presentations on given topics
- Activities on Group Discussion- Students participate in group discussions
- Interview Skills- Students participate in Mock Interviews
- Essay Writing - Students prepare their own paragraph and essay

Guidelines for conducting assessments as per 2019 regulations

- 30 hours - Two consecutive hours allotted for each class.
- Three Continuous assessments only conducted and no end semester exam.
- For the award of Continuous assessment the best three activities from Essay Writing, Oral Presentation, Extempore, Group Discussion and Mock Interview (one-on-one basis) can be taken.

OUTCOMES

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

- Improve vocabulary and express the same contextually
- Communicate to his peer group properly and make presentations
- Comprehend the general and technical text
- Write simple paragraph and essay in any topic
- Participate in group discussions expressing ideas relevantly, coherently and cogently

TEXT BOOKS

1. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011
2. Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford:2011

REFERENCES

1. Davis, Jason and Rhonda LIss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
2. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan 2007.

E - RESOURCES

1. www.youglish.com - (Speakers pronunciations)
2. www.Newwellington University.com - (vocabulary)

19MDC301	LEADERSHIP ENHANCEMENT PROGRAMME (Common to Civil, CSE, ECE, EEE & Mechanical)	L T P C 1 0 0 0

OBJECTIVES

The main objective of this course is to:

- Find new, innovative ways of developing and managing people.
- Develop new business opportunities.
- Tackle the broader societal issues the face.
- key benefits of leadership skills in different situations.
- Formulate and implement effective leadership strategies.

TOIPICS TO BE COVERED

1. Leadership for an Engineering students: Skills & Strategies
2. Qualities of good leaders and 21 irrefutable laws of Leadership
3. Empowering Others and Managing People
4. Leading Meetings
5. Leadership competencies and Leadership Styles
6. Difference between a boss and a leader.
7. Leadership and Assertiveness Skills: A Good Leader, Leadership Theories, Leadership Behaviour, Assertiveness skills.
8. Leadership development opportunities and suggestions
9. Teamwork and Leadership: Concept of teams, Building Effective teams, Concept of leadership and sharpening leadership skills.
10. Teamwork and Leadership Activities: Group discussion, Solving Puzzle as a team, describe a Leadership style.

OUTCOMES

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

- Develop the capabilities needed to increase team's work productivity.
- Help to decrease employee turnover and increase engagement, creating a strong and united team.
- Develop communication skills, mastering the art of negotiation, influence and conflict Management.
- More confident as a leader and find new ways of influencing the teams they lead.
- Effectively connect to people, developing the ability to give constructive feedback, and critically seek the feedback of the team.

TOTAL: 12 PERIODS

TEXT BOOKS

1. John maxwell, "21 irrefutable laws of leadership" 2008
2. Sara n. King, david g. Altman, robert j. Lee, "Discovering the leader in you"
3. Louis carter, David ulrich, Marshall goldsmith "Best practices in leadership development and Organization change.

REFERENCES

1. Barry Benator, Albert Thumann, "Project Management and Leadership Skills for Engineering and Construction Projects" 2003.
2. Sydänmaanlakka Pentti."Intelligent leadership and leadership competencies". Dissertation Series

E-RESOURCES

1. https://nptel.ac.in/courses/122/105/122105021/ - (Introduction to leadership)
2. www.ccl.org/leadership/research/index.aspx. - (leadership development)

SEMESTER IV

19MAT403	NUMERICAL METHODS (Common to CIVIL and EEE)	L T P C 3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Develop the basic concepts of solving algebraic, transcendental, exponential and logarithmic equations.
- Introduce the numerical techniques of interpolation in various intervals in real life situations.
- Apply numerical techniques of differentiation and integration.
- Explain various methods of solving ordinary differential equations.
- Produce the knowledge of various techniques in solving partial differential equations.

UNIT I: SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS **9+3**

Solution of algebraic and transcendental equations by Newton Raphson method - Solution of linear system of equations by Gauss elimination, Gauss Jordan and Gauss Seidel methods - Matrix Inversion by Gauss Jordan method - Eigen values of a matrix by Power method.

UNIT II: INTERPOLATION AND APPROXIMATION **9+3**

Interpolation with equal intervals by Newton's forward and backward difference formulae - Interpolation with unequal intervals by Lagrange's interpolation and Newton's divided difference formulae - Cubic Spline interpolation.

UNIT III: NUMERICAL DIFFERENTIATION AND INTEGRATION **9+3**

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal and Simpson's 1/3 rule - Romberg's Method - Two point and three point Gaussian quadrature formulae - Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV: INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Single step methods - Taylor's series method - Euler's and Modified Euler's method - Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V: BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Finite difference solution for the second order ordinary differential equations - Finite difference techniques for the solution of two dimensional Laplace and Poisson equations on rectangular domain - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Extend the basic concepts and techniques of solving algebraic, transcendental, exponential and logarithmic equations.
- Summarise the numerical techniques of interpolation and error approximations in various intervals in real life situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Evaluate ordinary differential equations of first and second order by various techniques and methods.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Dr.Kandasamy. P, Dr.Thilagavathy . K and Dr.Gunavathy .K. "Numerical Methods", S. Chand and Company Pvt. Ltd., New Delhi, 2016.

REFERENCES

1. Veerarajan. T and Ramachandran.T., "Numerical Methods with Programming in C" Tata Mc.GrawHill Publishers, New Delhi, 2007.
2. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/111/107/111107105/
2. https://www.classcentral.com/course/swayam-numerical-analysis-17709

19EET401 ELECTRICAL AND ELECTRONIC MEASUREMENTS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Confer the static and dynamic characteristics and define various errors.
- Derive torque equation for different types of meters.
- Calculate R, L, and C using bridges.
- Explain storage and display devices.
- Examine the working principle of different types of transducers.

UNIT I: INTRODUCTION 9

Functional elements of an instrument - Static characteristics: true value, static error, static correction, reproducibility, drift, repeatability, noise, signal to noise ratio, accuracy and precision, sensitivity, linearity, threshold, dead zone, resolution - Dynamic characteristics: speed of response, fidelity, lag, dynamic error - Errors: gross error, systematic error and random error - Statistical evaluation of measurement data - Standards and calibration.

UNIT II: ELECTRICAL AND ELECTRONICS INSTRUMENTS 9

Principle and operation of analog voltmeters and ammeters: Moving iron: Attraction and repulsion type instruments. Moving coil instruments; PMMC, Dynamometer type, torque equation - Single phase dynamometer type watt meter, toque expression - Single phase induction type energy meters - Measurement of power using instrument transformers - Single phase electrodynamometer power factor meters and Weston frequency meter.

UNIT III: COMPARATIVE METHODS OF MEASUREMENTS 9

DC bridges: Wheatstone bridge, Kelvin's double bridge, Megger - AC bridges: Maxwell's, Anderson, Schering, Wien - Transformer ratio & Self - balancing bridges - Interference & Screening - Multiple earths and earth loops - Electrostatic and electromagnetic interference - Grounding techniques.

UNIT IV: DIGITAL INSTRUMENTS AND DISPLAY DEVICES 9

Digital voltmeter: Ramp, Integrating and Successive approximation - Digital multi-meter - CRT display, dot matrix display, LED and LCD display - Digital energy meter - Digital Storage Oscilloscope (DSO) - Digital printers and plotters - Recorders: X-Y graphic recorders - Data loggers.

UNIT V: TRANSDUCERS AND DATA ACQUISITION SYSTEMS 9

Classification of transducers - Selection of transducers - Resistive, capacitive and inductive transducers - Measurement of temperature - RTD, thermistors and thermocouples - Piezoelectric transducers - Digital transducers - Optical encoders - Elements of data acquisition system - A/D & D/A converters.

TOTAL: 45 PERIODS

OUTCOMES

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

- Acquire knowledge on Basic functional elements of instrumentation.
- Understand the concepts of Fundamentals of electrical and electronic instrument.
- Compare between various measurements techniques.
- Acquire knowledge on various storage and display devices.
- Identify the various concept of transducers and data acquisition systems.

TEXT BOOKS

1. A.K.Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2nd Edition, 2021.
2. R.K.Rajput, "Electrical Measurements and Measuring Instruments", S.Chand and Company Pvt. Ltd., 2nd Edition, 2013.

REFERENCES

1. D.V.S. Moorthy, "Transducers and Instrumentation", Prentice Hall of India Pvt Ltd, 3rd Edition 2010.
2. E.O.Doebelin, "Measurement Systems - Application and Design", Tata McGraw Hill Publishing Company, 2nd Edition 2011.

E-RESOURCES

1. https://www.electrical4u.com/ - (Introduction of static characteristics)
2. https://nptel.ac.in/courses/108/105/108105153/ - (Electronic measurements)

19EET402 GENERATION, TRANSMISSION AND DISTRIBUTION L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Study the structure of electric power system and working operation of different types ofpower generation.
- Develop expressions for the computation of transmission line parameters.
- Obtain the equivalent circuits for the transmission lines based on distance and to determinevoltage regulation and efficiency.
- Understand the mechanical design of transmission lines and discuss about the types and grading of cables.
- Impart knowledge on distribution systems, types of substations, methods of grounding,EHVAC, HVDC and FACTS.

UNIT I: POWER GENERTION 9

Structure of electric power system - Sources of Electric Energy - Power Plants: Steam, Hydroelectric, Nuclear, Gas, Wind and Solar (Qualitative treatment only)

UNIT II: TRANSMISSION LINE PARAMETERS 9

Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition - Application of self and mutual GMD: skin and proximity effects -Typical configurations, conductor types

UNIT III: MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Performance of Transmission lines - Short line, medium line and long line - Equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance - Transmission efficiency and voltage regulation, real and reactive power flow in lines - Power Circle diagrams - Formation of Corona - Critical Voltages.

UNIT IV: MECHANICAL DESIGN OF LINES AND UNDER GROUND CABLES 9

Mechanical design of OH lines - Line Supports - Types of towers - Stress and Sag Calculation - Effects of Wind and Ice loading. Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators - Underground cables - Types of cables - Construction of single core and 3 core cables - Insulation Resistance - Potential Gradient - Capacitance of Single-core and 3 core cables - Grading of cables - Power factor and heating of cables - DC cables

UNIT V: DISTRIBUTION SYSTEMS **9**

Distribution Systems - General Aspects - Kelvin's Law - AC and DC distributions - Techniques of Voltage Control and Power factor improvement - Distribution Loss -Types of Substations - Methods of Grounding - Trends in Transmission and Distribution: EHVAC,HVDC and FACTS (Qualitative treatment only)

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the operation of conventional generating stations and renewable sources of electric power.
- Determine the electrical circuit parameters of transmission lines.
- Analyze the performance of short, medium and long transmission lines.
- Evaluate the sag and tension of tranmission lines,string efficiency of insulator and grading of cables.
- Design the appropriate distribution system

TEXT BOOKS

1. D.P.Kothari, I.J. Nagarath, "Power System Engineering " , McGraw-Hill Publishing Company limited, New Delhi, 3rd Edition, 2019.
2. C.L.Wadhwa, "Electrical Power Systems", New Age International Publishers, 7th Edition, 2016.

REFERENCES

1. A.Chakrabarti, M.L.Soni, P.V.Gupta, R.V.Bhatnagar, "A Text book on Power System Engineering" ,Dhanpat Rai & Co (limited), New Delhi, 2nd Edition, 2016.
2. V.K.Mehta, Rohit Mehta, "Principles of power system", S. Chand & Company Ltd, New Delhi, Revised Edition, 2021.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102047/ - (Power System Generation, Transmission and Distribution)
2. https://archive.nptel.ac.in/courses/108/105/108105104/ - (Power System Engineering)

19ECT404 DISCRETE TIME SYSTEM AND SIGNAL PROCESSING L T P C
3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Analyze the signals and systems & their mathematical representation.
- Acquire knowledge on discrete time systems.
- Apply transformation techniques & their computation.
- Understand the filters and their design for digital implementation.
- Elucidate the Programmability digital signal processor & quantization effects.

UNIT I: INTRODUCTION 9+3

Classification of systems - Continuous - Discrete - Linear - Causal - Stability - Dynamic - Recursive - Time variance classification of signals - Continuous and discrete - Energy and power - Mathematical representation of signals - Spectral density - Sampling techniques - Quantization - Quantization error - Nyquist rate - Aliasing effect.

UNIT II: DISCRETE TIME SYSTEM ANALYSIS 9+3

Z-transform and its properties - Inverse Z-transforms - Difference equation - Solution by Z transform - Application to discrete systems - Stability analysis - Frequency response - Convolution.

UNIT III: DISCRETE FOURIER TRANSFORM & COMPUTATION 9+3

Discrete Fourier Transform – Properties - Magnitude and phase representation - Computation of DFT using FFT algorithm - DIT & DIF using radix 2 FFT - Butterfly structure.

UNIT IV: DESIGN OF DIGITAL FILTERS 9+3

FIR & IIR filter realization - Parallel & cascade forms - FIR design: Windowing Techniques - Need and choice of windows - Linear phase characteristics - Analog filter design - Butterworth and Chebyshev approximations; IIR Filters - Digital design using impulse invariant and bilinear transformation Warping - Pre warping.

UNIT V: DIGITAL SIGNAL PROCESSORS 9+3

Introduction - Architecture - Features - Addressing Formats - Functional modes - Introduction to Commercial DS Processors.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand the importance of Fourier transforms digital filters and DS Processors.
- Acquire knowledge on Signals and systems & their mathematical representation.

- Recognize and analyze the discrete time systems.
- Analyze the transformation techniques & their computation.
- Attain knowledge on programmability digital signal processor & quantization effects.

TEXT BOOKS

1. J.G. Proakis and D.G. Manolakis, "Digital Signal Processing Principles", Algorithms and Applications", Pearson Education, New Delhi, PHI. 2018.
2. S.K. Mitra, "Digital Signal Processing" - A Computer Based Approach', McGraw Hill Edu, 2013.
3. Lonnie C.Ludeman , "Fundamentals of Digital Signal Processing",Wiley,2017.

REFERENCES

1. Poorna Chandra S, Sasikala. B ,Digital Signal Processing, Vijay Nicole/TMH, 2017.
2. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/117102060/NPTEL:Electronics & Telecommunication Engineering- Digital Signal Processing. - (Introduction of signal processing)
2. https://nptel.ac.in/courses/108/105/108105055/ - (Discrete time system and signal)

19EEE401 **DC MACHINES AND TRANSFORMERS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Understand magnetic circuit and laws, properties of magnetic materials and core loss.
- Know construction, working principles, testing and efficiency of Transformer.
- Learn the basic concepts of electromechanical energy conversion and concepts in rotating machines.
- Realize construction, principle of operation, methods of excitation and characteristics of DC generators.
- Recognize the working principle, characteristic, starting and testing of DC motor.
- Expose the students to the operation of D.C. machines and transformers and give themexperimental skill.

UNIT I: MAGNETIC CIRCUITS AND MAGNETIC MATERIALS **9**

Magnetic circuits - Laws governing magnetic circuits - Flux linkage, Inductance and energy - Statically and dynamically induced E.M.F - Properties of magnetic materials - Hysteresis and Eddy Current losses - AC operation of magnetic circuits.

UNIT II: TRANSFORMERS **9**

Construction - Principle of operation - Equivalent circuit - Losses - Testing - Efficiency and voltage regulation- All day efficiency-Inrush current - Three phase transformers connections - Phasing of transformer - Parallel operation of transformers-Auto transformer - Tap changing transformer- Tertiary winding.

UNIT III: ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES **9**

Energy in magnetic system-Field energy and coenergy-force and torque equations - Singly and multiply excited magnetic field systems-MMF of distributed windings - Winding Inductances - Magnetic fields in rotating machines - Rotating mmf waves - Magnetic saturation and leakage fluxes.

UNIT IV: DC GENERATORS **9**

Construction - Principle of operation - Lap and wave winding - E.M.F equations - Circuit model - Armature reaction - Methods of excitation - Commutation and inter poles - Compensating winding - Characteristics of DC generators.

UNIT V: DC MOTORS **9**

Principle and operations - Types of DC motors - Speed Torque Characteristics of DC Motors- Stating and speed control of DC motors - Plugging, Dynamic and Regenerative braking - Testing and efficiency - Retardation test - Swinburne's test and Hopkinson's test - Simulation of speed control.

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of DC shunt generator-critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swin burne's test of DC shunts motor.
7. Speed control of DC shunt motor.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Study of starters and 3-phase transformers connections.

TOTA : 45+15=60 PERIODS

OUTCOMES

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

- Gain knowledge on magnetic circuit and laws, properties of magnetic materials and core loss.
- Acquire information about construction, working principles, testing and efficiency of Transformer.
- Get n the basic concepts of electro mechanical energy conversion and concepts inrotating machines.
- Understand construction, principle of operation, methods of excitation and characteristics of DC generators.
- Expand the knowledge on working principle, characteristic, starting and testing of DC motors.
- Do load test and speed control in DC Machines and transformers.

TEXT BOOKS

1. B.L.Thereja and A.K.Theraja, "A Text of Electrical Technology", S.Chand publications, Volume 1 & 2,2015.
2. D P Kothari and I.J Nagarath, "Electrical Machines", McGraw Hill Education(India) Private Limited, 4th Edition ,2017.

REFERENCES

1. P. S. Bimbhra,"Electrical Machines",2ndEdition,Khanna PublicationPvt.Ltd,2017.
2. B.R.Gupta "Fundamental of Electric Machines" New age International Publishers, 3rd Edition Reprint 2015.

E-RESOURCES

1. https://nptel.ac.in/courses/108102146 - (DC Machines & Transformers)
2. https://www.classrcentral.com/course – (Electrical Machines)

19EEE402 **CONTROL SYSTEMS ENGINEERING** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Derive the transfer function of a given system using mathematical models.
- Assess the system performance using time domain analysis and methods for improving it.
- Import knowledge in obtaining the open lop and closed-loop frequency responses of systems
- Determine and analyze the stability of given system.
- Learn the various approaches for the state variable analysis.
- Provide practical knowledge on analysis and design of control system along with basics of instrumentation.

UNIT I: BASIC CONCEPTS AND SYSTEM REPRESENTATION **9**

Introduction - Open Loop and Closed Loop Systems - Mathematical Model of Control Systems - Transfer Functions - Mechanical Translational Systems - Mechanical Rotational Systems - Block Diagram Algebra - Signal Flow Graph - Mason's Gain Formula - Synchro's-AC and DC servo motors - Application of control systems.

UNIT II: TIME RESPONSE ANALYSIS **9**

Time Response - Standard Test Signals - Type and Order of Control System - Time Response of First order System for Unit Step - Unit Ramp and Impulse Input - Time Response of Second Order System for Unit Step Input - Time Domain Specifications - Steady State Error and Static Error Constants – P, PI and PID Controllers - Simulation of first and second order systems,Analysis of simple linear system models in MATLAB.

UNIT III: FREQUENCY RESPONSE ANALYSIS **9**

Frequency Response - Frequency Domain Specifications - Resonant Peak - Resonant Frequency - Bandwidth- Cut-Off Rate - Gain Margin and Phase Margin - Frequency Response Plots - Bode Plot-Polar Plot - Correlation between time and Frequency response-M and N Circles.

UNIT IV: STABILITY ANALYSIS **9**

Concepts of Stability - Necessary Conditions for Stability - Relative Stability - Routh Hurwitz Stability Criterion - Root Locus - Effect of Addition of Poles - Effect of Addition of Zeros - Nyquist Stability Criterion- Simulation of control system by mathematicaldevelopment tools in MATLAB.

UNIT V: COMPENSATORS AND STATE SPACE ANALYSIS **9**

Compensators: Introduction – Types, Lag ,Lead and Lag-Lead Design using Bode Plots. State Space Analysis: Concepts of State - State Variables and State phase Model for Linear Continuous Time Systems - Controllability and Observability- State space representation for Discrete time systems. Sampled Data control systems - Sampling Theorem - Sample & Hold - Open loop & Closed loop sampled data systems.

LIST OF EXPERIMENTS

1. Simulation of Control Systems by Mathematical development tools and Stability Analysis
2. Design of Lag, Lead and Lag-Lead Compensators
3. Position Control Systems
4. Synchro-Transmitter- Receiver and Characteristics
5. Bridge Networks AC and DC Bridges
6. Dynamics of Sensors/Transducers a. Temperature b. Pressure c. Displacement
7. Power and Energy Measurement

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Develop various representations of system based on the knowledge of Mathematics, Science and Engineering fundamentals.
- Determine the transient and steady state behavior of systems subjected to standard test signals.
- Analysis the various frequency response plots and its systems.
- Relate the concepts of various system stability criterions.
- Design the various compensators and digital control system using state variable models.
- Apply advanced control theory to practical engineering problems and their applications to various industries.

TEXT BOOKS

1. I.J.Nagrath and M.Gopal, "Control Systems Engineering", 6th Edition, New Age International (P)Ltd,Publishers, 2017.
2. K. Ogata "Modern Control Engineering", 4th Edition, Prentice Hall, 2015.

REFERENCES

1. M.Gopal, Control Systems, "Principles and Design", 4th Edition, Tata McGraw Hill, New Delhi, 2014.
2. A.Nagoorkani, "Control Systems Engineering", 3rd Edition, RBA Publications, 2021.

E-RESOURCES

1. http://www.nptel.ac.in/courses/107/106/107106081 - (Introduction of Control Systems)
2. http://www.nptel.ac.in/courses/108/106/108106098 - (Introduction of system and control)

19EEC302 **ENTREPRENEURSHIP DEVELOPMENT ACTIVITY** **L T P C**
(Common to all Branches) **0 0 2 0**

OBJECTIVES

The main objective of this course is to:

- Evaluate social and civil responsibilities of business ownership
- Describe typical behavioral characteristics of an effective entrepreneur
- Develop a business plan, including identifying an executive summary; conducting a marketing and competitive analysis report; and developing a marketing, management, and financial plan
- Determine career opportunities, responsibilities, and educational and credentialing requirements related to various entrepreneurship ventures.
- Interpret research data to determine market-driven problems faced by entrepreneurs

TOIPICS TO BE COVERED

1. Should You Become an Entrepreneur?
    - Entrepreneurship: Present & Past
    - Is Entrepreneurship Right for You
    - Identify Business Opportunities & Set Goals
2. What Skills Do Entrepreneurs Need
    - Communication Skills
    - Math Skills
    - Problem Solving Skills
3. Entrepreneurs in a Market Economy
    - What is an Economy?
    - The Concept of Cost
    - Government in a Market Economy
4. Select a Type of Ownership
    - Run an Existing Business
    - Own a Franchise or Start a Business
    - Choose the Legal Form of Your Business
5. Develop a Business Plan
    - Why Do You Need a Business Plan
    - What Goes into a Business Plan
    - Create an Effective Business Plan

6. Identify and Meet a Market Need
    - The Value of Market Research
    - How to Perform Market Research Entrepreneurship Syllabus
    - Identify Your Competition
7. Finance, Protect, and Insure Your Business
    - Put Together a Financial Plan
    - Obtain Financing for Your Business
    - Protect Your Business
8. Choose Your Location & Set Up for Business
    - Choose a Retail Business Location
    - Choose a Location for a Nonretail Business
    - Obtain Space and Design the Physical Layout
    - Purchase Equipment, Supplies, and Inventory
9. Market Your Business
    - The Marketing Mix
    - Product, Price, Distribution, Price, and Promotion
    - Set Marketing Goals
10. Hire and Manage a Staff
    - Hire Employees
    - Create a Compensation Package
    - Manage your Staff
11. Record-Keeping and Accounting
    - Set up a Record Keeping System
    - Understand Basic Accounting
    - Track Your Inventory
12. Financial Management
    - Manage your Cash Flow
    - Analyze Your Financial Performance
    - Hire Experts

13. Use Technology
    - Technology and Your Business
    - Learn about the Interest
    - Purchase Technology
14. Intellectual property Rights
    - Patents
    - Copyright
    - Industrial design rights
    - Trademarks
    - Trade secrets
15. Innovation Contest
    - Innovative Idea
    - Proof of Concept (PoC)
    - Prototype Creation
    - The students may be grouped into 2 to 3 and work under a project supervisor. The Prototypes to be fabricated may be decided in consultation with the supervisor. A innovative report to be submitted by the group and the model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department.

OUTCOMES

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

- Identify personal strengths and value systems
- Recall important tenets of digital literacy
- Discuss the essentials of matters pertaining to money
- Prepare for employment and self-employment
- Illustrate the basics of entrepreneurship and identify new business opportunities

TOTAL: 30 PERIODS

19MDC401 **VALUE ADDED COURSE – I** **L T P C**
- - - -

OBJECTIVES

The main objective of this course is to:

- Create the basic m scripts,simulink model in electrical application.
- Learn the knowledge of printed circuit board.
- Develop embedded-system programming and interfacing technology.
- Educate on obtaining circuit designers better understand the operation of a SPICE circuit simulator and semiconductor device models with emphasis on Deep-Submicron(DSM) transistors.

EITHER ONE OF THE COURSE IN THE LIST

- **MAT LAB**
- **PCB DESIGN**
- **EMBEDDED SYSTEM**
- **PIECE SPICE SOFTWARE**

OUTCOMES

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

- Understand the concept of m file and simulation.
- Design the printed circuit board various application.
- Aware the designing knowledge of embedded-system programming.
- Recognize the operation of a PIECE SPICE circuit simulator.

SEMESTER V

19EET501 MICROPROCESSORS AND MICROCONTROLLERS L T P C
3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Impart knowledge on basic functional blocks of 8085 microprocessor.
- Acquire knowledge on addressing modes and instruction sets of 8085 processor.
- Understand the interfacing of application devices.
- Knowledge on basic functional blocks and operations of 8051 microcontroller.
- Simple applications development withPIC microcontroller.

UNIT I : 8085 PROCESSOR **9+3**

Functional Building Blocks - Signals - I/O & data transfer concepts - Timing Diagram - Interrupts.

UNIT II: PROGRAMMING OF 8085 PROCESSOR **9+3**

Instruction format - Addressing modes - Instruction set - Need for assembly language - Development of assembly language programs - Introduction to ARM processor.

UNIT III: PERIPHERAL INTERFACING **9+3**

Architecture and interfacing: 8255 - 8259 - 8253 - 8251 - A/D and D/A converters - Interfacing with 8085.

UNIT IV: 8051 MICROCONTROLLER **9+3**

Architecture - Memory Organization - I/O ports - Addressing modes - Instruction set - Interrupt structure - Simple programming exercises - Stepper motor control - Washing Machine Control.

UNIT V: PIC MICROCONTROLLER - PERIPHERALS **9+3**

PIC Microcontroller - Peripherals - Timer 0 - Timer 1 - Compare and Capture mode - Timer 2 - PWM outputs - I^2C operation - ADC - UART.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand the internal operations of 8085 processor.
- Develop skills in writing assembly language program.
- Recognize the knowledge on interfacing the external devices to the processor according to the user requirements.
- Design the internal structure and instruction set of 8051 controller.
- Develop PWM outputs using PIC microcontroller.

TEXT BOOKS

1. Sunil Mathur & Jeebananda Panda, "Microprocessors and Microcontrollers", PHI Learning Pvt. Ltd, 1st Edition, 2016.
2. R.S.Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing, 6th Edition, 2013.

REFERENCES

1. Krishna Kant, "Microprocessor and Microcontrollers", Prentice Hall of India, New Delhi, 3rd Edition, 2017.
2. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086, 8051 "Tata McGraw Hill Education private Limited", 2nd Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105102/ - (Introduction of microprocessor and microcontroller)
2. https://nptel.ac.in/courses/106/108/106108100/ - (8085 microprocessor)

19EET502 **POWER SYSTEM ANALYSIS** **L T P C**
3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Model the power system under steady state operating condition.
- Solve power flow problem by iterative techniques.
- Analyze various type of short circuits.
- Different type of unsymmetrical fault.
- Explain power system operation and stability control.

UNITI: POWER SYSTEM **9+3**

Need for system planning and operational studies - Power scenario in India - Power system components - Representation - Single line diagram - Per unit quantities - Per unit impedance diagram - Per unit reactance diagram.

UNIT II: POWER FLOW ANALYSIS **9+3**

Formation of bus admittance matrix of large power network - Bus classification - Formulation of power flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of voltage controlled buses - Power flow solution by newton raphson method**.**

UNIT III: SYMMETRICAL FAULT ANALYSIS **9+3**

Assumptions in short circuit analysis - Formation of impedance bus - Symmetrical short circuit analysis using thevenin"s theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.

UNIT IV: UNSYMMETRICAL FAULT ANALYSIS **9+3**

Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - Unsymmetrical fault occurring at any point in a power system - Computation of post fault currents in symmetrical component and phasor domains.

UNIT V: STABILITY ANALYSIS **9+3**

Classification of power system stability - Rotor angle stability - Swing equation - Swing curve - Power angle equation - Equal area criterion - Critical clearing angle and time - Classical step-by-step solution of the swing equation - Modified Euler method.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand the per unit system.
- Identify and apply iterative techniques for power flow analysis.
- Model and carry out short circuit studies on power system.
- Acquire knowledge on Fault analysis.
- Model and analyze stability problems in power system.

TEXT BOOKS

1. John J. Grainger, William D. Stevenson, JR, "Power System Analysis", McGraw Hill Education Pvt. Ltd., New Delhi, 1st Edition, 2017.
2. Kothari.D.P. and Nagrath.I.J., "Power System Engineering", McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 2019.

REFERENCES

1. Hadi Saadat, "Power System Analysis", McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 2017.
2. Kundur P., "Power System Stability and Control", McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2018.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105104/ - (Power System Analysis)
2. https://nptel.ac.in/courses/108/102/108102047/ - (Power Generation Transmission and Distribution)

19EEE501 **POWER ELECTRONICS AND APPLICATIONS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Realize the characteristics of power semiconductor devices and commutation circuit
- Study and design single phase and three phase controlled converter
- Work in teams and independently for the design, development and testing of power electronics
- Understand the basic requirements of industrial power electronics by using the concept of inverters
- Impact knowledge on the basis and importance of AC-AC converters
- Learn about the operation and characteristics of power electronics equipments.

UNIT I: OVERVIEW OF POWER ELECTRONICS AND POWER DEVICES **9**

Structure, operation and characteristics of Diode, SCR, Power transistor, MOSFET,MCT and IGBT - Firing circuit for thyristor - Voltage and Current commutation of thyristor - Gate drive circuit for MOSFET and IGBT - Design of driver and snubber circuit.

UNIT II: AC - DC CONVERTERS **9**

2-pulse, 3-pulse and 6-pulse converters - Performance parameters - Effect of source inductance - Gate circuit schemes for phase Control - Dual converters - Applications of controlled rectifiers.

UNIT III: DC - DC CONVERTERS **9**

Step-down and step-up chopper - Control strategy - Forced commutated chopper - Voltage commutated, Current commutated, Load commutated, Switched mode regulators - Buck, boost, buck- boost converter - Introduction to Resonant Converters - Applications of choppers.

UNIT IV: DC - AC CONVERTERS **9**

Single phase and three phase voltage source inverters (both 120^0 mode and 180^0 mode) - Voltage & harmonic control - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM - Multiple PWM - Introduction to space vector modulation - Current source inverter.

UNIT V: AC - AC CONVERTERS **9**

Single phase and three phase AC voltage controllers - Control strategy - Power Factor Control - Multistage sequence control - Single phase and three phase cyclo converters - Introduction to matrix converters - Applications of cyclo converter.

LIST OF EXPERIMENTS

1. Gate Pulse Generation using R, RC and UJT
2. Characteristics of SCR and Triac
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled and fully controlled converter
5. Step down and step up MOSFET based choppers
6. IGBT based single phase and three phase PWM inverter
7. Simulation of PE circuits (1Φ & 3Φ semi converter, 1Φ & 3Φ full converter, dc-dc converter, ac voltage controller)
8. AC to AC half controlled and fully controlled converter

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Apply the knowledge of power electronic devices and converters.
- Demonstrate the performance of converters and power semiconductor devices.
- Analyze the performance of DC-DC converters.
- Understand the operation of inverter circuits.
- Enrich the knowledge of cyclo converter.
- Use power electronic simulation package for analyzing and designing power control applications.

TEXT BOOKS

1. M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, 4th Edition 2017.
2. P.S.Bimbra, "Power Electronics" Khanna Publishers, 3rd Edition, 2018.

REFERENCES

1. Ned Mohan, Tore. M. Under and, William. P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and sons, 3rd Edition, 2013.
2. M.D. Singh and K.B. Khanchandani, Power Electronics" McGraw Hill India, 3rd Edition , 2015.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102145/ - (Power Electronics)
2. https://nptel.ac.in/courses/108/105/108105066/ - (Power Electronics)

19EEE502 **INDUCTION AND SYNCHRONOUS MACHINES** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Edifice and performance of salient and non - salient pole type synchronous generators.
- Understand the operation and performance characteristics of synchronous motor.
- Educate the operating principle and performance of induction machines.
- Overview on Starting and speed control of three-phase induction motors.
- Acquire knowledge on Construction, principle of operation and performance of single phase induction motors and special machines.
- Know about the operating characteristics, losses and efficiency, speed control of synchronous and induction machines.

UNIT I: ALTERNATOR **9**

Constructional details - Types of rotors - Armature windings - EMF equation - Alternator on load - Synchronous reactance - Voltage regulation - EMF, MMF and ZPF methods - Synchronizing of alternators - Synchronizing current and power - Change of excitation and mechanical input - Blondel‟s theory - Determination of X_d and X_q using slip test.

UNIT II: SYNCHRONOUS MOTOR **9**

Principle of operation - Starting methods - Power flow - Effect of change of excitation and load - Expression for back EMF - Power equations - Power/power angle relations - Construction of V curves & Inverted V curves - Hunting - Synchronous condenser - Applications.

UNIT III: THREE PHASE INDUCTION MOTOR **9**

Constructional details - Principle of operation - Types of rotor - Slip and its importance - Torque equations - ST characteristics - Power and efficiency - Equivalent circuit - Crawling and Cogging - Double cage induction motors - Induction generators - Synchronous induction motor.

UNIT IV: STARTERS AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9**

Load test - No load and blocked rotor test - Need for starters - Types of starters - Speed control - Cascaded connection - Braking of three phase induction motor Plugging - Dynamic braking - Regenerative braking.

UNIT V: SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES **9**

Principle of operation - Double revolving field theory - Types of single phase induction motor - Equivalent circuit - No load and blocked rotor test - Construction and working principles of reluctance motor, repulsion motor, hysteresis motor, and universal motor - Applications.

LIST OF EXPERIMENTS

1. Regulation of three phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF and ASA methods.
3. Regulation of three phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. Load test on three-phase induction motor.
6. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
7. Load test on single-phase induction motor.
8. No load and blocked rotor test on single-phase induction motor.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Identify the construction and working principle of synchronous generator.
- Understand mmf curves and armature windings.
- Acquire knowledge on synchronous motor.
- Develop the construction and working principle of three phase induction motor.
- Recognize the construction and working principle of special machines.
- Determine the performance and operating characteristics of synchronous and induction machines.

TEXT BOOKS

1. A.E.Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery", 7th Edition, McGraw Hill Education, 2020.
2. Vincent Del Toro, "Basic Electric Machines" ,Pearson India Education, 2nd Edition, 2016.

REFERENCES

1. D.P. Kothari and I.J. Nagrath, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.
2. P.S. Bhimbhra, "Electrical Machinery", Khanna Publishers, 1st Edition, 2014.

E-RESOURCES

1. https://nptel.ac.in/courses/108/106/108106072/ - (Induction machines)
2. https://nptel.ac.in/courses/108/105/108105131/ - (Electrical machines II)

19EEC501 **QUANTITATIVE APTITUDE LEARNING** **L T P C**
(Common to Civil, CSE, ECE, EEE and Mechanical) **0 2 0 0**

OBJECTIVES

The main objective of this course is to:

- Introduce the basics concepts and techniques of numbers, Highest common factor and Least common multiple.
- Develop the use of decimal fraction and problems on ages.
- Introduced basic concepts of time, work, distance, calender and clock.
- Acquaint the student with the concept of simple and compound interest.
- Produced the knowledge of polynomial and quadratic equations.

UNIT I: NUMBERS, HIGHEST COMMON FACTOR AND LEAST COMMON MULTIPLE **9**

Numbers and their basic classification - Types of number - Basic operations of numbers - Progression - Tests of divisibility - Highest common factor - Least common multiple.

UNIT II: DECIMAL FRACTION AND PROBLEMS BASED ON AGES **9**

Decimal fraction - Types of fraction - Comparison of fractions - Inserting fractions in between two given fractions - Relation between decimal fraction and normal fraction - Conversion of a decimal fraction into a vulgar fraction - Types of decimals - Conversion of mixed recurring decimal into a vulgar fraction - Standard form of decimal - Problems based on ages.

UNIT III: TIME, WORK, DISTANCE, CALENDER AND CLOCK **9**

General rule for time and work - General rule for work and wages - Speed - Unit of speed - Average speed - Some useful relations - Problems on Trains - Calendars and clocks - Odd days - Ordinary year - Leap year.

UNIT IV: SIMPLE INTEREST, COMPOUND INTEREST AND ELEMENTARY ALGEBRA **9**

Simple interest - Compound interest - Some useful relations - Difference between compound interest and simple interest - Short cut methods to solve special types of problems - Elementary Algebra and averages.

UNIT V: POLYNOMIAL AND QUADRATIC EQUATIONS **9**

Polynomial introduction - Degree of a polynomial - Types of polynomial - Operations on polynomial - Remainder and factor theorem - Quadratic equation - Pure Quadratic equation - Discriminant - Roots of the Quadratic equations - Solution of Quadratic equation - Framing of a Quadratic equation - Special types of roots.

TOTAL: 45 PERIODS

OUTCOMES

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

- Use the basic concepts and techniques of the numbers, Highest common factor and Least common multiple.
- Apply the concept of decimal fraction and problems on ages.
- Apply the concept of time, work, distance, calender and clock.
- Acquire skills in simple interest, compound interest and elementary algebra.
- Be exposed to concepts and properties of polynomial and quadratic equations.

TEXT BOOKS

1. Agarwal R.S., "Quantitative Aptitude", S.Chand & Company Ltd, New Delhi, 2012.
2. Dinesh Khattar, "Quantitative Aptitude for competitive examinations", Pearson India Education Services Pvt. Ltd, New Delhi, 2019.

REFERENCES

1. Praveen R.V., "Quantitative Aptitude and Reasoning", PHI Learning Private Limited, Delhi, 2013.
2. Gupta P, "A unique Approach to Quantitative Aptitude ", Unique Publishers (I) Pvt. Ltd, New Delhi, 2017.

E-RESOURCES

1. https://youtube.com/playlist?list=RDQM5XI256aOq24
2. https://youtu.be/KE7tQf9spPg

19MDC501	VALUE ADDED COURSE – II	L T P C
		- - - -

OBJECTIVES

The main objective of this course is to:

- Create and modify diagrams, layouts in 2D and 3D models of electric circuits in PCB.
- Learn how to create a project, deal with text editor, and compile the created code.
- Study the concept of theory and applications of programmable logic controllers.
- Design and develop the electrical power system in steady, transients and dynamics condition.

EITHER ONE OF THE COURSE IN THE LIST

- **ECAD**
- **MODELSIM**
- **PLC**
- **ETAP**

OUTCOMES

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

- Design and develop the diagrams, layouts such as printed circuit boards (PCBs) and integrated circuits (ICs).
- Identify the appropriate methods in MODELSIM.
- Acquire knowledge of concept and applications of PLC.
- Understand the designing and simulation knowledge in electrical power systems.

SEMESTER VI

19EET601 **PROTECTION AND SWITCHGEAR** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Educate the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- Introduce the characteristics and functions of relays.
- Impart knowledge on apparatus protection.
- Discuss evolution of relays from electromechanical to numerical relay.
- Describe the functioning of circuit breakers.

UNIT I: PROTECTION SCHEMES **9**

Principles and need for protective schemes - Nature and causes of faults - Types of faults - Effects of Faults - Fault Statistics - Methods of Neutral Grounding - Zones of protection and essential qualities of protection - Protection schemes.

UNIT II: ELECTROMAGNETIC RELAYS **9**

Operating principles of relays - Universal relay - Torque equation - R-X diagram - Electromagnetic relays - over current, directional, distance, differential, negative sequence and under frequency relays.

UNIT III: APPARATUS PROTECTION **9**

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line - Apparatus protection using artificial intelligence (AI) techniques.

UNIT IV: STATIC RELAYS AND NUMERICAL PROTECTION **9**

Static relays - Phase, Amplitude Comparators - Synthesis of various relays using Static comparators - Block diagram of Numerical relays - Numerical over current protection, Numerical transformer differential protection, Numerical distance protection of transmission lines.

UNIT V: CIRCUIT BREAKERS **9**

Physics of arcing phenomenon and arc interruption - Re-striking voltage and recovery voltage - Rate of rise of recovery voltage - Resistance switching - Current chopping - Interruption of capacitive current - Air blast, Air break, Oil, SF_6, MCBs, MCCBs and vacuum circuit breakers - Rating and selection of circuit breakers - Testing of Circuit breakers.

TOTAL: 45 PERIODS

OUTCOMES

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

- Differentiate different types of faults and earthing in the power system.
- Understand and analyze the various types relays.
- Select different types of protective schemes for generator, transformer, busbars and feeders.
- Study about the importance of static relays.
- Acquire knowledge of different circuit breakers and suggest suitable circuit breaker for particular operation.

TEXT BOOKS

1. Sunil S.Rao, "Switchgear Protection and power systems", Khanna Publishers, New Delhi, 14th Edition, 2019.
2. B.Rabindranath and N.Chander, "Power System Protection and Switchgear", New Age International (P) Ltd, 2nd Edition, 2018.

REFERENCES

1. Badri Ram and B.H.Vishwakarma, "Power System Protection and Switchgear", New Age InternationalPvt Ltd , 2nd Edition , 2017.
2. M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co., 2nd Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105167/ - (Power System Protection)
2. https://nptel.ac.in/courses/108/101/108101039/ - (Power System Protection)

19EET602 **ELECTRICAL DRIVES** **L T P C**
3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Provide fundamental concept of electrical drive systems.
- Impart knowledge on chopper fed DC motor drives.
- Describe about the various speed control of induction motor drives.
- Acquire knowledge on digital control techniques.
- Understand and analyze the speed controllers for a closed loop system.

UNIT I: INTRODUCTION **9+3**

Basic elements - Types of Electric drives - Factors influencing the choice of electrical drives - Multi quadrant operation - Heating and cooling curves - Loading conditions and classes of duty - Selection of power rating for drive motors - Drive motor characteristics - Braking of electrical motors.

UNIT II: CONVERTER / CHOPPER FED DC MOTOR DRIVE **9+3**

Steady state analysis of the single and three phase converter fed separately excited DC motor drive - Continuous and discontinuous conduction - Time ratio and current limit control - 4 quadrant operation of converter / chopper fed drive.

UNIT III: CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF AC DRIVES **9+3**

Stator voltage control - Energy efficient drive - V/F control - Constant air gap flux - Field weakening mode - Voltage/current fed inverter - Closed loop control - Rotor control - Rotor resistance control and slip power recovery schemes - Principle of vector control.

UNIT IV: DIGITAL CONTROL TECHNIQUES FOR SPEED CONTROL OF DRIVES **9+3**

Digital techniques in speed control - Advantages and limitations - Microprocessor based control of drives - Microcontroller based control of drives - PLC Based drives.

UNIT V: DESIGN OF CONTROLLERS FOR DRIVES **9+3**

Introduction - Transfer function for DC motor / load and converter - Closed loop control with Current and speed feedback - Armature voltage control and field weakening mode - Design of controllers - Current controller and speed controller - Converter selection and characteristics.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand steady state operation and transient dynamics of a motor load system.
- Identify the operation of the converter, chopper fed dc drive and solve simple problems.
- Study and analyze the speed control of induction motor drive.
- Use recent microcontroller for motor control and PLC based control of drives.
- Analyze and design of various controllers for solid state drives.

TEXT BOOKS

1. Dubey G.K., "Fundamentals of Electrical Drives", Narosa Publishing House, 2nd Edition ,2016
2. Bimal.K.Bose. "Modern Power Electronics and AC Drives", Pearson Education, 2nd Edition, 2015.

REFERENCES

1. S.K.Pillai, "A First course on Electrical Drives", New Age International Publishers, 3rd Edition, 2013.
2. Krishnan.R. "Electric Motor & Drives: Modelling, Analysis and Control", Pearson Education India, 3rd Edition,2015.

E-RESOURCES

1. https://nptel.ac.in/courses/108/104/108104011/ - (Advanced Electric Drives)
2. http://www.nptelvideos.in/2012/11/ - (Electrical Drives)

19EEE601 EMBEDDED CONTROLLERS AND REAL TIME OPERATING SYSTEMS **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Understand the building blocks of embedded systems.
- Analyze the bus communication in processors, Input/output interfacing.
- Elucidate the uses of various protocols and their functionalities.
- Acquire the concepts of real time operating systems and its functions.
- Impart the basics of Real time operating system and its tools.
- Write programs to interface memory, I/Os with processor

UNIT I: INTRODUCTION TO EMBEDDED SYSTEMS **9**

Embedded systems - Classification - Characteristics and components of embedded system - Functional building blocks of embedded system - Challenges in embedded system - Embedded system design process - Applications of embedded systems.

UNIT II: PROCESSOR AND MEMORY ORGANIZATION **9**

Structural units in a processor - Selection of processor for embedded system - Interrupts, Memory - Segments and blocks - Direct Memory Access, Interfacing with I/O Devices.

UNIT III: COMMUNICATION PROTOCOLS **9**

Introduction to Serial/Parallel Communication protocols - Serial communication protocols - Inter Integrated Circuits - Controller Area Network - Universal Serial Bus - RS232 standard, RS422 standard RS485 standard -Fire-wire - Parallel communication protocols: ISA, PCI - ARM bus - Wireless protocols - Bluetooth.

UNIT IV: RTOS FOR EMBEDDED SYSTEMS **9**

Introduction to RTOS - Tasks and Task States - Interrupt Service Routines - Semaphores - Mutex - Message Queues - Mailboxes - Pipes - Scheduling policies - Inter process communication.

UNIT V: REAL TIME OPERATING SYSTEM TOOLS AND CASE STUDIES **9**

Introduction to µCOS - II and VX Works - Comparison of µCOS - II and VX works - Case study of coding for an automatic chocolate vending machine - Case study of an embedded system for an adaptive cruise control system in a car - Case study of an embedded system for a smart card - ATM Machine - Digital camera.

LIST OF EXPERIMENTS

1. Interfacing ADC and DAC.
2. Interfacing LED and PWM.
3. Interfacing keyboard and LCD.
4. Interfacing EPROM and interrupt.
5. Mailbox and semaphore.
6. Interfacing stepper motor and temperature sensor.
7. Implementing zigbee protocol with ARM.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand the concept of composition, design and implementation of embedded systems.
- Analyze the interfacing techniques between processors and peripheral devices related to embedded system.
- Acquire the concept of communication protocols and apply advanced technical knowledge in multiplecontexts.
- Realize the management tasks needed for developing embedded system.
- Assess various testing tools for hardware- software debugging and learn its applications.
- Develop the program for interfacing keyboard, display, motor and sensor.

TEXT BOOKS

1. Rajkamal, "Embedded Systems - Architecture, Programming, Design", McGraw Hill Education, 3rd Edition, 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons, 2nd Edition, 2019.

REFERENCES

1. Jonathan W.Valvano,"Embedded Microcomputer Systems Real Time Interfacing", Cengage Learning, 3rd Edition, 2018.
2. Shibu. K.V, "Introduction to Embedded Systems", Mcgraw Hill Education, 2nd Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102169/ - (Embedded systems)
2. https://nptel.ac.in/courses/106/105/106105086/ - (Real time scheduling)

19EEE602 **POWER SYSTEM OPERATION AND CONTROL** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Significance of power system operation and control.
- Analyze the real power load frequency control.
- Implemented for reactive power-voltage interaction and the control actions.
- Solve the economic dispatch problem.
- Know the concepts of SCADA and its application for real time operation and control of power systems.
- Formation of bus admittance and impedance matrices and solution of networks.

UNIT I: PRELIMINARIES ON POWER SYSTEM OPERATION AND CONTROL **9**

Power scenario in Indian grid - National and Regional load dispatching centers - Requirements of good power system - Necessity of voltage and frequency regulation - System load variation, load curves and basic concepts of load dispatching - Load forecasting - Regulation of two generators in parallel.

UNIT II: REAL POWER - FREQUENCY CONTROL **9**

Basics of speed governing mechanisms and modeling - Speed load characteristics - Load Frequency Control (LFC) of single area system - Static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - Tie line modeling - Block diagram representation of two area system - Static and dynamic analysis.

UNIT III: REACTIVE POWER - VOLTAGE CONTROL **9**

Generation and absorption of reactive power - Basics of reactive power control Types of excitation system - Block diagram representation of AVR loop - Static and dynamic analysis stability compensation - Voltage drop in transmission line - Methods of reactive power injection tap changing transformer - SVC (TCR + TSC) and STATCOM for voltage control.

UNIT IV: ECONOMIC OPERATION OF POWER SYSTEM **9**

Statement of economic dispatch problem - Input and output characteristics of thermal plant - Incremental cost curve - Optimal operation of thermal units without and with transmission loses (no derivation of transmission loss coefficients) - Statement of unit commitment (UC) problem - Constraints on UC problem - Solution of UC problem using priority list.

UNIT V: COMPUTER CONTROL OF POWER SYSTEMS **9**

Need of computer control of power systems - Concept of energy control centers and functions system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - State estimation problem - Various operating states - State transition diagram.

LIST OF EXPERIMENTS

1. Computation of transmission line parameters
2. Formation of bus admittance and impedance matrices
3. Power flow analysis using Gauss-seidel method and Newton raphson method
4. Symmetric and unsymmetrical fault analysis
5. Transient stability analysis of SMIB system
6. Economic dispatch in power systems
7. Simulation of load frequency dynamics of single- area and two-area power systems

TOTAL: 45+15 = 60 PERIODS

OUTCOMES

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

- Understand power system planning and operational studies.
- Design the power-frequency controller.
- Maintain the voltage profile against varying system load.
- Appreciate the economic operation of power system.
- Know the need of computer control of power systems.
- Simulate of load - frequency dynamics of single- area and two-area power systems.

TEXT BOOKS

1. Allen. J. Wood and Bruce F. Wollen berg, "Power Generation, Operation and Control", McGraw-Hill Education, 3rd Edition, 2013.
2. Kothari D.P. and Nagrath I.J., „Power System Engineering", McGraw-Hill Education, 3rd Edition, 2019.

REFERENCES

1. Hadi Saadat, "Power System Analysis", McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 2019.
2. Kundur P., "Power System Stability and Control", McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2022.

E-RESOURCES

1. https://nptel.ac.in/courses/108/101/108101040/ - (Power System Operation and Control)
2. https://studentsfocus,com/108/101/108104052/ - (Power System Operation and Control)

19EEC604 **MINI PROJECT** **LT P C**
0 0 2 1

OBJECTIVES

The main objective of this course is to:

- Design and fabrication of one or more components of a complete working model, which is designed by them.
- Ability to fabricate any components using different manufacturing tools.

GUIDELINES FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

OUTCOMES

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

- Design and fabricate the machine element or the mechanical product.
- Demonstrate the working model of the machine element or the mechanical product.

19MDC601 **CONSTITUTION OF INDIA** **L T P C**
(Common to Civil, CSE, ECE, EEE & Mechanical) **3 0 0 0**

OBJECTIVES

The main objective of this course is to:

- Understand the meaning of the Constitution law and Constitutionalism.
- Realize the fundamental rights.
- Understand the execution powers of union and states bout.
- Be aware of the Constitutional powers.
- Acquaint with other Constitutional functionaries.

UNIT I: INTRODUCTION **3**

Meaning of the Constitution law and constitutionalism - Historical perspective of the Constitution of India - Preamble - Salient features and characteristics of the Constitution of India - Citizenship.

UNIT II: FUNDAMENTAL RIGHTS **3**

Scheme of the fundamental rights - The scheme of the fundamental duties and its legal status - The directive principles of state policy - Its importance and implementation.

UNIT III: UNION AND STATE EXECUTIVE **3**

Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary form of Government in India - The Constitution powers and status of the President of India - Governor - Appointment, powers and functions.

UNIT IV: CONSTITUTIONAL POWERS **3**

Amendment of the Constitutional powers and procedure - The historical perspectives of the Constitutional amendments in India - Emergency provisions : National emergency, President rule, financial emergency.

UNIT V: OTHER CONSTITUIONAL FUNCTIONARIES **3**

Election Commission of India: Organization, powers and functions, Union Public Service Commission, State Public Service Commission - Local Self Government.

TOTAL: 15 PERIODS

OUTCOMES

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

- Understand the salient features and characteristics of the Constitution of India.
- Analyze the scheme of the fundamental rights and duties.
- Evaluate in detail the powers between the Union and the States.
- Know the concept of Constitutional powers.
- Recognize other Constitutional functionaries.

TEXT BOOKS

1. Introduction to the Constitution of India - Durga Das Basu.
2. Our Constitution by Subhash by C. Kashyap.

REFERENCES

1. Indian Polity by Spectrum.
2. The Indian Constitution: Cornerstone of a Nation, by Granville Austin.

E-RESOURCES

1. https://www.youtube.com/watch?v=vq2Q1_v6TNU
2. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text

SEMESTER VII

19EET701	ELECTRIC VEHICLES	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Develop the field of electric vehicle technology.
- Provide different types and energy storage devices.
- Explain the technology, design methodologies and control strategy to DC & AC Electrical Machines of electric drive vehicles.
- Study the concepts and drive train configurations of electric drive vehicles.
- Elucidate plug - in hybrid electric vehicle architecture, design and component sizing used in hybrid electric vehicles.

UNIT I: ELECTRIC VEHICLES **9**

Introduction - Components - Vehicle mechanics - Roadway fundamentals - Vehicle kinetics - Dynamics of vehicle motion - Propulsion System Design

UNIT II: BATTERY **9**

Basics - Types - Parameters - Capacity, Discharge rate, State of charge, state of discharge, Depth of discharge - Technical characteristics - Battery pack design - Properties of batteries

UNIT III: DC & AC ELECTRICAL MACHINES **9**

Motor and engine rating - Requirements - DC machines - Three phase AC machines- Induction machines - Permanent magnet machines - BLDC Motor - Switched reluctance machines

UNIT IV: ELECTRIC VEHICLE DRIVE TRAIN **9**

Transmission configuration - Components - Gears - Differential - Clutch - Brakes Regenerative braking - Motor sizing

UNIT V: HYBRID ELECTRIC VEHICLES **9**

Types - Series - Parallel and series - Parallel configuration - Design - Drive train - Sizing of components.

TOTAL: 45 PERIODS

OUTCOMES

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

- Recognize the working of different configurations of Electric Vehicles.
- Know the properties of batteries and its types.

- Design DC & AC Electrical Machines Configurations its components performance analysis.
- Understand the properties of electric vehicle drive train Systems.
- Appreciate of describe hybrid vehicles and their performance.

TEXT BOOKS

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2nd Edition, 2017.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 1st Edition, 2015.

REFERENCES

1. Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", CRC press, 2nd Edition, 2011.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2nd Edition, 2020.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102121/ - (Electric Vehicles)
2. https://nptel.ac.in/courses/108/103/108103009/ - (Hybrid Electric Vehicles)

19EEE701	RENEWABLE ENERGY SYSTEMS (Lab Embedded Theory Course)	L T P C 3 0 2 4

OBJECTIVES

The main objective of this course is to:

- Awareness about renewable Energy Sources and technologies.
- Learn the fundamental concepts about wind energy systems and devices.
- Impart knowledge on Solar PV and thermal systems.
- Recognize of the processes for converting biomass to fuels by various approaches.
- Know the working of Ocean Thermal Energy Conversion system and different possible ways of extracting energy from ocean, Fuel cell and Hybrid Energy Systems.
- Train the students in Renewable Energy Sources and technologies.

UNIT I: RENEWABLE ENERGY SOURCES **9**

Environmental consequences of fossil fuel use - Importance of Renewable Sources (RE) of energy - Sustainable design and development - Types of RE sources - Limitations of RE sources - Present Indian and international energy scenario of conventional and RE sources.

UNIT II: WIND ENERGY **9**

Power in the wind - Types of wind power plants(wpps) - Components of wpps - Working of wpps - Siting of wpps - Grid integration issues of wpps.

UNIT III: SOLAR PV AND THERMAL SYSTEMS **9**

Solar radiation - Radiation measurement - Solar thermal power plant - Central receiver power plants - Solar ponds - Thermal energy storage system with pcm - Solar photovoltaic systems - Basic principle of spv conversion - Types of pv systems -Maximum power point tracking - Best free solar pv system simulation.

UNIT IV: BIOMASS ENERGY **9**

Introduction - Bio mass resources - Energy from bio mass - Conversion processes - Biomass cogeneration - Environmental benefits - Geothermal energy - Basics - Direct use - Geothermal electricity - Mini/micro hydro power - Classification of hydropower schemes - Classification of water turbine - Turbine theory - essential components of hydroelectric system.

UNIT V: OTHER ENERGY SOURCES **9**

Tidal energy - Energy from the tides - Barrage and non barrage tidal power systems - Wave energy - Energy from waves - Wave power devices - Ocean thermal energy conversion (otec) - Hydrogen production and storage - Fuel cell - Principle of working - Various types - Construction and applications - Energy storage system - Hybrid energy systems.

LIST OF EXPERIMENTS

1. Simulation study on solar pv energy system and wind energy generator.
2. Experiment on vi-characteristics and efficiency of 1kwp solar pv system.
3. Test on shadowing effect & diode based solution in 1kwp solar pv system.
4. Experimentation on performance assessment of grid connected and standalone 1kwp solarpower system.
5. Experiment on performance assessment of micro wind energy generator.
6. Simulation study on hybrid (solar-wind) power system.
7. limitation study on hydel power.
8. Replication study on intelligent controllers for hybrid systems.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Understand role significance of solar energy.
- Provide importance of wind energy.
- Acquire knowledge about solar pv & thermal systems.
- Assess the biomass resource, appropriate conversion technology for the given biomass resource & end use.
- Know and analyze of ocean, fuel cell and hybrid energy systems.
- Do testing and performance analysis the various renewable energy sources.

TEXT BOOKS

1. Scott Grinnell, "Renewable Energy & Sustainable Design", Cengage Learning, USA, 2nd Edition, 2016.
2. Richard A. Dunlap, "Sustainable Energy" , Cengage Learning India Private Limited, 2nd Edition, 2015.

REFERENCES

1. ShobhNath Singh, "Non-conventional Energy resources", Pearson Education India , 2nd Edition, 2015.
2. Bradley A. Striebig, Adebayo A.Ogundipe and Maria Papadakis, "Engineering Applications in Sustainable Design and Development", Cengage Learning India Private Limited, 1st Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/108/108/108108078/ - (Renewable Energy Systems)
2. https://nptel.ac.in/courses/108/105/108105058/ - (Non-Conventional Energy resources)

19EEJ701 **PROJECT WORK (PHASE - I)** **L T P C**
0 0 2 1

OBJECTIVES

The main objective of this course is to:

- Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- Build up skills to formulate a technical project.
- Develop the methodology to solve the identified problem.
- Teach use of new tools, algorithms and techniques required to carry out the projects.
- Train the students in preparing project reports and to face reviews and viva-voce examination.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 works on a topic approved by the head of the department under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 15 PERIODS

OUTCOMES

At the end of the project, the students will be able to:

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies.
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
- Prepare technical report and oral presentations.
- At the end of the course the students will have a clear idea of their area of work and they will be in aposition to carry out the remaining phase II work in a systematic way.

SEMESTER VIII

19EEJ801	PROJECT WORK (PHASE - II)	L T P C 0 0 20 10

OBJECTIVES

The main objective of this course is to:

- Develop skills to formulate a technical project.
- Develop the ability to solve specific problem.
- Teach use of new tools, algorithms and techniques required to carry out the projects.
- Give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- Provide guidelines to prepare technical report of the project.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 300 PERIODS

OUTCOMES

At the end of the project, the students will be able to:

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies.
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
- Prepare technical report and oral presentations.
- On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering and find better solutions to it.

PROFESSIONAL ELECTIVE – I

19EEPX01 **ADVANCED CONTROL SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Acquire knowledge in state variable model.
- Design a state feedback control and state observer.
- Develop sampled data control system using Z transform.
- Get basic knowledge in describing function analysis.
- Learn the design of optimal controller.

UNIT I: STATE VARIABLE ANALYSIS 9

Introduction - Concepts of state variables and state model -State model for linear continuous time systems - Diagonalisation - Solution of state equations - Concepts of controllability and observability.

UNIT II: STATE VARIABLE DESIGN 9

Introduction to state model: Effect of state feedback - Pole placement design - Necessary and sufficient condition for arbitrary pole placement - State regulator design - Design of state observers - Separation principle - Design of servo systems: State feedback with integral control.

UNIT III: SAMPLED DATA ANALYSIS 9

Introduction - Spectrum analysis of sampling process - Signal reconstruction - Differential equations - Z transform and inverse Z transform function - Response of Linear discrete system - Z transform analysis of sampled data control systems - Response between sampling instants - Z and S domain relationship - Stability analysis and compensation techniques.

UNIT IV: NON LINEAR SYSTEMS 9

Introduction - Common physical non linearity -The phase plane method: Concepts, Singular points, Stability of non linear systems - Construction of phase trajectories system analysis by phase plane method -The describing function method - Stability analysis by describing function method - Jump resonance.

UNIT V: OPTIMAL CONTROL 9

Introduction - Classical control and optimization - Formulation of optimal control problem - Typical optimal control performance measures - Optimal state regulator design: Lyapunov equation, Matrix Riccati equation - LQR steady state optimal control - Application examples.

TOTAL: 45 PERIODS

OUTCOMES

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

- Find the controllability and observability of the system.
- Design a servo system.
- Determine the stability analysis and compensation.
- Understand and analyze the nonlinear systems.
- Apply advanced control strategies to practical engineering problems.

TEXT BOOKS

1. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill India, 4th Edition, 2017.
2. K. Ogata, "Modern Control Engineering", Pearson Education, 5th Edition, 2017.

REFERENCES

1. M.Gopal, "Modern Control System Theory", New Age International Publishers, 3rd Edition, 2014.
2. K.P.Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2nd Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/108/103/108103007/ - (Advanced Control Systems)
2. https://nptel.ac.in/courses/108/107/108107115/ - (Advanced Linear Continuous Control Systems)

19EEPX02 **DESIGN OF ELECTRICAL APPARATUS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Study the magnetic circuit parameters of electrical machines.
- Design the armature and field systems for D.C. machines.
- Acquire knowledge on the output equation of transformers.
- Fabricate of stator and rotor of induction machines and synchronous machines.
- Importance of computer aided design method.

UNIT I: INTRODUCTION **9**

Definition for design - Considerations and limitations in design - Concept of magnetic circuit - Comparison of magnetic and electric circuits - MMF calculation for air gap and teeth - Real and apparent flux density in rotating machines - Total loadings - Specific loadings - Leakage reactance - Magnetic leakage calculations.

UNIT II: D.C MACHINES **9**

Output equation - Main dimensions - Separation of D and L - Choice of specific loadings - Choice of number of poles - Core length - Armature diameter - Pole proportions - Design of air gap - Armature design - Design of commutator and brushes - Computer program - Design of armature main dimensions.

UNIT III: TRANSFORMERS **9**

Classification of transformers - Output of single phase and three phase transformers - Volt per turn and transformer constants - Optimum design - Design of core, windings and yoke for core and shell type transformers - Temperature rise of transformers - Design of tanks and cooling tubes - Computer program - Complete design of single phase core transformer.

UNIT IV: THREE PHASE INDUCTION MOTOR **9**

Output equation - Main dimensions - Separation of D and L - Choice of specific loadings - Design of stator - Length of air gap - Design of rotor bars and end rings of squirrel cage rotor - Design of wound rotor - Computer program - Design of slip ring rotor.

UNIT V: SYNCHRONOUS MACHINES **9**

Output equation - Runaway speed - Main dimensions - Separation of D and L - Choice of specific loadings - Short circuit ratio - Estimation of air gap length - Design of stator and rotor of cylindrical pole and salient pole machines - Design of damper winding - Design of field winding - Computer program - Design of stator - Main dimensions.

TOTAL: 45 PERIODS

OUTCOMES

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

- Approximate the design values for machine dimensions for the required power.
- Relate the output power of a DC machine with its main dimensions and design the armature of a DCMachine.
- Correlate the output power of a transformer with its core dimensions and design the transformer.
- Show the power of an induction motor with its main dimensions and design squirrel cage and slip ring induction motors.
- Illustrate the power of a synchronous machine with its main dimensions and design salient pole and
- cylindrical pole type synchronous machines.

TEXT BOOKS

1. Sawhney, A.K., "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, 2nd Edition 2016.
2. Sen, S.K., "Principles of Electrical Machine Designs with Computer Programmes", Oxford and IBHPublishing Co. Pvt. Ltd., New Delhi, 1st Edition 2016.

REFERENCES

1. A.Shanmugasundaram, G.Gangadharan, R.Palani, "Electrical Machine Design Data Book", New AgeInternational Pvt. Ltd., Reprint 2011.
2. A.Nagoor kani , "Electrical Machine Design", RBA publications, 3rd Edition 2018.

E-RESOURCES

1. http://nptel.vtu.ac.in/econtent/courses/EEE/06EE63/index.php - (Design of Electrical Apparatus)
2. https://motorsolver.com/workshops/electric-machine-design - (Electric Machine Design)

19EEPX03 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the concept of DC power transmission.
- Expose various HVDC converters.
- Realize the HVDC system control.
- Analyze harmonics and design of filters.
- Perform steady state analysis of AC/DC system.

UNIT I: INTRODUCTION **9**

DC Power transmission technology - Comparison of AC and DC transmission - Application of DC transmission - Description of DC transmission system - Planning for HVDC transmission - Modern trends in HVDC technology - DC breakers - Operating problems - HVDC transmission based on VSC - Types and applications of MTDC systems.

UNIT II: ANALYSIS OF HVDC CONVERTERS **9**

Line commutated converter - Analysis of Graetz circuit with and without overlap - Pulse number - Choice of converter configuration - Converter bridge characteristics - Analysis of a 12 pulse converters - Analysis of VSC topologies and firing schemes.

UNIT III: CONVERTER AND HVDC SYSTEM CONTROL **9**

Principles of DC link control - Converter control characteristics - System control hierarchy - Firing angle control - Current and extinction angle control - Starting and stopping of DC link - Power control - Higher level controllers - Control of VSC based HVDC link.

UNIT IV: REACTIVE POWER AND HARMONICS CONTROL **9**

Reactive power requirements in steady state - Sources of reactive power - SVC and STATCOM - Generation of harmonics - Design of AC and DC filters - Active filters.

UNIT V: POWER FLOW ANALYSIS IN AC/DC SYSTEMS **9**

Per unit system for DC quantities - DC system model - Inclusion of constraints - Power flow analysis - Case study.

TOTAL: 45 PERIODS

OUTCOMES

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

- Explain about High voltage DC transmission.
- Analysis of HVDC converters.
- Investigate the firing angle control.
- Apply the knowledge of reactive power and design the filters.
- Identify factors affecting AC-DC transmission.

TEXT BOOKS

1. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission", McGraw Hill Education Pvt. Ltd., New Delhi, 2nd Edition, 2020.
2. K. R. Padiyar, "HVDC Power Transmission Systems", New age publishers, 3rd Edition, 2017.

REFERENCES

1. Drgan Jovcic and Khaled Ahmed, "High Voltage Direct Current Transmission", Wiley publishers, 2nd Edition, 2015.
2. S. Rao, "EHV-AC, HVDC Transmission and Distribution Engineering", 3rd Edition. 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/108/104/108104013/ - (High Voltage DC Transmission)
2. https://nptel.ac.in/courses/108/104/108104048/ - (High Voltage Engineering)

19EEPX04 **POWER QUALITY** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the power quality problem.
- Educate on production of voltages sags, over voltages and harmonics and methods of control.
- Study overvoltage problems.
- Sources and effect of harmonics in power system.
- Impart knowledge on various methods of power quality monitoring.

UNIT I: INTRODUCTION TO POWER QUALITY **9**

Terms and definitions & Sources-Overloading, under voltage, over voltage-Concepts of transients -Short duration variations such as interruption-Long duration variation such as sustained interruption - Sags and swells -Voltage sag- Voltage swell - Voltage imbalance -Voltage fluctuations-Power frequency variations - International standards of power quality-Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II: VOLTAGE SAGAND SWELL **9**

Estimating voltage sag performance -Thevenin"s equivalent source -Analysis and calculation of various faulted condition -Estimation of the sag severity - Mitigation of voltage sag, Static transfer switches and fast transfer switches - Capacitor switching - Lightning - Ferro resonance-Mitigation of voltage swell -An introduction to computer analysis tools for transients, PSCAD and EMTP.

UNIT III: HARMONICS **9**

Harmonic sources from commercial and industrial loads - Locating harmonic sources - Power system response characteristics - Harmonics Vs transients - Effect of harmonics - Harmonic distortion - Voltage and current distortions - Harmonic indices - Inter harmonics - Resonance Harmonic distortion evaluation -IEEE and IEC standards.

UNIT IV: PASSIVE POWER COMPENSATORS **9**

Principle of Operation of Passive Shunt and Series Compensators -Analysis and Design of Passive Shunt Compensators -Simulation and Performance of Passive Power Filters -Limitations of Passive Filters -Parallel Resonance of Passive Filters with the Supply System and Its Mitigation-Fundamentals of load compensation - Voltage regulation & power factor correction.

UNIT V: POWER QUALITY MONITORING & CUSTOM POWER DEVICES **9**

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters Disturbance analyzer - Applications of expert systems for power quality monitoring -Principle& working of DSTATCOM - DSTATCOM in Voltage control mode, current control mode -DVR Structure - Rectifier supported DVR - DC Capacitor supported DVR -Unified power quality conditioner .

TOTAL: 45 PERIODS

OUTCOMES

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

- Gain knowledge on various sources, causes and effects of power quality issues.
- Acquire knowledge on voltage sag and swell.
- Ability to understand the concepts about Voltage and current distortions, harmonics.
- Get knowledge on analyzation , design the passive filters and compensation techniques.
- Knowledge on DVR.

TEXT BOOKS

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality", McGraw Hill, 3rd Edition ,2018
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality Problems & Mitigation Techniques" Wiley,2015.

REFERENCES

1. G.T. Heydt, "Electric Power Quality", 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 2011.
2. M.H.J Bollen,"Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press),2011.

E-RESOURCES

1. https://nptel.ac.in/courses/108/106/108106025/ - (Power Quality in Power Distribution System)
2. https://nptel.ac.in/courses/108/107/108107157/ - (Power Quality Improvement Techniques)

19EEPX05 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the basic concepts of total quality management and principles.
- Impart knowledge on Continuous process improvement.
- Train them with various tools and techniques of Quality Management.
- Inculcate the importance of Performance measures in an organization.
- Recognize about the ISO Quality systems.

UNIT I: INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM -TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II: TQM PRINCIPLES **9**

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III: TQM TOOLS AND TECHNIQUES - I **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types - Case studies.

UNIT IV: TQM TOOLS AND TECHNIQUES - II **9**

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures - Case studies.

UNIT V: QUALITY MANAGEMENT SYSTEM **9**

Introduction - benefits of ISO Registration - ISO 9000 Series of Standards - Sector-Specific Standards - AS 9100, TS16949 and TL 9000 - ISO 9001 Requirements - Implementation - Documentation - Internal Audits - Registration - Environmental Management System: Introduction - ISO 14000 Series Standards - Concepts of ISO14001- Requirements of ISO 14001- Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOMES

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

- Prioritize quality goals based on customer expectations & competition.
- Implement various principles of quality management.
- Ability to acquire knowledge on statistical process.
- Analyze the various types of techniques are used to measure quality.
- Realize the quality system for ISO certification.

TEXT BOOKS

1. Dale H.Besterfiled, Carol B.Michna, Glen H. Bester field, Mary B.Sacre, Hemant and Rashmi, "Total Quality Management", Pearson Education Asia, Revised 5rd Edition, Indian Reprint, 6th Impression, 2017.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2015.

REFERENCES

1. Janakiraman.B and Gopal.R.K, "Total Quality Management" - Text and Cases", Prentice Hall (India) Pvt. Ltd. 2nd Edition, 2015.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt Ltd, 3rd Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/110/104/110104080/ - (Total Quality Management- I)
2. https://nptel.ac.in/courses/110/104/110104085/ - (Total Quality Management- II)

19EEPX31 **AUTOMOTIVE ELECTRONICS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To learn about the role and importance of electronics in functioning of an Automobile and their diagnosis
- Be familiar with the fundamental concepts of the engine control system
- Select the appropriate sensors and actuators for automotive systems
- Analyze the engine's mode of operation by the engine's electronic control system
- Learn about modern vehicle motion controls and communication systems
- Understand the role of instrumentation in the digital Engine Control System and identify various faults

UNIT I ENGINE CONTROL ELECTRONICS **9**

Semiconductor devices – Electro optics – Microcomputer fundamentals – microcomputer application in automotive systems – working of two stroke and four stroke engine – concept of an electronic engine control system – definition of engine performance terms – electronic fuel control – ignition system, spark plug and electronic ignition.

UNIT II: SENSORS AND ACTUATOR **10**

Variables to be measured – airflow rate sensor – pressure measurements – engine Crankshaft Angular Position Sensor – Magnetic Reluctance Position Sensor-Hall-Effect Position Sensor-Optical crankshaft position sensor – throttle angle sensor – temperature sensor – coolant sensor – sensors for feedback control – knock sensor – digital video camera – automotive engine control actuators – electric motor actuators.

UNIT III: DIGITAL ENGINE CONTROL **9**

Digital engine control features – control modes for fuel control – EGR control – variable valve timing control – turbo charging – integrated engine control system.

UNIT IV: VEHICLE MOTION CONTROL AND COMMUNICATION **8**

Cruise control system – antilock braking system – electronic suspension system – steering control – CAN – LIN – GPS navigation – Autonomous vehicle (block diagram).

UNIT V: AUTOMOTIVE INSTRUMENTATION AND DIAGNOSTICS **9**

Modern automotive instrumentation – input and output signal conversion – display devices – coolant temperature and oil pressure measurement – vehicle speed measurement – trip information function – electronic control system diagnostics – service bay diagnostic tool – onboard diagnostics – diagnostic fault codes.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the concepts of engine control system [U]
- Choose the Sensors and Actuators suitable to automotive systems [AP]
- Analyze Electronic control system, determine the mode of operation of the engine [AN]
- Understand various advanced vehicle motion controls and communication system [U]
- Interpret the role of instrumentation in digital Engine Control System and identify various faults [U]

TEXT BOOKS

1. William B. Ribbens, Understanding Automotive Electronics, 8th Edition, Butterworth, Heinemann Woburn, 2017
2. Judge. A. W., Modern electrical Equipment of Automobiles, Chapman & Hall, London, 2012

REFERENCES

1. Automotive Electrical Equipment, P L Kohli, Tata McGraw-Hill Publishing Company, 2004
2. Automotive Hand Book, Robert Bosch, Bently Publishers, 2004.

E-RESOURCES

1. https://nptel.ac.in/courses/107106088
2. https://www.sciencedirect.com/topics/engineering/automotive-electronics

PROFESSIONAL ELECTIVE – II

19EEPX06 **PRINCIPLES OF ROBOTICS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the basic concepts of Robotics.
- Make the students familiar with the functional elements of Robotics.
- Impart knowledge on the use of end effectors.
- Educate on various path planning techniques.
- Know the impact of vision systems in robotics.

UNIT I: BASIC CONCEPTS 9

Brief History - Types of robots - Degrees of freedom of robots - Robot configurations and concept of workspace -Technology - Robot classifications and specifications - Work cell - Programming languages.

UNIT II: ELEMENTS OF ROBOTS 9

Representation of joints - Link representation using D-H parameters - Different kind of actuators - Stepper, DC - Servo and brushless motors - Model of a DC servo motor - Types of transmissions - Purpose of sensor

- Internal and external sensor - Common sensors - Encoders - Tachometers - Strain gauge based force torque sensor - Proximity and distance measuring sensors and vision.

UNIT III: END EFFECTORS 9

Classification of end effectors - Tools as end effectors - Drive system for grippers - Mechanical Adhesive - Vacuum magnetic - Grippers, hooks and scoops - Gripper force analysis and gripper design - Active and passive grippers.

UNIT IV: PATH PLANNING 9

Introduction - Path planning - Overview - Road map path planning - Cell decomposition path planning - Potential field path planning - Obstacle avoidance - Case studies.

UNIT V: VISION SYSTEM 9

Robotic vision systems - Image representation - Object recognition and categorization - Depth measurement - Image data compression - Visual inspection - Software considerations.

TOTAL: 45 PERIODS

OUTCOMES

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

- Explain the basic concepts of working of robot.
- Analyze Instrumentation systems and their applications to various robots.
- Understand the differential motion and statics in robotics.
- Program the robot for a typical application and path planning .
- Use the advanced techniques for robot processing using robotic vision.

TEXT BOOKS

1. R.K.Mittal and I.J.Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi, 4th Reprint, 2017.
2. JohnJ.Craig, "Introduction to Robotics Mechanics and Control", 4th Edition, Pearson Education, 2017.

REFERENCES

1. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, "Industrial Robotics", McGraw Hill Education; 2nd Edition, 201
2. AshitavaGhoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6th impression, 2010.

E-RESOURCES

1. https://nptel.ac.in/courses/112/105/112105249/ - (Robotics)
2. https://nptel.ac.in/courses/107/106/107106090/ - (Introduction to Robotics)

19EEPX07 **COMMUNICATION ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand different methods of analog communication and their significance.
- Acquire various analog and digital modulation techniques.
- Study the principles behind information theory and coding.
- Introduce MAC used in communication systems for enhancing the number of users.
- Acquire various media for digital communication.

UNIT I: ANALOG COMMUNICATION **9**

Amplitude modulation: Frequency spectrum - Vector representation - Power relations generation of AM - SB, SB/SC, SSB; AM transmitter: Low level and high level transmitter, AM receiver: Super heterodyne Receiver - Power relation between FM and PM, Generation (Armstrong method) and detection (Foster Seely Discriminator) of FM and PM.

UNIT II: DIGITAL COMMUNICATION **9**

Concept of sampling and sampling theorems, Pulse modulation techniques: PAM, PWM, PCM, DM, Adaptive delta modulation, Keying techniques: ASK, FSK and PSK - Introduction to smart communication devices: IoT and Zigbee.

UNIT III: SOURCE CODES, LINE CODES & ERROR CONTROL **9**

Source codes: Shannon - Fano coding, Huffman codes, Line Codes: NRZ and RZ, Error control codes : Linear block codes - Hamming codes, convolutions & block codes.

UNIT IV: SPREAD SPECTRUM AND MULTIPLEACCESS TECHNIQUES **9**

Spread Spectrum techniques: DSSS & FHSS techniques. Multiple Access techniques: FDMA, TDMA, CDMA, SDMA.

UNIT V: SATELLITE AND OPTICALFIBER COMMUNICATION **9**

Satellite communication - Types of satellites, Satellite orbits, INTELSAT and INSAT - Optical fiber communication - Technology - Single mode and Multimode fibers.

TOTAL: 45 PERIODS

OUTCOMES

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

- Analog communication and their significance.
- Understand the digital Communication methods for high bit rate transmission.
- Realize the concepts of source and line coding techniques for enhancing the transmission rate.
- Know various MAC protocols used in communication systems for enhancing the number of user.
- Examine the various media for digital communications.

TEXT BOOKS

1. Taub & Schiling "Principles of Communication Systems" , Tata McGraw Hill, 2017.
2. J.Das, "Principles of Digital Communication" New Age International, 2011.

REFERENCES

1. G.Kennedy, "Electronic Communication Systems", Mcgraw Hill, 4th Edition.,2012.
2. Gerd Keiser, "Optical Fiber Communications", McGraw Hill Education (India) Private Limited, 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/117/101/117101051/ - (communication system)
2. http://www.nptelvideos.in/2012/11/ - (communication-engineering.html)

19EEPX08 **EHVAC TRANSMISSION** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Learn the basic concepts of EHVAC Transmission lines.
- Realize the Electrostatic field of AC lines.
- Study the basics of power control in EHV lines .
- Know the impact of Corona in EHV lines.
- Recognize the steady state and transient limits.

UNIT I: INTRODUCTION **9**

EHVAC Transmission line trends and preliminary aspect - Standard transmission voltages - Estimation at line and ground parameters-Bundle conductors: Properties - Inductance and capacitance of EHV lines - Positive, negative and zero sequence impedance - Line Parameters for Modes of Propagation.

UNIT II: ELECTROSTATIC FIELDS **9**

Electrostatic field and voltage gradients - Calculations of electrostatic field of AC lines - Effect of high electrostatic field on biological organisms and human beings - Surface voltage gradients and Maximum gradients of actual transmission lines - Voltage gradients on sub conductor.

UNIT III: POWER CONTROL **9**

Electrostatic induction in unenergized lines - Measurement of field and voltage gradients for three phase single and double circuit lines - Un energized lines. Power Frequency Voltage control and overvoltage in EHV lines: No load voltage - Charging currents at power frequency - Voltage control - Shunt and Series compensation.

UNIT IV: CORONA EFFECTS AND RADIO INTERFERENCE **9**

Corona in EHV lines - Corona loss formulae-Charge voltage diagram- Attenuation of traveling waves due to Corona - Audio noise due to Corona, its generation, characteristic and limits - Measurements of audio noise radio interference due to Corona - Properties of radio noise - Frequency spectrum of RI fields - Measurements of RI and RIV.

UNIT V: STEADY STATE AND TRANSIENT LIMITS **9**

Design of EHV lines based on steady state and transient limits - EHV cabilitys and their characteristics - Introduction six phase transmission - UHV.

TOTAL: 45 PERIODS

OUTCOMES

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

- Acquire knowledge on principles and types of EHVAC system.
- Gain knowledge on electrostatic field of AC lines.
- Get knowledge on the compensation.
- Expand the knowledge about the corona in E.H.V. lines.
- Ability to analyze the steady state and transient limits.

TEXT BOOKS

1. Rokosh Das Begamudre, "Extra High Voltage AC Transmission Engineering"- Wiley Eastern LTD., New delhi , 2013.
2. S. Rao, "HVAC and HVDC Transmission, Engineering and Practice" Khanna Publisher, Delhi, 2015.

REFERENCES

1. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, 2013.
2. Roberto Benato, Antonio Paolucci, "EHV AC Undergrounding Electrical Power", Springer,2012.

E-RESOURCES

1. https://nptel.ac.in/courses/108/106/108106160/ - (Power transmission Systems)
2. https://nptel.ac.in/courses/108/107/108107127/ - (Power System)

19EEPX09 **SPECIAL ELECTRICAL MACHINES** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Building the principle of operation, control and performance of stepping motors.
- Get Basic knowledge in Construction, principle of operation, control and performance of switchedreluctance motors.
- Presentation of permanent magnet brushless D.C. motors.
- Impart knowledge on the Construction, principle of operation and performance of permanent magnetsynchronous motors.
- Learn the Construction of Linear Induction motor.

UNIT I: STEPPER MOTORS **9**

Constructional features - Principle of operation -Types - Torque Equations - Modes of excitation - Characteristics - Driver Circuits - Microprocessor control of stepper motors - Concept of lead angle - Applications.

UNIT II: SWITCHED RELUCTANCE MOTORS (SRM) **9**

Constructional features - Principle of operation - Torque prediction-Characteristics Steady state performance prediction - Analytical method - Power controllers - Methods of rotor position sensing - Control of SRM drive - Sensor less operation of SRM -Applications.

UNIT III: PERMANENT MAGNET BRUSHLESS D.C. MOTORS **9**

Permanent Magnet materials - Magnetic Characteristics - Types - Principle of operation - Magnetic circuit analysis - EMF and Torque equations - Power Converter Circuits and their controllers - Characteristics and control - Applications.

UNIT IV: PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM) **9**

Constructional features - Principle of operation - Ideal PMSM - EMF and Torque equations - Sine wave motor with practical windings - Phasor diagram - Power controllers - Performance characteristics - Digital controllers - Applications.

UNIT V: OTHER SPECIAL MACHINES **9**

Constructional features - Principle of operation and Characteristics of Hysteresis motor – Synchronous Reluctance Motor - Linear Induction motor - Repulsion motor - Applications.

TOTAL: 45 PERIODS

OUTCOMES

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

- Select suitably configured modern electric motors for constrained applications with the knowledge of fundamental principles, constructions and classifications.
- Examine the special machines used in different applications.
- Analyze the performance characteristics of special electrical machines with suitable equations and phasor diagram techniques.
- Understand the different control techniques of special electrical machines to satisfy the variousrequirements based on the applications.
- Outline the characteristics of synchronous reluctance motor.

TEXT BOOKS

1. T. Kenjo, "Stepping Motors and their Microprocessor Controls" , Oxford; 2nd Edition, 2017.
2. E.G. Janardanan, "Special Electrical Machines" , PHI learning Private Limited, Delhi, 2nd Edition 2014.

REFERENCES

1. R.Krishnan, "Switched Reluctance Motor Drives - Modeling, Simulation, Analysis, Design and Application" , CRC Press, 1st Edition 2017.
2. K.Venkataratnam, "Special Electrical Machines" , Universities Press (India) Private Limited, 1st Edition 2018.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102156/ - (Special Electromechanical Systems)
2. https://freevideolectures.com/course/3114/advanced-electric-drives/ - (Advanced Electric Drives)

19EEPX10 **VLSI DESIGN** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Study the fundamentals of CMOS circuits and its characteristics.
- Learn the design and realization of combinational & sequential digital circuits.
- Architectural choices and performance tradeoffs involved in designing.
- Realize the circuits in CMOS technology are discussed.
- Learn the different FPGA architectures and testability of VLSI circuits.

UNIT I: INTRODUCTION TO MOS TRANSISTOR **9**

MOS Transistor - CMOS logic - Inverter - Pass Transistor - Transmission gate - Layout Design Rules - Gate Layouts -Stick Diagrams - Long Channel i-v characteristics - cv characteristics - Non ideal I-V Effects - DC Transfer characteristics - RC Delay Model - Elmore delay - Linear delay model - Logical effort - Parasitic delay - Delay in logic gate.

UNIT II: COMBINATIONAL MOS LOGIC CIRCUITS **9**

Static CMOS - Rationed Circuits - Cascade Voltage Switch Logic - Dynamic Circuits - Pass Transistor Logic - Transmission Gates - Domino, Dual Rail Domino - CPL, DCVSPG, DPL, Circuit Pitfalls.

UNIT III: SEQUENTIAL CIRCUIT DESIGN **9**

Static latches and Registers - Dynamic latches and Registers - Pulse Registers - Sense Amplifier based register - Pipelining - Schmitt trigger - Mon stability Sequential Circuits - Astability Sequential Circuits.

UNIT IV: DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM **9**

Arithmetic Building Blocks: Data Paths - Adders - Multipliers - Shifters - ALUs - Power and speed tradeoffs - Case Study: Design as a tradeoff - **Designing Memory and Array structures** - Memory Architectures and Building Blocks - Memory Core - Memory Peripheral Circuitry.

UNIT V: IMPLEMENTATION STRATEGIES AND TESTING **9**

FPGA Building Block Architectures - FPGA Interconnect Routing Procedures - Design for Testability - Ad Hoc Testing, Scan Design - BIST, IDDQ Testing, Design for Manufacturability - Boundary Scan.

TOTAL: 45 PERIODS

OUTCOMES

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

- Realize the concepts of digital building blocks using MOS transistor.
- Design combinational MOS circuits and power strategies.
- Plan and construct Sequential Circuits and Timing systems.
- Arithmetic building blocks and memory subsystems.
- Apply and implement FPGA design flow and testing.

TEXT BOOKS

1. Neil H.E.Weste,David Money Harris ,"CMOSVLSIDesign:A Circuits and Systems Perspective",4th Edition, Pearson , 2017.
2. Jan M. Rabaey ,AnanthaChandrakasan, Borivoje. Nikolic, "Digital Integrated Circuits:A Design perspective", 2nd Edition , Pearson ,2016.

REFERENCES

1. M.J. Smith, "Application Specific Integrated Circuits", Addisson Wesley,2017.
2. Sung-Mo kang, Yusuf leblebici,Chulwoo Kim "CMOS Digital Integrated Circuits:Analysis & Design",4th Edition McGraw Hill Education,2013.

E-RESOURCES

1. https://nptel.ac.in/courses/117/101/117101058/ - (Introduction of VLSI design)
2. https://nptel.ac.in/courses/108/107/108107129/ - (CMOS digital VLSI design)

19EEPX32 **INTRODUCTION TO INTERNET OF THINGS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To impart necessary and practical knowledge of components of Internet of Things
- To develop skills required to build real-life IoT based projects.
- Become familiar with the internet of things' hardware and software components
- Implement I/O device, sensor, and communication module interface concepts.
- Monitor and control devices by analyzing data from sensors
- Describe and demonstrate real-world IoT projects.

UNIT I: INTRODUCTION TO IOT **9**

Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT II: ELEMENTS OF IOT **9**

Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

UNIT III: IOT APPLICATION DEVELOPMENT **9**

Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration.

UNIT IV: IOT DATA STORAGE **9**

Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

UNIT V: IOT CASE STUDIES **9**

IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the impact and need and of IoT in the present scenario. [U]
- Understand internet of Things and its hardware and software components [U]
- Apply concepts of interfacing I/O devices, sensors & communication modules [AP]
- Interpret monitoring data and control devices [AN]
- Illustrate real life IoT based projects [AP]

TEXT BOOKS

1. Vijay Madisetti, ArshdeepBahga, Ïnternet of Things, "A Hands-on Approach", University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs

REFERENCES

1. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
2. Adrian McEwen, "Designing the Internet of Things", Wiley

E-RESOURCES

1. https://nptel.ac.in/courses/106/105/106105166/
2. https://nptel.ac.in/courses/108108123

PROFESSIONAL ELECTIVE – III

19EEPX11 **COMPUTER ARCHITECTURE** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart Knowledge About Architecture And Function Of General Computer System.
- Understand The Memory Hierarchies, Cache Memories And Virtual Memories.
- Learn The Different Ways Of Communication With I/O Devices.
- Understand The Architecture And Addressing Mode.
- Discover basics of Pipelined execution.

UNIT I: BASIC STRUCTURE OF A COMPUTER SYSTEM **9**

Functional Units - Basic Operational Concepts - Performance - Instructions: Language of the Computer - Operations, Operands - Instruction representation - Logical operations - Decision making - MIPS Addressing.

UNIT II: MEMORY ORGANIZATION **9**

System memory, Cache memory - Types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

UNIT III: SYSTEM ORGANIZATION **9**

Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

UNIT IV: DIFFERENT ARCHITECTURE **9**

80x86 Architecture, IA - 32 and IA - 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes ,VLIW Architecture, DSP Architecture, SoC architecture.

UNIT V: PIPE LINING **9**

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set. MIPS Processor and programming.

TOTAL: 45 PERIODS

OUTCOMES

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

- Realize the concepts of digital building blocks using MOS transistor.
- Aim combinational MOS circuits and power strategies.
- Design and construct Sequential Circuits and Timing systems.
- Imply arithmetic building blocks and memory subsystems.
- Apply and implement FPGA design flow and testing.

TEXT BOOKS

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

REFERENCES

1. J. L. Hennessy and D. A. Patterson, "Computer Architecture a Quantitative Approach", Morgan Kauffman, 2nd Edition, 2011.
2. John P. Hayes, "Computer Architecture and Organization", Tata McGraw Hill, 3rd Edition, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/106/103/106103206/ - (Advanced Computer Architecture)
2. https://nptel.ac.in/courses/106/102/106102157/ - (Computer Architecture)

19EEPX12 **DIGITAL CONTROL SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Discrete Representation of Continuous Systems.
- Isolated System Analysis Using Z-Transform.
- State Space Model for Discrete Time Systems.
- Design of Digital Control System.
- Aim of Output Feedback Control for Discrete Systems.

UNIT I: DISCRETE REPRESENTATION OF CONTINUOUS SYSTEMS **7**

Basics of Digital Control Systems - Discrete representation of continuous systems - Sample and hold circuit. Mathematical Modelling of sample and hold circuit - Effects of Sampling and Quantization - Choice of sampling frequency - ZOH equivalent.

UNIT II: DISCRETE SYSTEM ANALYSIS **10**

Z-Transform and Inverse Z Transform for analyzing discrete time systems - Pulse Transfer function - Pulse transfer function of closed loop systems - Mapping from s-plane to z plane.Solution of Discrete time systems.Time response of discrete time system - Stability analysis by Jury test.Stability analysis using bilinear transformation - Design of digital control system with dead beat response - Practical issues with dead beat response design.

UNIT III: STATE SPACE APPROACH FOR DISCRETE TIME SYSTEMS **10**

State space models of discrete systems - State space analysis - Lyapunov Stability – Controllability – Reach-ability - Reconstructibility and observability analysis - Effect of pole zero cancellation on the controllability & observability.

UNIT IV: DESIGN OF DIGITAL CONTROL SYSTEM **9**

Design of Discrete PID Controller - Design of discrete state feedback controller - Design of set point tracker - Design of Discrete Observer for LTI System - Design of Discrete compensator.

UNIT V: DISCRETE OUTPUT FEEDBACK CONTROL **9**

Design of discrete output feedback control - Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

TOTAL: 45 PERIODS

OUTCOMES

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

- Have in-depth knowledge and critical understanding of the theory and principles of digital controlsystems and their applications.
- Analyze the behavior of a discrete system in time domain and in frequency domain.
- Design and synthesize controllers that will be implemented using digital hardware.
- Apply digital control systems‟ principles and techniques to discrete time systems.
- Design and synthesize discrete output feedback control systems.

TEXT BOOKS

1. K. Ogata, "Discrete-Time Control Systems ", Pearson Education India; 2nd Edition, 2015.
2. M. Gopal, "Digital Control Engineering", New Age International Private Limited; 2nd Edition, 2014.

REFERENCES

1. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Ellis-Kagle Press; 3rd Edition, 2019.
2. B.C. Kuo, "Digital Control System", Oxford University Press; 2nd Edition, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/108/103/108103008/ - (Digital Control System)
2. http://www.nptelvideos.in/2012/11/advanced-control-system-design_27.html - (Advanced Control System Design)

19EEPX13 **ARTIFICIAL NEURAL NETWORKS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the biological neural network and to model equivalent neuron models.
- Impart knowledge on perceptron models.
- Realize the architecture, learning algorithm and issues of various feed forward and feedback neuralnetworks.
- Concepts of Associative memories.
- Educate on Self Organizing Maps and Adaptive Resonance Theory.

UNIT I: INTRODUCTION **9**

A Neural Network - Human Brain - Models of a Neuron - Evolution of Neural Networks - Models of ANNs - Feed forward& feedback networks - learning rules - Hebbian learning rule - perception learning rule - delta learning rule - Widrow-Hoff learning rule - correction learning rule - Winner - lake all learning rule

UNIT II: SINGLE LAYER PERCEPTION CLASSIFIER **9**

Classification model - Features & Decision regions - training & classification using discrete perceptron - algorithm - single layer continuous perceptron networks for linearly separable classifications

UNIT III: FEED FORWARD AND FEEDBACK NETWORKS **9**

Multi-layer Feed forward Networks: Linearly non-separable pattern classification - Delta learning rule for multi-perceptron layer - Generalized delta learning rule - Error back- propagation training - learning factors - Examples. Single layer feedback Networks: Basic Concepts - Hopfield networks - Boltzmann‟s Algorithm-Training & Examples

UNIT IV: ASSOCIATIVE MEMORIES **9**

Linear Association - Basic Concepts of recurrent Auto associative memory: retrieval algorithm - Storage algorithm - By directional associative memory - Architecture - Association encoding & decoding -Stability.

UNIT V: SELF ORGANIZING MAPS(SOM) AND ADAPTIVE RESONANCE THEORY(ART) **9**

Introduction - Competitive Learning - Vector Quantization - Self-Organized Learning Networks - Kohonen Networks - Training Algorithms - Linear Vector Quantization - Stability-Plasticity Dilemma - Feed forward competition - Feedback Competition - Instar - Out star - ART1, ART2, Applications - Convolutional neural network.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the ideological basics of artificial neural networks.
- Identify the different structures of artificial neural networks.
- Create different neural networks of various architectures.
- Perform the training of neural networks using various learning rules.
- Make the testing of neural networks and do the perform analysis of these networks.

TEXT BOOKS

1. Simon Haykin, Neural Networks: A Comprehensive Foundations, PHI, 2013.
2. Gunjan Goswami, Introduction to Artificial Neural Networks, S.K. Kataria & Sons, 2012.

REFERENCES

1. Li Min Fu, "Neural Networks in Computer Intelligence", Mcgraw Hill Education, 2013.
2. James A Freeman, David M S Kapura, "Neural Networks", Pearson Education, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/117/105/117105084/ - (Neural Networks and Applications)
2. https://nptel.ac.in/courses/127/105/127105006/ - (Fuzzy Logic and Neural Networks)

19EEPX14 FIBRE OPTICS AND LASER INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Expose the students to the basic concepts of optical fibres and their properties.
- Give adequate knowledge about the Industrial applications of optical fibres.
- Description the students to the Laser fundamentals.
- Present adequate knowledge about Industrial application of lasers.
- Provide adequate knowledge about holography and Medical application of Lasers.

UNIT I: OPTICAL FIBRES AND THEIR PROPERTIES 9

Theory and classification of fiber optics: Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics - Absorption losses - Scattering losses- Dispersion - Connectors and splicers - Optical sources - Optical detectors.

UNIT II: INDUSTRIAL APPLICATION OF OPTICAL FIBRES 9

Fibre optic sensors - Different types of modulators - Fibre optic communication set up - Interferometric method of measurement of length - Moire fringes - Measurement of pressure – Temperature – voltage - liquid level - strain.

UNIT III: LASER FUNDAMENTALS 9

Fundamental characteristics of lasers - Three level and four level lasers - Properties of laser - Laser modes - Resonator configuration - Q-switching and mode locking - Cavity damping - Types of lasers.

UNIT IV: INDUSTRIAL APPLICATION OF LASERS 9

Laser for measurement of velocity and Atmospheric effect - Material processing - Laser heating Welding - Melting and trimming of material - Removal and vaporization.

UNIT V: HOLOGRAM AND MEDICAL APPLICATIONS 9

Holography - Basic principle - Methods - Holographic Interferometry and application - Holography for non-destructive testing - Holographic components - Medical applications of lasers - Laser and tissue interactive - Laser instruments for surgery - Removal of tumors of vocal cards - Brain surgery - Plastic surgery - Gynaecology and oncology.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the principle, transmission, dispersion and attenuation characteristics of optical fibers.
- Apply the gained knowledge on optical fibers for its use as communication medium.
- Realize laser theory and laser generation system.
- Pertain laser theory for the selection of lasers for a specific Industrial and medical application.
- Know the basic principle and methods of Holographic interferometry and application of laser instruments in medical surgeries.

TEXT BOOKS

1. Ignacio Del Villar; Ignacio R. Matias "Optical Fibre Sensors: Fundamentals for Development of Optimized Devices" John Wiley & Sons, 2021.
2. "Optoelectronics" (English, Paperback, Tricker Ray) 5th Edition Pearson Education, 10 February 2018.

REFERENCES

1. Gerd Keiser "Optical Fiber Communication (SIE)" 5th Edition, McGraw Hill Education, 1 July 2017.
2. Yoshihiro Deguch "Industrial Applications of Laser Diagnostics" CRC Press. Taylor & Francis Group 2011.

E-RESOURCES

1. http://nptel.ac.in/courses/117101002/ - (Fibre transmission)
2. https://nptel.ac.in/courses/117/101/117101054/ - (signal distortion)

19EEPX15 **DIGITAL DESIGN WITH VHDL** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Enable and design the real circuits using VHDL.
- Implement VHDL programming in combinational circuits.
- Familiarize VHDL programming in sequential circuits.
- Learn the knowledge in PLDs model using VHDL.
- Simulate and test the VHDL system.

UNIT I: INTRODUCTION **9**

VHDL"s history - Benefits of VHDL - Concepts of VHDL - Entity and Architecture - Behavioral, data flow and structural specifications - Concurrent statements - Sequential statements - Syntax of VHDL - Library - Packages - Procedures - Functions - Data types and Operators - Loops - Delay models - RTL design - Test bench.

UNIT II: VHDL MODEL FOR COMBINATIONAL CIRCUITS **9**

VHDL Description of combinational circuits - VHDL model for logic gates, Adders, Subtractors, Multiplexer and Demultiplexer, Decoder and Encoders, Magnitude comparators and Parity checkers - Test benches for combinational circuits

UNIT III: VHDL MODEL FOR SEQUENTIAL CIRCUITS **9**

VHDL Description of sequential circuits - VHDL model for latches, flipflops, Registers and counters, Sequential Multiplier - Test benches for sequential circuits - State machines in VHDL - Implementation of the dice game -Implementation of traffic controller.

UNIT IV: VHDL MODEL FOR PLDs, MEMORY AND BUS **9**

VHDL model for PLA - VHDL model for PAL - VHDL model for sequential programming logic devices - Design of a keypad scanner - VHDL model for static RAM - Simplified 486 bus model - VHDL model of a simple microprocessor.

UNIT V: VHDL SIMULATION, SYNTHESIS AND TESTING **9**

Event Driven Simulation - Simulation of VHDL models - Simulation modeling issues - Fire Operations - RTL Synthesis - Constraints- Synthesis for FPGAs - Behavioral Synthesis - Verifying Synthesis Results - Need for Testing - Fault Models - Fault oriented Test Pattern Generation - Fault Simulation - Fault Simulation in VHDL.

TOTAL: 45 PERIODS

OUTCOMES

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

- Design any circuit for practical application.
- Implement any digital system using VHDL.
- Program any VHDL code for practical implementation.
- Analyze the hardware realization of any complex system.
- Acquire knowledge in testing of digital system using VHDL.

TEXT BOOKS

1. M. Morris Mano, "Digital design: With an introduction to the Verilog HDL, VHDL and systemVerilog", Pearson Education, 6th Edition, 2018.
2. Stephen Brown, "Fundamentals of Digital logic with VHDL design", Tata McGraw Hill Education, 3rd Edition, 2017.

REFERENCES

1. Charles H. Roth Jr and LizyKurian John, "Digital system design using VHDL", Cengage Learning, 3rd Edition , 2018.
2. A.Anand Kumar, "Fundamentals of Digital Circuits", Prentice Hall of India Pvt. Ltd, 4th Edition, 2016.

E- RESOURCES

1. https://nptel.ac.in/courses/117/108/117108040/ - (Digital System Design with PLDs and FPGAs)
2. https://nptel.ac.in/courses/106/102/106102181/ - (Synthesis of Digital Systems)

19EEPX33 **INDUSTRIAL ELECTRICAL SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart knowledge on the various components and wiring of the industrial electrical systems.
- Analyze residential, commercial and industrial electrical wiring systems to determine component sizes
- Acquire working knowledge of various light illumination schemes
- Be familiar with the industrial substation and its components.
- Learn about the backup and automation systems in the industry

UNIT I: ELECTRICAL SYSTEM COMPONENTS **9**

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

UNIT II: RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS **9**

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

UNIT III: INDUSTRIAL ELECTRICAL SYSTEMS I **9**

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

UNIT IV: INDUSTRIAL ELECTRICAL SYSTEMS II **9**

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

UNIT V: INDUSTRIAL ELECTRICAL SYSTEM AUTOMATION **9**

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand various components of industrial electrical systems [U]
- Analyze the electrical wiring systems for residential, commercial and industrial Consumers then select the proper size of various electrical system components [AN]
- Understand the various lamp illumination systems [U]
- Understand the industry substation and its other components [U]

TEXT BOOKS

1. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.
2. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.

REFERENCES

1. V.K.Mehta and Rohith Mehta, "Principles of Power Systems", S.Chand, 2005
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007

E-RESOURCES

1. https://nptel.ac.in/courses/108105063
2. https://archive.nptel.ac.in/courses/108/105/108105062/

PROFESSIONAL ELECTIVE - IV

19EEPX16 **POWER SYSTEMS TRANSIENTS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the causes for transients and types.
- Study the generation of switching transients and their control using circuit - theoretical concept.
- Realize the mechanism of lighting strokes and the production of lighting surges.
- Recognize the propagation, reflection and refraction of travelling waves.
- Know the impact of voltage transients caused by faults, circuit breaker action, and load rejection on integrated power system.

UNIT I: INTRODUCTION 9

Review and importance of the study of transients - Causes for transients - RL circuit transient with sine wave excitation - Double frequency transients - Basic transforms of the RLC circuit transients - Different types of power system transients - Effect of transients on power systems - Role of the study of transients in system planning.

UNIT II: SWITCHING TRANSIENTS 9

Over voltages due to switching transients - Resistance switching - Load switching and equivalent circuit - Waveforms for transient voltage across the load and the switch - Normal and abnormal switching transients - Current suppression - Current chopping - Capacitance switching - Capacitance switching with a restrike with multiple restrikes - Ferro resonance.

UNIT III: LIGHTNING TRANSIENTS 9

Review of the theories in the formation of clouds and charge formation - Rate of charging of thunder clouds - Mechanism of lightning discharges and characteristics of lightning strokes - Model for lightning stroke - Factors contributing to good line design - Protection using ground wires - Tower footing resistance - Interaction between lightning and power system.

UNIT IV: TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS 9

Computation of transients - Transient response of systems with series and shunt lumped parameters and distributed lines - Traveling wave concept - Step response - Bewely"s lattice diagram - Standing waves and natural frequencies - Reflection and refraction of travelling waves.

UNIT V: TRANSIENTS IN INTEGRATED POWER SYSTEM **9**

The short line and kilometric fault - Distribution of voltages in a power system - Line dropping and load rejection - Voltage transients on closing and reclosing lines - Over voltage induced by faults - Switching surges on integrated system Qualitative application of EMTP for transient computation.

TOTAL: 45 PERIODS

OUTCOMES

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

- Gain knowledge on causes for transients and types.
- Acquire knowledge on generation of switching transients and their control using circuit - theoretical concept.
- Get knowledge on the mechanism of lighting strokes and the production of lighting surges.
- Understand the propagation, reflection and refraction of travelling waves.
- Expand the knowledge on impact of voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

TEXT BOOKS

1. Allan Greenwood, "Electrical Transients in Power Systems", Wiley Inter Science, New York, 2nd Edition, 2010.
2. Juan A. Martinez-Velasco, "Transient Analysis of Power Systems - A Practical Approach", Wiley Inter Science, 1st Edition, 2020.

REFERENCES

1. M.S.Naidu and V.Kamaraju, "High Voltage Engineering", Tata McGraw Hill Education, 5th Edition, 2017.
2. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, TeruoOhno, Koichi Yamabuki,"Power System transients Theory and Applications",CRS press, 2nd Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/108/104/108104048/ - (High voltage engineering)
2. https://nptel.ac.in/courses/108/106/108106026/ - (Power System)

19EEPX17 **COMPUTER METHODS IN POWER SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Remember the dynamic characteristics of power system equipment.
- Educate on modeling of synchronous machine.
- Study excitation system modeling.
- Recognize dynamic performance of power systems.
- Illustrate the system stability and controls.

UNIT I: BASIC CONCEPTS **9**

Power system stability states of operation and system security - System dynamics - Problems system model analysis of steady State stability and transient stability - Simplified representation of excitation control.

UNIT II: MODELING OF SYNCHRONOUS MACHINE **9**

Synchronous machine - Park‟s Transformation - Analysis of steady state performance - per unit quantities - Equivalent circuits of synchronous machine determination of parameters of equivalent circuits.

UNIT III:EXCITATION SYSTEM **9**

Excitation system modeling-excitation systems block Diagram - System representation by state equations- Dynamics of a synchronous generator connected to infinite bus - System model Synchronous machine model - Stator equations rotor equations - Synchronous machine model with field circuit - One equivalent damper winding on q axis - Calculation of Initial conditions.

UNIT IV: ANALYSIS OF SINGLE MACHINE SYSTEM **9**

Small signal analysis with block diagram - Representation of characteristic equation and application of Routh Hurwitz criterion - Synchronizing and damping torque analysis - Small signal model - State equations.

UNIT V: APPLICATION OF POWER SYSTEM STABILIZERS **9**

Basic concepts in applying PSS - Control signals - Structure and tuning of PSS - Washout circuit - Dynamic compensator analysis of single machine infinite bus system with and without PSS.

TOTAL: 45 PERIODS

OUTCOMES

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

- Gain knowledge on dynamic characteristics of power system equipment.
- Acquire knowledge on modeling of synchronous machine.
- Ability to understand the concepts about excitation system modeling.
- Get knowledge on dynamic performance of power systems.
- Ability to acquire knowledge on system stability and controls.

TEXT BOOKS

1. Stagg and Ei-abiad ,"Computer Methods in Power System Analysis", Medtech Publications, 2019.
2. M.Pai, "Computer Techniques in Power System Analysis", 2nd Edition, 2012.

REFERENCES

1. K.Umarao , "Computer Techniques and Models in Power System", 2nd Edition, 2014.
2. James A.Momoh, Mohamed. E. El-Hawary. " Electric Systems, Dynamics and Stability with Artificial Intelligence applications", Marcel Dekker, USA ,1st Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108/107/108107127/ - (Computer Aided Power System Analysis)
2. https://nptel.ac.in/courses/108/105/108105104/ - (Power System Engineering)

19EEPX18 **UTILIZATION OF ELECTRICAL ENERGY** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart how to design the traction system considering economic and technology up gradation.
- Introduce the energy saving concept by different ways of illumination.
- Acquaint with the different types of heating and welding techniques.
- Familiarize the refrigeration and air-conditioning systems.
- Learn the knowledge in UPS, house wiring and earthing.

UNIT I: TRACTION **9**

Merits of electric traction - Requirements of electric traction system - Systems of railway electrification - Mechanics of train movement and energy consumption - Traction motors and control - Track equipment and collection gear - Electric braking - Recent trends in electric traction - Introduction to EMU and metro railways.

UNIT II: ILLUMINATION **9**

Importance of lighting - Properties of good lighting scheme - Important terms used in illumination engineering - Laws of illumination - Polar curves - Photometry - Types of lamps - Lighting calculations - Design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting - Energy efficient lamps.

UNIT III: HEATING AND WELDING **9**

Introduction - Advantages of electric heating - Modes of heat transfer - Resistance, Arc ,Induction, Dielectric, Infrared, Microwave and Solar heating - Brief introduction to electric welding - Resistance, Arc and Radiation welding - Welding generator, welding transformer and the characteristics - Introduction to TIG, MIG Welding.

UNIT IV: REFRIGERATION AND AIRCONDITIONING **9**

Refrigeration - Domestic refrigerator and water coolers - Air-Conditioning - Various types of air-conditioning system and their applications - Smart air conditioning units - Energy Efficient motors: Standard motor efficiency - Need for efficient motors - Motor life cycle - Direct Savings and payback analysis - Efficiency evaluation factor.

UNIT V: DOMESTIC UTILIZATION OF ELECTRICAL ENERGY **9**

Domestic utilization of electrical energy: House wiring, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects - Nonlinear and domestic loads - Earthing - Domestic, Industrial and Substation - Introduction to E-Vehicle (Qualitative treatment only).

TOTAL: 45 PERIODS

OUTCOMES

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

- Realize the appropriate type of electric supply system as well as to evaluate the performance of a traction unit
- Create lighting system using LED Technologies
- Identify an appropriate method of heating for any particular industrial application
- Construct an electric connection for any domestic appliance like refrigerator and air conditioner
- Design a battery charging circuit for a specific household application

TEXT BOOKS

1. Wadhwa.C.L, "Generation, Distribution and Utilization of Electrical Energy", New Age International Pvt. Ltd, 3rd Edition, 2015.
2. Gupta.J.B, "Utilization of Electric Power and Electric Traction", S.K.Kataria and Sons, 2nd Edition, 2013.

REFERENCES

1. R.K.Rajput, "Utilisation of Electric Power including electric drives and traction", Laxmi Publications, 2nd Edition, 2016.
2. Dr.Uppal S.L. and Prof.S.Rao, "Electrical Power Systems", Khanna Publishers, New Delhi, 15th Edition, 2014.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105060/ - (Illumination Engineering)
2. https://nptel.ac.in/courses/112/105/112105129/ - (Refrigeration and Air conditioning)

19EEPX19 **ADAPTIVE CONTROL** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Study the definition of adaptive control and methods of adaptation.
- Introduce to linear parameter identification of systems.
- Understand the self-tuning of pid controllers based on parameter identification.
- Study the model reference adaptive control.
- Analyze and design the gain scheduling control systems.

UNIT I: INTRODUCTION **9**

Introduction to adaptive control - Effects of process variations - Adaptive control schemes - Adaptive control problem - Non-parametric identification - Step response method - Impulse response method - Frequency response method.

UNIT II: PARAMETRIC IDENTIFICATION **9**

Linear in parameter models - ARX - ARMAX - ARIMAX - Least square estimation - Recursive least square estimation - Extended least square estimation - Maximum likelihood estimation - Introduction to non-linear systems identification - Pseudo random binary sequence.

UNIT III: SELF-TUNING REGULATOR **9**

Deterministic in-direct self-tuning regulators - Deterministic direct self-tuning regulators - Introduction to stochastic self-tuning regulators - Stochastic indirect self-tuning regulator.

UNIT IV: MODEL REFERENCE ADAPTIVE CONTROLLER **9**

Quality control - Queing assurance and its importance - SQC - Attribute - Sampling inspection with single and double sampling - Control charts - Applications - Numerical examples. TQM: Zero defect concept - Quality circles - Implementation - Applications - ISO quality system - Six sigma.

UNIT V: TUNING OF CONTROLLERS AND CASE STUDIES **9**

Design of gain scheduling controller - Auto-tuning of PID regulator - Stability analysis of adaptive controllers - Application of adaptive control in chemical reactor, distillation column and variable area tank system.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand the effect of parameter variation and principle of adaptive control schemes.
- Distinguish different parametric identification methods.
- Understand deterministic and stochastic self tuning regulators.
- Design of model reference adaptive controller.
- Apply adaptive control schemes for industrial processes.

TEXT BOOKS

1. Karl J. Astrom & Bjorn Wittenmark, "Adaptive Control", Pearson Education (Singapore), 3rd Edition, 2013.
2. Shankar Sastry and Marc Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall, 2nd Edition, 2011.

REFERENCES

1. Chalam, "Adaptive Control Systems: Techniques and Applications", CRC Press, 5th Edition,2018.
2. Landau, I.D., Lozano, R., M'Saad, M., Karimi, A, "Adaptive Control Algorithms, Analysis and Applications", 2nd Edition, Springer, 2011.

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102113/ - (Nonlinear and adaptive control)
2. https://freevideolectures.com/course/4363/ - (Nonlinear-adaptive-control)

19PEEPX20 ENERGY AUDITING AND CONSERVATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Get the current energy scenario of world.
- Learn the methods of energy audit and usage of instruments.
- Understand the methods to improve energy efficiency in electrical systems.
- Impart knowledge on energy management in various industry equipments.
- Study the methodologies of different energy efficient devices.

UNIT I: ENERGY SCENARIO **9**

Principles - Past and present energy scenario of world - Energy consumption in India - Resource availability - Demand supply gap - Energy needs of growing economy - Long term energy scenario - Energy pricing - Energy sector reforms - Energy conservation and its importance - Restructuring of the energy supply sector - Energy strategy for the future - Energy Conservation Act - 2001.

UNIT II: ENERGY MANAGEMENT&AUDIT **9**

Definition - Energy audit - Needs - Types of energy audit - Energy management (audit) approach - Understanding energy costs - Bench marking - Energy performance - Maximizing system efficiencies - Energy audit instruments - Role of Energy manager - Material and Energy balance.

UNIT III: ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS **9**

Electrical system: Electricity billing - Power factor improvement and its benefits - Selection and location of capacitors - Performance assessment of PF capacitors - Distribution and transformer losses - Electric motors: Types - Losses in induction motors - Motor efficiency-Energy saving opportunities with energy efficient motors.

UNIT IV: ENERGY EFFICIENCY IN INDUSTRIALSYSTEMS **9**

Compressed Air System, Fans and blowers, Pumps and Pumping System, Cooling Tower: Types - Performance evaluation - Efficient system operation.

UNIT V: ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS **9**

Maximum demand controllers - Automatic power factor controllers - Energy efficient motors Soft starters with energy saver - Variable speed drives - Energy efficient transformers - Electronic ballast - Occupancy sensors - Energy efficient lighting controls - Energy saving potential of each technology.

TOTAL: 45 PERIODS

OUTCOMES

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

- Know the importance of energy conservation.
- Carryout energy accounting and balancing.
- Suggest the suitable for power factor improvement.
- Design various energy efficient industrial systems.
- Apply the concepts of energy efficient devices in homes and industries.

TEXT BOOKS

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).

REFERENCES

1. Barunkumar. D.E, "Energy Management, Audit and Conservation", Vrinda Publications Private Limited, 2nd Edition, 2018.
2. Amalan Chakrabarti, "Energy Engineering and Management", PHI Learning Private Limited, 2nd Edition, 2019.

E-RESOURCES

1. https://nptel.ac.in/courses/109/106/109106161/ - (Energy Economics and Policy)
2. https://nptel.ac.in/courses/109/101/109101171/ - (Energy Resources, Economics and Environment)

19EEPX34 **ENERGY STORAGE DEVICES** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Explore the fundamentals, technologies and applications of energy storage enabling to identify the optimal solutions to a particular energy storage application/utility.
- Recall the historical context of energy storage technology.
- Recognize the various technical methods of energy storage.
- Determine the performance factors that affect the efficiency of energy storage systems.
- Identify the opportunities for renewable energy systems.
- Learn about the performance, characterization, modeling and design of fuel cells.

UNIT I :STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES **9**

Storage Needs – Variations in Energy Demand – Variations in Energy Supply- Interruptions in Energy Supply - Transmission Congestion - Demand for Portable Energy - Demand and scale requirements - Environmental and sustainability issues.

UNIT II: TECHNICAL METHODS OF STORAGE **9**

Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs) - Kinetic energy (mechanical flywheels) - Thermal energy without phase change passive (adobe)and active(water)-Thermal energy with phase change (ice, molten salts, steam)-Chemical energy (hydrogen, methane, gasoline, coal, oil) - Electrochemical energy (batteries, fuel cells) - Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets) - Different Types of Energy Storage Systems.

UNIT III: PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS **9**

Energy capture rate and efficiency - Discharge rate and efficiency - Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety-Risks of fire, explosion, toxicity - Ease of materials, recycling and recovery - Environmental consideration and recycling, Merits and demerits of different types of Storage.

UNIT IV: APPLICATION CONSIDERATION **9**

Comparing Storage Technologies-Technology options – Performance factors and metrics -Efficiency of Energy Systems - Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium-Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.

UNIT V: HYDROGEN FUEL CELLS AND FLOW BATTERIES **9**

Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations-Operation and Design methods – Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery+Capacitor" Combinations: need, operation and Merits; Level2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation - Applications: Lithium ion batteries, Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.

TOTAL: 45 PERIODS

OUTCOMES

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

- Recollect the historical perspective of energy storage [U]
- Understand the various technical methods of energy storage [U]
- Determine the performance factors of energy storage systems [U]
- Identify applications for renewable energy systems [AP]
- Learn fuel cell performance, characterization and modeling; fuel cell system design [U]

TEXT BOOKS

1. Detlef Stolten,"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", Wiley, 2010.
2. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "Electrochemical Technologies for Energy Storage and Conversion", John Wiley and Sons, 2012.

REFERENCES

1. Francois Beguin and Elzbieta Frackowiak ,"Super capacitors", Wiley, 2013.
2. Doughty Liaw, Narayan and Srinivasan, "Batteries for Renewable Energy Storage", The Electrochemical Society, New Jersy,2010.

E-RESOURCES

1. https://nptel.ac.in/courses/106108058
2. https://nptel.ac.in/courses/112107283

PROFESSIONAL ELECTIVE – V

19EEPX21 **POWER SYSTEMS DYNAMICS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Know the basics of dynamics and stability problems.
- Modeling of synchronous machines.
- Excitation system and speed-governing controllers.
- Small signal stability of a single-machine infinite bus system with excitation system and power system stabilizer.
- Transient stability simulation of multi machine power system.

UNIT I: INTRODUCTION 9

Basics of system dynamics - Numerical techniques - Introduction to software packages to study the responses - Concept and importance of power system stability in the operation and design - Distinction between transient and dynamic stability - Complexity of stability problem in large system - Necessity for reduced models - stability of interconnected systems.

UNIT II: SYNCHRONOUS MACHINE MODELLING 9

Synchronous machine - Flux linkage equations - Park‟s transformation - Per unit conversion- Normalizing the equations - Equivalent circuit - Current space model - Flux linkage state space model - Sub-transient and transient inductances - Time constants - Simplified models (one axis and constant flux linkage) - Steady state equations and phasor diagrams.

UNIT III: MACHINE CONTROLLERS 9

Exciter and voltage regulators - Function and types of excitation systems - Typical excitation system configuration - Block diagram and state space representation of IEEE type 1 excitation system - Saturation function - Stabilizing circuit - Function of speed governing systems - Block diagram and state space representation of IEEE mechanical hydraulic governor and electrical hydraulic governors for hydro turbines and steam turbines.

UNIT IV: TRANSIENT STABILITY 9

State equation for multi machine system with one axis model and simulation - Modelling of multi machine power system with one axis machine model including excitation system and speed governing system and simulation using R-K method of fourth order (Gill‟s technique) for transient stability analysis - Power system stabilizer.

UNIT V: DYNAMIC STABILITY **9**

System response to small disturbances - Linear model of the unregulated synchronous machine and its modes of oscillation - Regulated synchronous machine - Distribution of power impact - Linearization of the load equation for the one machine problem - Simplified linear model - Effect of excitation on dynamic stability - Approximate system representation.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand and analyze power system operation, stability, control and protection.
- Design and modeling of synchronous machines.
- Study about excitation system and speed-governing controllers.
- Understand the concept of transient stability simulation.
- Get knowledge on dynamics stability.

TEXT BOOKS

1. Jan Machowski, Zbigniew Lubosny, Janusz W. Bialek, James R.Bumby, "Power System Dynamics Stability and Control", Wiley, 2nd Edition, 2020.
2. Peter W. Sauer, M. A. Pai, Joe H. Chow , "Power System Dynamics and Stability", Wiley, 2nd Edition, 2017.

REFERENCES

1. M.Pai, "Computer Techniques in Power System Analysis", McGraw Hill Education, 3rd Edition, 2017.
2. James A.Momoh, Mohamed. E. EI-Hawary, "Electric Systems, Dynamics and Stability with Artificial Intelligence applications", Marcel Dekker, USA 1st Edition, 2000.

E-RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102080/ - (Power System Dynamics)
2. https://nptel.ac.in/courses/108/105/108105133/ - (Power System Stability)

19EEPX22 **MICROCONTROLLER BASED SYSTEM DESIGN** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the architecture of PIC controller.
- Educate on use of interrupts and timers.
- Teach on the peripheral devices for data communication and transfer.
- Initiate the functional blocks of ARM processor.
- Impart knowledge on the architecture of ARM Processors.

UNIT I: INTRODUCTION TO PIC MICROCONTROLLER **9**

Introduction to PIC Microcontroller - PIC 16C6x and PIC16C7x Architecture - IC16cxx -Pipelining - Program Memory considerations - Register File Structure - Instruction Set - Addressing modes - Simple Operations.

UNIT II: INTERRUPTS AND TIMER **9**

PIC micro controller Interrupts - External Interrupts - Interrupt Programming - Loop time subroutine Timers - Timer Programming - Front panel I/O - Soft Keys - State machines and key switches - Display of Constant and Variability strings.

UNIT III: PERIPHERALS AND INTERFACING **9**

I^2C Bus for Peripherals Chip Access - Bus operation-Bus subroutines - Serial EEPROM -Analog to Digital Converter - UART- Baud rate selection - Data handling circuit - Initialization - LCD and keyboard Interfacing - ADC - DAC -Sensor Interfacing.

UNIT IV: INTRODUCTION TO ARM PROCESSOR **9**

Architecture - ARM programmer"s model - ARM Development tools - Memory Hierarchy - ARM AssemblyLanguage Programming - Simple Examples - Architectural Support for Operating systems.

UNIT V: ARM ORGANIZATION **9**

3 Stage Pipeline ARM Organization - 5Stage Pipeline ARM Organization - ARM Instruction Execution - ARM Implementation - ARM Instruction Set - ARM coprocessor interface - Architectural support for High Level Languages - Embedded ARM Applications.

TOTAL: 45 PERIODS

OUTCOMES

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

- Describe the architectures of processors.
- Acquire knowledge on Interrupts and timers.
- Use the importance of Peripheral devices for data communication.
- Design and develop the basics to ARM Processor.
- Obtain knowledge in Architecture of ARM processors.

TEXT BOOKS

1. M. Bates, "PIC Microcontrollers", Newnes, 3rd Edition, 2011.
2. Andrew N.Sloss, Dominic Symes, Chris Wright, "ARM Developer"s Guide", Elsevier, 1st Edition, 2010

REFERENCES

1. W.A. Smith, "ARM Microcontroller Interfacing: Hardware and Software", Elketor, 1st Edition, 2010.
2. Kenneth Ayala, "The 8051 Microcontroller & Embedded Systems Using Assembly and C", Cengage Learning, 1st Edition,2010.

E-RESOURCES

1. https://nptel.ac.in/courses/117/104/117104072/ - (PIC Microcontroller)
2. https://nptel.ac.in/courses/117/106/117106111/ - (ARM Processor)

19EEPX23 **BIOMEDICAL INSTRUMENTATION** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce fundamentals of biomedical engineering
- Understand the diagnostic process in biomedical systems
- Learn measurement of certain important electrical and non-electrical parameters
- Recognize the basic principles in imaging techniques
- Acquire knowledge on life assisting and therapeutic devices

UNIT I: FUNDAMENTALS OF BIOMEDICAL ENGINEERING **9**

Cell and its structure - Resting and Action Potential - Nervous system and its fundamentals - Basic components of a biomedical system - Cardiovascular systems- Respiratory systems - Physiological signals and transducers - Transducers selection criteria - Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors.

UNIT II: NON ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURE **9**

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements - Electromagnetic and ultrasound blood flow measurements - Spirometer - Photo Plethysmography - Body Plethysmography - Blood Gas analysers - pH of blood - measurement of blood pCO2, pO2 - Finger-tip oxymeter - ESR, GSR measurements.

UNIT III: ELECTRICAL PARAMETERS ACQUISITIONAND ANALYSIS **9**

Electrodes - Limb electrodes - Floating electrodes - Pregelled disposability electrodes - Micro, needle and surface electrodes - Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - ECG - EEG - EMG - ERG - Lead systems and recording methods and problem - Electrical safety in medical environment, shock hazards - Leakage current - Instruments for checking safety parameters of biomedical equipment.

UNIT IV: FUNDAMENTALS OF BIOMEDICAL ENGINEERING **9**

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

UNIT V: LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES **9**

Pacemakers - Defibrillators - Ventilators - Nerve and muscle stimulators - Diathermy - Heart - Lung machine - Audio meters - Dialysers - Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery - Orthopedic prostheses fixation.

OUTCOMES

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

- Understand the physiology of biomedical systems.
- Analyze the various pulmonary measurements, respiratory rate measurement procedures.
- Gain knowledge on different types of electrodes and electrical hazards.
- Understand applications of imaging instruments and the modalities involved in each techniques.
- Identify the medical assistance/techniques, robotic and therapeutic equipments.

TEXT BOOKS

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 3rd Edition, 2017
2. Kanpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2nd Edition,2014.

REFERENCES

1. M.Arumugam, "Bio-Medical Instrumentation", Anuradha Agencies, 2nd Edition, 2013.
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2nd Edition, 2010.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105101/ - (biomedical signal processing)
2. https://nptel.ac.in/courses/102/107/102107058/ - (biomedical nanotechnology)

19EEPX24 **SMART GRID** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the concepts of Smart Grid and its present developments.
- Recognize the concepts of substation automation and wide area monitoring system.
- Realize distributed generation and smart consumption in smart grid.
- Make use of advanced metering infrastructure in real time scenario.
- Know the regulations and market models for smart grid.

UNIT I: INTRODUCTION TO SMART GRID **9**

Evolution of electric Grid - Concept definitions - Need for smart grid - Difference between Conventional grid and smart grid - Opportunities & Barriers of Smart Grid - Functions and benefits - Present development and international policies in smart grid.

UNIT II: SMART GRID TECHNOLOGIES **9**

Technology Drivers - Smart energy resources Smart Sensors, Smart storage, SMES - Smart substations-Home & building automation - Substation automation - Feeder automation - Transmission systems: EMS - FACTS and HVDC - Wide area monitoring - Protection and control - Distribution systems: DMS - Volt/VAR control - Fault Detection - Isolation and service restoration - Outage management - High-Efficiency distribution transformers - Phase shifting transformers - Plug in Hybrid Electric Vehicles(PHEV).

UNIT III: SMART METERS AND ADVANCED METERING INFRASTRUCTURE **9**

Introduction to smart meters - Advanced metering infrastructure (AMI) drivers and benefits - AMI protocols - standards and initiatives - AMI needs in the smart grid - Phasor measurement Unit (PMU) - Intelligent electronic devices (IED) & their application for monitoring & protection.

UNIT IV: POWER QUALITY MANAGEMENT IN SMART GRID **9**

Power quality & EMC in smart grid - Power quality issues of grid connected renewable energy sources - Power quality conditioners for smart grid - Web based power quality monitoring - Power quality audit - Concept of micro grid - Need & applications of micro grid - Formation of micro grid - Protection & control of micro grid.

UNIT V: HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS **9**

Local area network (LAN) - House area network (HAN) - Wide area network (WAN) - Broad band over power line (BPL) - IP based protocols - Basics of web service and cloud computing to make smart grids smarter - Cyber security for smart grid.

TOTAL: 45 PERIODS

OUTCOMES

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

- Develop more understanding on the concepts of Smart Grid and its present developments.
- Learn about different Smart Grid technologies.
- Acquire knowledge about different smart meters and advanced metering infrastructure.
- Knowledge on power quality management in Smart Grids.
- Understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

TEXT BOOKS

1. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRCPress, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley2015.

REFERENCES

1. K S Manoj, "Smart Grid: Concepts to Design", Notion Press; 1st Edition, 2019.
2. Jha I S, "Smart Grid Fundamentals & Applications", New Age International Publishers; 1st Edition, 2019.

E-RESOURCES

1. https://nptel.ac.in/courses/108/107/108107113/ - (Introduction to smart grid)
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee42/ - (smart grid applications)

19EEPX25 **HIGH VOLTAGE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Various types of over voltages in power system and protection methods.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Generation of over voltages in laboratories.
- Different technique of measuring over voltage.
- Testing of power apparatus in high voltage system.

UNIT I: OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS **9**

Causes of over voltages and its effects on power system – Lightning mechanism, energy in lightning – Switching surges and temporary over voltages – Corona and its effects – Bewley lattice diagram- Protection against over voltages.

UNIT II: DIELECTRIC BREAKDOWN **9**

Properties of Dielectric materials – Gaseous breakdown in uniform and non-uniform fields - Corona discharges - Vacuum breakdown - Conduction and breakdown in pure and commercial liquids – Maintenance of oil Quality - Breakdown mechanisms in solid and composite dielectrics – Applications of insulating materials in electrical equipments.

UNIT III: GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS **9**

Generation of High DC voltage: Rectifiers, voltage multipliers, vandigraff generator - Generation of high impulse voltage: single and multistage Marx circuits - Generation of nonstandard impulse voltage and very fast transients voltage (VFTO) - Generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil - Generation of switching surges - Generation of impulse currents - Triggering and control of impulse generators.

UNIT IV: MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS **9**

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

UNIT V: HIGH VOLTAGE TESTING & INSULATION COORDINATION **9**

High voltage testing of electrical power apparatus as per International and Indian standards - Power frequency, impulse voltage and DC testing of Insulators - Circuit breakers - Bushing, isolators and transformers - Insulation Coordination & testing of cable.

TOTAL: 45 PERIODS

OUTCOMES

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

- Explain the transients in power system.
- Select the suitable insulation for an electrical power equipment.
- Design and simulation of generate impulse voltage.
- Understand measurement of high voltage.
- Different methods of insulation coordination in high voltage devices.

TEXT BOOKS

1 S.Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education Pvt. Ltd., New Delhi, 6th Edition, 2020.

2 Ravindra roar and H.C.WolfgangMosch, "High voltage Insulation Engineering", New Age International Publishers, 1st Edition, 2016.

REFERENCES

1. W.A Auguesteen and K.R Vadivelu, "Principles of High Voltage Engineering", Notion Publishers, 1st Edition,2019.
2. C.L. Wadhwa, "High voltage Engineering", New Age International Publishers, 3rd Edition, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/108/104/108104048/ - (High Voltage Engineering)
2. https://nptel.ac.in/courses /108/104/108104013/ - (High Voltage DC Transmission)

19EEPX35 **ELECTRICAL CAD** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Develop the ability to produce simple electrical engineering drawing and sketches based on electrical components.
- Develop the means for communication of ideas, thoughts and design of objects though fundamental features of Electrical CAD
- Know the use of 2D drawing tools and present electrical engineering drawings and sketches
- Examine the photographs and drawings of three phase AC armature windings.
- Learn about transformer manufacturing and construction designs.
- Learn half section elevation and side view drawings for DC machines and induction motors.

UNIT I : INTRODUCTION **9**

Introduction to AutoCAD. Preparation of simple 2D AutoCAD drawings using the commands/tools of AutoCAD -Draw, Edit, View, Modify, dimension style, plotting, object and layer selection. Drawing of Electrical symbols and introduction to symbol libraries and icons of Electrical CAD.

UNIT II: PREPARATION OF ARMATURE WINDINGS **9**

Simplex lap / wave dc armature windings with end connections, indicating the brush positions. Preparation of Simplex lap /wave DC armature windings with equalizer rings/ dummy coils in AutoCAD. Simplex lap/ wave, integral/ fractional slot, double layer three phase ac armature windings with full pitched/ short chorded coils. Preparation of Mush type and concentric bifurcated/ unbifurcated 2 tier/ 3 tier single layer three phase ac armature winding in AutoCAD.

UNIT III: TRANSFORMERS **9**

Sectional plan and elevation of a transformer limb with windings. Sectional plan and elevation of the core assembly of a power transformer. Sectional plan and elevation of a distribution transformer tank with its accessories. Sketches of capacitor and oil filled type transformer bushings.

UNIT IV: DC MACHINES **9**

Half sectional Elevation and side view of armature with commutator including the connections. Preparation of Sectional Elevation and side view of yoke and pole assembly with main field winding and interpole windings in AutoCAD. Preparation of Half Sectional Elevation of a DC machine with field, armature and commutator including connections in AutoCAD.

UNIT V: INDUCTION MOTORS **9**

Preparation of Half Sectional elevation of slip ring induction motor with slip rings and brushes in AutoCAD. Half sectional front and side elevation of squirrel cage induction motor.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understand about 2D drawing tools effectively and able to present electrical engineering drawings and sketches. [A]
- Analyze the images and drawings related in three phase AC armature windings engineering perspective. [A]
- Understand about manufacturing and construction drawings used in transformer. [A]
- Understand about half section elevation and side view drawings related to DC machines. [A]
- Understand about half section elevation and side view drawings related to induction motors. [A]

TEXT BOOKS

1. Narang K.L., A Text Book of Electrical Engineering Drawing, Tech India Publications, 2016.
2. Bhattacharya S.K, Electrical Engineering Drawing, 2nd ed., Wiley Eastern., 2009

REFERENCES

1. Engineering Drawing and Graphics+Auto CAD- K. Venugopal. New Age International Publishers.
2. E. Finkelstein -AutoCAD 2007 Bible-Wiley Publishing Inc.2007

E-RESOURCES

1. https://www.udemy.com/course/lear-autocad-electrical-from-scratch/

https://www.tutorialspoint.com/learn_autocad_electrical_video_lecture_free/index.asp

PROFESSIONAL ELECTIVE – VI

19EEPX26 COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Initiate the importance of computer aided design method.
- Provide basic electromagnetic field equations and the problem formulation.
- Get familiarized with Finite Element Method as applicable for Electrical Engineering.
- Introduce the organization of a typical CAD package.
- Design of different Electrical apparatus.

UNIT I: INTRODUCTION **9**

Conventional design procedures - Limitations - Need for field analysis based design - Review of Basic principles of energy conversion - Development of Torque/Force.

UNIT II: MATHEMATICAL FORMULATION OF FIELD PROBLEMS **9**

Electromagnetic Field Equations - Magnetic Vector/Scalar potential - Electrical vector /Scalar potential - Stored energy in Electric and Magnetic fields - Capacitance - Inductance- Laplace and Poisson‟s Equations - Energy functional.

UNIT III: PHILOSOPHY OF FEM **9**

Mathematical models - Differential/Integral equations - Finite Difference method - Finite element method - Energy minimization - Variation method - 2D field problems -Discretisation Shape functions - Stiffness matrix - Solution techniques.

UNIT IV: CAD PACKAGES **9**

Elements of a CAD System -Preprocessing - Modeling - Meshing - Material properties - Boundary Conditions - Setting up solution - Post processing.

UNIT V: DESIGN APPLICATIONS **9**

Voltage Stress in Insulators - Capacitance calculation - Design of Solenoid Actuator - Inductance and force calculation - Torque calculation in Switched Reluctance Motor- BLDC Motor.

TOTAL: 45 PERIODS

OUTCOMES

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

- Learn the importance of computer aided design method.
- Apply basic electromagnetic field and Magnetic field equations.
- Design various electro-mechanical devices.
- Interpret drawings, draw interferences and workout other technical details.
- Simulate/Test simple electrical and electronics circuits using Simulation software.

TEXT BOOKS

1. Nicola Bianchi, "Electrical Machine Analysis Using Finite Elements", CRC Press,Taylor and Francis, 2015.
2. David Griffiths, "Introduction to Electrodynamics", Addison-Wesley, 2012.

REFERENCES

1. M.N.O. Sadiku and S.V. Kulkarni, "Principles of electromagnetics", Oxford University Press, 6th Edition 2015
2. P.Seshu, "Finite Element Analysis", PHI Learning private Limited, New Delhi ,2012

E-RESOURCES

1. http://www.nptelvideos.in/2012/12/computer-aided-design.html - (Computer Aided Design)
2. https://onlinecourses.nptel.ac.in/noc20_ee81/ - (Electrical Equipment & Machines: Finite ElementAnalysis)

19EEPX27 DYNAMIC MODELING AND ANALYSIS OF ELECTRICAL MACHINES **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Acquire knowledge in electromechanical energy conversion of various types of electrical machines.
- Design and modeling of synchronous machines.
- Analyze steady state operations of rotor with various loading conditions.
- Learn and develop the torque equations of PMBLDC machine.
- Get knowledge in computer simulation of electrical machines.

UNIT I: BASIC PRINCIPLE FOR ELECTRICAL MACHINE ANALYSIS **9**

Introduction - Magnetically coupled circuits - Electromechanical energy conversion - Machine Windings - Airgap MMF - Winding Inductances - Voltage Equations.

UNIT II: SYMMETRICAL INDUCTION MACHINES **9**

Voltage and torque equations in machine variables - Equation of transformation for rotor circuits - Voltage & torque equations in arbitrary reference frame variables - Per unit system - Analysis of steady state equations - Free acceleration characteristics viewed from various reference frames - Dynamic model and analysis for sudden change in load torque - Dynamic model & analysis during three phase fault at the machine terminals - Unbalanced operation at symmetrical Induction Machines - Symmetrical component theory and analysis of unbalanced stator voltages - Analysis of steady state operation with unbalanced rotor conditions.

UNIT III: SYNCHRONOUS MACHINES **9**

Voltage & torque equations in machine variables - Stator voltage equations in arbitrary reference frame variables - Voltage equations in rotor reference frame variables - Park's equation - Torque equation - Rotor angle and angle between rotors - Per unit system - Analysis of steady state operation - Dynamic performance during a sudden change in input torque.

UNIT IV: ANALYSIS OF PM BLDC MACHINES **9**

Introduction to PM BLDC machine - Voltage and torque equations in machine variables - Analysis of steady state operations.

UNIT V: COMPUTER SIMULATION OF ELECTRIC MACHINES **9**

Simulation of symmetrical Induction and synchronous machines - Thermal model of induction machine - Induction machine dynamics during starting, braking and reversing.

TOTAL: 45 PERIODS

OUTCOMES

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

- Learn about the basic concepts of AC/ DC machine modeling.
- Study about the dynamic modeling and phase transformation.
- Analyze various methodologies in small signal machine modeling.
- Understand the modeling of synchronous machine modeling.
- Learn the performance and dynamic modeling of synchronous machines.

TEXT BOOKS

1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & control", Pearson Publications, 1st Edition, 2015.
2. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 3rd Edition, 2016.

REFERENCES

1. P.S.Bimbra, "Generalized Theory of Electrical Machines", Khanna publications, 7th Edition, 2015.
2. CheeMunOng, "Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications, 2014.

E-RESOURCES

1. http://nptel.ac.in/courses/108106023/ - (Modeling and Analysis of Electrical Machines)
2. https://freevideolectures.com/course/3527/ - (Dynamic Modeling of Electrical Machines)

19EEPX28 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Provide knowledge about the stand alone and grid connected renewable energy systems
- Analyze and comprehend the Electrical Machines for Renewable Energy Conversion.
- Design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- Study and comprehend the various operating modes of wind electrical generators and solar energy systems.
- Develop maximum power point tracking algorithms.

UNIT I: INTRODUCTION 9

Environmental aspects of electric energy conversion - Impacts of renewable energy generation on environment - Qualitative study of different renewable energy resources - Solar - Wind - Ocean - Biomass - Fuel cell - Hydrogen energy systems and hybrid renewable energy systems.

UNIT II: ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Reference theory fundamentals - Principle of operation and analysis - IG - PMSG - SCIG and DFIG.

UNIT III: POWER CONVERTERS 9

Solar - Block diagram of solar photo voltaic system - Principle of operation - Line commutated converters - Boost - Buck and buck-boost converters - Selection of inverter - battery sizing - Wind - Three phase AC voltage controllers - AC-DC-AC converters - Grid Interactive Inverters - Matrix converters.

UNIT IV: ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system - Grid connection Issues - Grid integrated PMSG - SCIG Based WECS -Grid Integrated solar system - HOMER Software for Renewable Energy Base Station Design.

UNIT V: HYBRID RENEWABLEENERGY SYSTEMS 9

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

TOTAL: 45 PERIODS

OUTCOMES

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

- Examine the various types of renewable energy sources.
- Acquiring the knowledge about the performance of IG, PMSG, SCIG and DFIG.
- Create different power converters namely AC to DC , DC to DC and AC to AC converters forrenewable energy sources.
- Analyze various operating modes of wind electrical generators and solar energy system.
- Strengthen the knowledge about maximum power point tracking algorithms.

TEXT BOOKS

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer. "Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration". Springer Science & Business, 2nd Edition, 2013.
2. Andrzej M.Trzynnadlowski, "Introduction to Modern Power Electronics", Wiley India Pvt. Ltd, 2nd Edition, 2012.

REFERENCES

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley-IEEE Press, 3rd Edition, 2019.
2. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems" , John Wiley and Sons, Ltd., 2011.

E- RESOURCES

1. https://nptel.ac.in/courses/121/106/121106014/ - (Renewable Energy)
2. https://www.pdfdrive.com/ - (power-electronics-for-renewable-energy-systems-transportation-and-industrial-applications)

19EEPX29 **MODERN POWER CONVERTER** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart knowledge on Switched mode power supplies.
- Provide an adequate knowledge about design and analysis of AC to DC converters.
- Learn about the concept of cascade multilevel inverter.
- Get basic ideas of single-phase bi-directional controllers with R,L and R-L loads, three phasecontrollers.
- Study about soft switching converter technique.

UNIT I: SWITCHED MODE POWER SUPPLIES **9**

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

UNIT II: AC-DC CONVERTERS **9**

Single and three phase topologies - Switching techniques - High input power factor.reduced input current harmonic distortion,Improved efficiency, with and without input-output isolation, performance indices design examples. Effect of source impedance and overlap ,reactive power and power balance in converter circuits.

UNIT III: DC-AC CONVERTERS **9**

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

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

Matrix converters. Basic topology of matrix converter- Modulation techniques - Scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter with DC link converters.

UNIT V: SOFT SWITCHING POWER CONVERTER **9**

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

TOTAL: 45 PERIODS

OUTCOMES

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

- Learn about design the converter and closed loop performance.
- Assess the performance of power converters using AC-DC Converters.
- Gain the knowledge about diode clamped inverters.
- Understand the analysis of modulation techniques.
- Use the importance of hard switched and soft switched converters.

TEXT BOOKS

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 4th Edition, 2017.
2. P.C Sen., "Modern Power Electronics", S.Chand Publications, 2nd Edition, 2015.

REFERENCES

1. Mohan N.,Undeland and Robbins, "Power Electronics-Converters, Applications and Design",JohnWiley and sons, Inc., New York, 2nd Edition,2019.
2. Agarwal, "Power Electronics: Converters, Applications, and Design", 3rd Edition, Prentice Hall India, 2013.

E- RESOURCES

1. https://nptel.ac.in/courses/108/105/108105066/ - (Power converter)
2. https://nptel.ac.in/courses/108/107/108107128/ - (Advanced power electronics control)

19EEPX30 **MICRO ELECTRO MECHANICAL SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Provide knowledge of semiconductors and solid mechanics to fabricate mems devices.
- Understand about various sensors and actuators.
- Introduce different materials used for mems.
- Educate on the rudiments of micro fabrication techniques.
- Acquire knowledge on applications of mems to disciplines beyond electrical and mechanical engineering.

UNIT I: INTRODUCTION **9**

Intrinsic Characteristics of MEMS - Energy Domains and Transducers - Sensors and ActuatorsIntroduction to Micro fabrication - Silicon based MEMS processes - New Materials - Review of Electrical and Mechanical concepts in MEMS - Semiconductor devices - Stress and strain analysis - Flexural beam bending - Torsional deflection.

UNIT II: SENSORS AND ACTUATORS-I **9**

Electrostatic sensors - Parallel plate capacitors - Applications - Interdigitated Finger capacitor Comb drive devices - Micro Grippers - Micro Motors - Thermal Sensing and Actuation - Thermal expansion - Thermal couples - Thermal resistors - Thermal Bimorph - Applications - Magnetic Actuators - Micromagnetic components - Case studies of MEMS in magnetic actuators - Actuation using Shape MemoryAlloys.

UNIT III: SENSORS AND ACTUATORS-II **9**

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements- Applications to Inertia, Pressure, Tactile and Flow sensors - Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials - Applications to Inertia, Acoustic, Tactile and Flow sensors.

UNIT IV: MICRO MACHINING **9**

Silicon Anisotropic Etching - Anisotrophic Wet Etching - Dry Etching of Silicon - Plasma Etching - Deep Reaction Ion Etching (DRIE) - Isotropic Wet Etching - Gas Phase Etchants - Case studies - Basic surface micro machining processes - Structural and Sacrificial Materials - Acceleration of sacrificial Etch - Striction and Antistriction methods - LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V: POLYMER AND OPTICAL MEMS **9**

Polymers in MEMS- Polimide - SU-8 - Liquid Crystal Polymer (LCP) - PDMS - PMMA – Parylene - Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS.

TOTAL: 45 PERIODS

OUTCOMES

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

- Integrate the knowledge of semiconductors and solid mechanics required to fabricate MEMS devices.
- Differentiate the need of various sensors and actuators in MEMS.
- List the types of different materials used for MEMS.
- Recommend the various Micro fabrication techniques.
- Understand the various applications of MEMS.

TEXT BOOKS

1. Chang Liu, "Foundations of MEMS", Pearson Education, 2nd Edition, 2011.
2. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture", Tata McGraw Hill Education, 2nd Edition, 2017.

REFERENCES

1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2nd Edition, 2010.
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & SonS Limited, 2nd Edition, 2013.

E-RESOURCES

1. https://www.memsnet.org/about/ - (Micro Electro Mechanical System Design)
2. https://www.mems-exchange.org/ - (Micro Sensors MEMS)

19EEPX36 **WEARABLE TECHNOLOGIES** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Expose the development of wearable devices and its implications on various sectors.
- Recognize the necessity for wearable device development and its impact on numerous sectors.
- Understand the biomedical applications of wearable inertial sensors.
- Understand the use of biochemical and gas sensors as wearable devices.
- Know the use of various wearable locomotive tools for safety, security, navigation, and other current uses.

UNIT I : INTRODUCTION TO WEARABLE DEVICES **9**

Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview- sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

UNIT II: WEARABLE INERTIAL SENSORS **9**

Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection, Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients. Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

UNIT III: WEARABLE DEVICES FOR HEALTHCARE **13**

Wearable Bioelectric impedance devices for Galvanic skin response; Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode-Skin Interface; Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, electrodes and instrumentation; Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement – wearable surface electrodes, SEMG Signal Conditioning, Applications.

Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Study of flexible and wearable Piezo resistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles – thermistor, infrared radiation, thermopile, Modality of measurement wearable, adhesive/tattoo type. Conductive textile electrodes, Knitted Piezo resistive Fabric (KPF) sensors.

UNIT IV: WEARABLE CAMERAS & MICROPHONES **9**

Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones,

Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials.

UNIT V: OTHER WEARABLE DEVICES **9**

Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist, forearm and feet, vests and belts, head-mounted devices. Wearable devices with Global Positioning System (GPS) integration for tracking and navigation. Wearable Optical Sensors -chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture.

TOTAL: 45 PERIODS

OUTCOMES

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

- Identify and understand the need for development of wearable devices and its influence on various sectors. [U]
- Discuss the applications of various wearable inertial sensors for biomedical applications [U]
- Discuss and analyze the usage of various biochemical and gas sensors as wearable devices [AN]
- Identify the use of various wearable locomotive tools for safety and security, navigation & acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications. [U]
- Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistive devices. [AP]

TEXT BOOKS

1. Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018.
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.

REFERENCES

1. Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.
2. "Wearable Electronics Sensors - For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015.

E-RESOURCES

1. https://nptel.ac.in/courses/108108123
2. https://www.coursera.org/lecture/wearable-technologies/introduction-to-wearable-technology-e0kP5

OPEN ELECTIVE – I

19EEOX01 FLEXIBLE AC TRANSMISSION SYSTEMS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the reactive power control techniques.
- Study the static VAR compensators and their applications.
- Provide knowledge on Thyristor controlled series capacitors.
- Educate on STATCOM devices.
- Impart knowledge on FACTS controllers.

UNIT I: INTRODUCTION **9**

Real and reactive power control in electrical power transmission lines - Loads & system compensation - Uncompensated transmission line - Shunt and series compensation.

UNIT II: STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS **9**

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

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

Operation of the TCSC - Different modes of operation - Modelling of TCSC - Variability reactance model - Modelling for power flow and stability studies - Applications: Improvement of the system stability limit - Enhancement of system damping.

UNIT IV: VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS **9**

Static Synchronous Compensator (STATCOM) - Principle of operation - V-I characteristics - Applications: Steady state power transfer - Enhancement of transient stability - Prevention of voltage instability - SSSC - Operation of SSSC and the control of power flow - Modelling of SSSC in load flow and transient stability studies - Dynamic voltage restorer (DVR).

UNIT V: ADVANCED CONTROLLERS **9**

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

TOTAL: 45 PERIODS

OUTCOMES

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

- Differentiate between shunt and series compensation.
- Design the static VAR compensator regulator.
- Model the thyristor controller series capacitor.
- Analyze the performance of steady state and transients of FACTS controllers.
- Ability to apply the advanced FACTS controllers in power system.

TEXT BOOKS

1. R.Mohan Mathur, Rajiv K.Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, 2nd Edition, 2011.
2. Narain G.Hingorani, "Understanding FACTS - Concepts and Technology of Flexible AC Transmission Systems", Wiley India Private Limited, 2nd Edition, 2011.

REFERENCES

1. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, 2nd Edition, 2016.
2. Bjarne R. Anderson, "Flexible A.C.Transmission Systems", Springer, 1st Edition, 2020.

E-RESOURCES

1. https://www.infocobuild.com/education/audio-video-courses/electronics/flexible-AC- Transmission systems devices-IIT-Roorkee / lecture-37.html - (FACTS Devices)
2. https://nptel.ac.in/courses/108/107/108107114/ - (FACTS Devices)

19EEOX02 ELECTRICAL ENERGY AUDITING AND CONSERVATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Familiarize about energy conservation.
- Acquire the knowledge of energy conservation measures in thermal systems.
- Impart knowledge in energy conservation in electrical systems.
- Utilize the available resources in optimal ways.
- Learn the methods of energy audit and usage of instruments.

UNIT I: INTRODUCTION TO ENERGY CONSERVATION 9

Principles - Past and present energy scenario of world - Energy consumption in India - Resource availability - Demand supply gap - Environmental aspects - Energy conservation act - Standards and labeling - Designated consumers.

UNIT III: ENERGY CONSERVATION IN THERMAL SYSTEMS 9

Steam systems - Boilers - Blow down control - Furnaces - Thermic fluid heaters - Steam traps - Insulators and refractories - Cooling tower - Air pressure control - Waste heat recovery - Cogeneration.

UNIT III: ENERGY CONSERVATION IN ELECTRICAL SYSTEMS 9

Components of EB billing - Types of tariff - HT and LT supply - Transformers - Cable selection - Power factor improvement - Capacitors - Harmonics - Electric motors - Efficiency - Energy efficient motors - Variable speed drives - Lighting - Types - Efficacy - LED.

UNIT IV: ENERGY CONSERVATION IN INDUSTRIES 9

Pumps - Fans - Blowers - Compressed air systems - Refrigeration and air conditioning systems - Cooling towers - DG sets.

UNIT V: ENERGY AUIDT AND ENERGY ECONOMICS 9

Energy audit - Needs - Types - Benefits - Methodology and barriers - Role of energy managers - Instruments for energy auditing; Energy economics - Discount rate - Depreciation cost - Payback period - Internal rate of return - Net present value - Life cycle costing - Case study.

TOTAL: 45 PERIODS

OUTCOMES

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

- Analyze the energy data of industries.
- Suggest the methodologies for energy savings in thermal systems.
- Quantify the energy conservation opportunities in electrical systems.
- Identify and evaluate the energy conservation in different industrial equipments.
- Carryout energy accounting and balancing.

TEXT BOOKS

1. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", CRC Press, 7th Edition, 2014.
2. Barunkumar.D.E, "Energy Management, Audit and Conservation", Vrinda Publications Private Limited, 2nd Edition, 2018.

REFERENCES

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Amalan Chakrabarti, "Energy Engineering and Management", PHI Learning Private Limited, 1st Edition, 2011.

E-RESOURCES

1. https://nptel.ac.in/courses/109/106/109106161/ - (Energy Economics and Policy)
2. https://nptel.ac.in/courses/109/101/109101171/ - (Energy Resources, Economics and Environment)

19EEOX03 **ADVANCED ELECTRIC DRIVES** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the different topologies PWM converter and inverter.
- Study and analyze the operation of Induction motor drives.
- Learn the performance of Synchronous motor drives.
- Understand the operations and performances of special drives.
- Impart knowledge on Construction, principle of operation and performance of DSP based motion control.

UNIT I: POWER CONVERTERS FOR AC DRIVES **9**

PWM control of inverter - Selected harmonic elimination - Space vector modulation - Current control of VSI - Three level inverter - Different topologies - SVM for 3 level inverter - Diode rectifier with boost chopper - PWM converter as line side rectifier - Current fed inverters with self- commutated devices - Control of CSI - H bridge as a 4-Q drive.

UNIT II: INDUCTION MOTOR DRIVES **9**

Different transformations and reference frame theory - Modelling of induction machines - Voltage fed inverter control - V/F control - Vector control - Direct torque and flux control (DTC).

UNIT III: SYNCHRONOUS MOTOR DRIVES **9**

Modeling of synchronous machines - Open loop Vv/f control - Vector control - Direct torque control - CSI fed synchronous motor drives.

UNIT IV: PERMANENT MAGNET MOTOR DRIVES AND SWITCHED RELUCTANCE MOTOR DRIVES **9**

Introduction to various PM motors - BLDC and PMSM drive configuration - Comparison - Block diagrams - Speed and torque control in BLDC and PMSM - Evolution of switched reluctance motors - Various topologies for SRM drives - Comparison - Closed loop speed and torque control of SRM.

UNIT V: DSP BASED MOTION CONTROL **9**

Use of DSPs in motion control - Various DSPs available - Realization of some basic blocks in DSP for implementation of DSP based motion control.

TOTAL: 45 PERIODS

OUTCOMES

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

- Analyze the operation of power electronic converters and their control strategies.
- Model the induction motor drives.
- Design the synchronous motor drives.
- Select the suitable drive for particular application.
- Design DSP based motion control.

TEXT BOOKS

1. B. K. Bose, "Modern Power Electronics and AC Drives", Prentice Hall of India, 1st Edition, 2003.
2. P.C.Krause, O.Wasynczuk and S.D.Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 1st Edition, 2013.

REFERENCES

1. H. A.Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2nd Edition, 2019.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 1st Edition, 2009.

E-RESOURCES

1. https://nptel.ac.in/courses/108/104/108104011/ - (Fundamentals of Electric Drives)
2. https://nptel.ac.in/courses/108/104/108104140/ - (Advanced Electric Drives)

19EEOX04 **DIGITAL CONTROL SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

2. Provide knowledge on basic system modeling.
3. Obtain discrete representation of LTI systems.
4. Analyze the stability of open loop and closed loop discrete-time systems.
5. Design and analyze digital controllers.
6. Understand the state feedback and output feedback controllers.

UNIT I: DISCRETE REPRESENTATION OF CONTINUOUS SYSTEMS **9**

Basics of digital control Systems - Discrete representation of continuous systems - Sample and hold circuit - Mathematical modeling of sample and hold circuit - Effects of sampling and quantization - Choice of sampling frequency - ZOH equivalent.

UNIT II: DISCRETE SYSTEM ANALYSIS **9**

Z-Transform and Inverse Z Transform for analyzing discrete time systems - Mapping from s -plane to z plane - Solution of Discrete time systems - Time response of discrete time system - Stability analysis using bilinear transformation - Design of digital control system with dead beat response - Practical issues with dead beat response design.

UNIT III: STATE SPACE APPROACH FOR DISCRETE TIME SYSTEMS **9**

State space models of discrete systems - State space analysis - Lyapunov Stability - Controllability and observability analysis - Effect of pole zero cancellation on the controllability & observability.

UNIT IV: DESIGN OF DIGITAL CONTROL SYSTEM **9**

Design of Discrete PID Controller - Design of discrete state feedback controller - Design of set point tracker - Design of Discrete Observer for LTI System - Design of Discrete compensator.

UNIT V: DISCRETE OUTPUT FEEDBACK CONTROL **9**

Design of discrete output feedback control - Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

TOTAL: 45 PERIODS

OUTCOMES

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

- Have in-depth knowledge and critical understanding of the theory and principles of digital control systems and their applications.
- Analyze the behavior of a discrete system in time domain and frequency domain.

- Design and synthesize controllers that will be implemented using digital hardware.
- Apply digital control systems principles and its techniques to discrete time systems.
- Model the discrete output feedback control design.

TEXT BOOKS

1. K. Ogata, "Discrete-Time Control Systems", Pearson Education India , 2nd Edition, 2015.
2. M.Gopal, "Digital Control Engineering", New Age International Private Limited, 2nd Edition, 2014.

REFERENCES

1. G.F.Franklin, J.D.Powell and M.L.Workman, "Digital Control of Dynamic Systems", Ellis-Kagle Press, 3rd Edition,2019.
2. B.C. Kuo, "Digital Control System", Oxford University Press, 2nd Edition, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/108/103/108103008/ - (Digital Control System)
2. https://nptel.ac.in/courses/108/106/108106024/ - (Non Linear Control System)

19EEOX05 **POWER SYSTEM DYNAMICS AND CONTROL** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the power system dynamics and control.
- Educate on generation control loop.
- Study transient stability problems.
- Study the power system model for low frequency oscillation studies.
- Impart knowledge on various methods of voltage stability problem.

UNIT I: INTRODUCTION **9**

Basics of system dynamics - Numerical techniques - Introduction to software packages to study the responses - Concept and importance of power system stability in the operation and design - Distinction between transient and dynamic stability - Complexity of stability problem in large system - Necessity for reduced models - Stability of interconnected systems.

UNIT II: GENERATION CONTROL LOOP **9**

Generation control loop - AVR loop - Performance and response - Automatic generation control of single area and multi area systems - Static and dynamic response of AGC loops - Economic dispatch and AGC - AGC in a deregulated environment - Recent advances in AGC.

UNIT III: TRANSIENT STABILITY PROBLEM **9**

Modeling of synchronous machine: Loads, Network, Excitation systems, Turbine and governing system - FACTS and HVDC systems - Trapezoidal rule of numerical integration technique for transient stability analysis - Simultaneous implicit approach for transient stability analysis of multi machine systems - Transient stability enhancement methods.

UNIT IV: LOW FREQUENCY OSICILATIONS **9**

Power system model for low frequency oscillation studies - Eigen value analysis -Improvement of system damping with supplementary excitation control - Standard model for PSS representation - Introduction to sub synchronous resonance and counter measures - IEEE benchmark models for SSR studies.

UNIT V: VOLTAGE STABILITY PROBLEM **9**

Real and reactive power flow in long transmission lines - Effect of ULTC and load characteristics on voltage stability - Voltage stability limit -Voltage stability assessment using PV curves - System modeling - Static and dynamic analysis - Voltage collapse - Proximity indices - Voltage stability improvement methods.

TOTAL: 45 PERIODS

OUTCOMES

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

- Find the stability of interconnected systems.
- Analyze the performance of single and multi area systems.
- Model the synchronous machine.
- Get knowledge on power system model for low frequency oscillation studies.
- Know the various stability problem of voltage.

TEXT BOOKS

1. Jan Machowski, Zbigniew Lubosny, Janusz W. Bialek, James R. Bumby, "Power System Dynamics Stability and Control", Wiley, 3rd Edition, 2020.
2. Pter W.Sauer, M.A.Pai, Joe H.Chow, "Power system Dynamics and Stability", Wiley, 2nd Edition, 2017.

REFERENCES

1. Prabha Kundur, "Power System Stability and control ", Tata McGraw Hill Education, 2nd Edition, 2020.
2. James A.Momoh, Mohamed.E.El-Hawary. "Electric Systems, Dynamics and Stability with Artificial Intelligence applications", CRC Press, 2nd Edition, 2018.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105133/ - (Power System Dynamics, Control and Monitoring)
2. https://nptel.ac.in/courses/108/106/108106026/ - (Power System Stability and Control)

OPEN ELECTIVE – II

19EEOX06	INDUSTRIAL ELECTRICAL SYSTEMS	L T P C
		3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the characteristics and speed control of DC motors.
- Impart knowledge on the speed control of induction motors.
- Identify the characteristics and speed control of synchronous motors.
- Study the working principle of control components.
- Acquire the knowledge on working principle of Electromagnetic controllers.

UNIT I: SPEED CONTROL OF DC MOTOR **9**

Conventional Control - Methods of speed control - Solid state control: Half controlled and fully controlled rectifier fed schemes for DC separately excited and series motors - Solid state ward leonard schemes - Chopper control scheme (Time ratio control only) - Current and speed feedbacks - Comparison of proportional and proportional plus integral control.

UNIT II: SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9**

Conventional Control: Methods of speed control - Solid state control: Line AC voltage controller scheme - Voltage source fed scheme - Pulse width modulated fed inverter scheme - Comparison of VSI fed and CSI fed schemes - Cyclo Converter fed scheme - Static rotor resistance scheme - Slip power recovery scheme - Block diagram of closed loop control scheme.

UNIT III: SOLID STATE CONTROL OF SYNCHRONOUS & FHP MOTOR **9**

Self-commutated inverter fed scheme - Voltage source inverter fed scheme - Block diagram of closed loop control scheme - Half wave and full wave single thyristor schemes - AC Motor Control - Triac Control Scheme - Single phase AC voltage controller scheme.

UNIT IV: CONTROL COMPONENTS **9**

Relays: General purpose - Over load - Timing - Contactors: Solenoid type - Clapper type - Uses and combination fuse switch units - Miniature circuit breaker - Push buttons - Limit switches - Phase failure relay - Selector switch - Master controller and drum switches.

UNIT V: ELECTROMAGNETIC CONTROLLERS **9**

Symbols for various components - Schematic control diagram - Wire control diagram - Forward/reverse operation of three phase squirrel cage induction motor - Slip ring induction motor starter - Plugging of squirrel cage induction motor - DC shunt motor starter - Synchronous motor starter - Starter for capacitor type split phase motor - Reversal of universal motor.

TOTAL: 45 PERIODS

OUTCOMES

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

- Apply the solid state speed control to DC motors.
- Design the slip power recovery scheme of three phase induction motor.
- Find the different control schemes for synchronous induction motor.
- Get adequate knowledge of control components.
- Know the role of electromagnetic controllers in motor.

TEXT BOOKS

1. Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2nd Edition, 2010.
2. Austin Hughes and Bill Drury, "Electric Motors and Drives: Fundamentals, Types and Applications", Newnes Publishers, 4th Edition, 2013.

REFERENCES

1. B.R Mehta & Y.J Reddy, "Industrial process automation systems: Design and Implementation", Butterworth - Heinemann, 1st Edition, 2014.
2. Vedam Subramanyam, "Electric Drives Concepts and Applications", Tata McGraw Hill Education, 2nd Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105063/ - (Industrial Automation and Control)
2. https://nptel.ac.in/courses/108/105/108105088/ - (Industrial Automation and Control)

19EEOX07	POWER QUALITY AND FACTS	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Understand the Causes and Mitigation techniques of various PQ events.
- Study the three phase balanced and unbalanced system.
- Identify the fundamentals of FACTS Controllers.
- Acquire knowledge about Shunt and Series compensation.
- Analyze the functioning and control of GCSC, TSSC and TCSC.

UNIT I: POWER QUALITY **9**

Introduction - Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation, power acceptability curves - Power quality problems - Power quality standards.

UNIT II: ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM **9**

Single phase sinusoidal, non-sinusoidal source supplying linear and nonlinear loads - Three phase balanced and unbalanced system - Three phase unbalanced and distorted source supplying nonlinear loads - Concept of PF - Three phase three wire system - Three phase four wire system.

UNIT III: FACTS CONCEPTS **9**

Transmission interconnections power flow in an AC system - Loading capability limits - Dynamic stability considerations - Importance of controllable parameters - Basic types of FACTS controllers - Voltage source converters - current source converters - Comparison of current source converters with voltage source converters.

UNIT IV: FACTS COMPENSATORS **9**

Objectives of shunt compensation - Mid-point voltage regulation - Voltage instability prevention - Improvement of transient stability - Power oscillation damping - Methods of controllable VAR generation - Variable impedance type - Static VAR generators - Switching converter type VAR generators - Hybrid VAR generators - SVC and STATCOM.

UNIT V: STATIC SERIES COMPENSATORS **9**

Concept of series capacitive compensation - Improvement of transient stability - Power oscillation damping - Functional requirements of GTO - Thyristor controlled series capacitor (GCSC) - Thyristor switched series capacitor (TSSC) - Thyristor controlled series capacitor (TCSC) - Control schemes for GSC, TSSC and TCSC.

TOTAL: 45 PERIODS

OUTCOMES

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

- Get knowledge on power quality issues.
- Analysis of single phase, three phase linear and non linear loads.
- Know the importance of FACTS controllers in power system.
- Choose proper controller for the specific application based on system requirements.
- Detect the Power and control circuits of Series Controllers GCSC, TSSC and TCSC.

TEXT BOOKS

1. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, "Electrical Power Systems Quality", McGraw Hill Education, 3rd Edition, 2017.
2. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, 2nd Edition, 2016.

REFERENCES

1. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality Problems & Mitigation Techniques",Wiley, 1st Edition, 2015.
2. Zhang, Xiao-Ping, Rehtanz,Christian, Pal, Bikash, "Flexible AC Transmission Systems: Modeling and Control", Springer, 2nd Edition, 2014.

E-RESOURCES

1. https://nptel.ac.in/courses/108/107/108107157/ - (Power Quality Improvement Techniques)
2. https://nptel.ac.in/courses/108/107/108107114/ - (FACTS Devices)

19EEOX08 **WIND ENERGY AND SOLAR ENERGY SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Learn about the wind energy basic concepts.
- Impart knowledge in different types of wind machines.
- Get exposure on solar radiation and its environmental impact to power.
- Know about the various collectors used for storing solar energy.
- Identify the various applications in solar energy.

UNIT I: WIND ENERGY **9**

Introduction - Basic principles of wind energy conversion - Wind energy scenario world and India - The nature of the wind - The power in the wind - Forces on the Blades - Wind Energy Conversion - Wind Data and Energy Estimation - Site Selection Considerations - Wind energy systems: Environment and Economics Environmental benefits and problems of wind energy - Economics of wind energy - Factors influence the cost of energy generation - Machine parameters - Life cycle cost analysis.

UNIT III: BASIC COMPONENTS OF A WIND ENERGY CONVERSION (WEC) SYSTEM **9**

Classification of WEC systems - Advantages and Disadvantages of WECS - Types of Wind Machines (Wind Energy Collectors) - Analysis of Aerodynamic Forces Acting on the Blade - Performance of Wind - Machines - Generating Systems - Energy Storage - Applications of Wind Energy - Environmental Aspects.

UNIT III: PRINCIPLES OF SOLAR RADIATION **9**

Role and potential of new and renewable source - Solar energy option - Environmental impact of solar power - Physics of the sun - Solar constant - Extraterrestrial and terrestrial solar radiation - Solar radiation on titled surface - Instruments for measuring solar radiation and sun shine - Solar radiation data.

UNIT IV: SOLAR ENERGY COLLECTION **9**

Flat plate and concentrating collectors - Classification of concentrating collectors - Orientation and thermal analysis - Advanced collectors.

UNIT V: SOLAR ENERGY STORAGE AND APPLICATIONS **9**

Different methods - Sensible - Latent heat and stratified storage - Solar ponds - Solar Applications: Solar heating/cooling technique - Solar distillation and drying - Photovoltaic energy conversion.

TOTAL: 45 PERIODS

OUTCOMES

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

- Impart knowledge in wind energy with its economic aspects.
- Understand the components of wind energy conversion system.
- Acquire knowledge about solar energy and its radiation.
- Classify the solar energy collectors and also methodologies of storing solar energy.
- Get Knowledge in applying the solar energy in a useful way.

TEXT BOOKS

1. Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers, 2011.
2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011.

REFERENCES

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House, 2007.
2. Ramesh R & Kumar K.U, "Renewable Energy Technologies", Narosa Publishing House, 2014.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105058/ - (Energy Resources and Technology)
2. https://nptel.ac.in/courses/115/103/115103123/ - (Energy Engineering and Technology)

19EEOX09	MICROPROCESSORS	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart knowledge on the Architecture of µP 8085 & µC 8051.
- Acquire knowledge on the timing diagrams of 8085 & 8051.
- Study the addressing modes & instruction set of 8085 & 8051.
- Introduce commonly used peripheral / interfacing.
- Program simple applications development with 8085 & 8051.

UNIT I: FUNDAMENTALS OF MICROPROCESSORS **9**

Fundamentals of Microprocessor Architecture - 8-bit Microprocessor and Microcontroller architecture - Comparison of 8-bit microcontrollers - 16-bit and 32-bit microcontrollers - Definition of embedded system and its characteristics.

UNIT II: THE 8051 ARCHITECTURE **9**

Internal Block Diagram - CPU, ALU, Address, Data and Control bus, Working registers, SFRs, Clock and RESET circuits - Stack and Stack Pointer - Program Counter - I/O ports - Memory Structures - Data and Program Memory - Timing diagrams and Execution Cycles.

UNIT III: INSTRUCTION SET AND PROGRAMMING **9**

Addressing modes: Introduction - Instruction syntax - Types - Subroutines - 8051 Instruction set - Instruction timings - Instruction sets - Assembly language programs - Assemblers and compilers - Programming and debugging tools.

UNIT IV: MEMORY AND I/O INTERFACING **9**

Memory and I/O expansion buses - Control signals - Memory wait states - Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, Timers, Counters, Memory devices.

UNIT V: EXTERNAL COMMUNICATION INTERFACE & APPLICATIONS **9**

Synchronous and Asynchronous Communication - RS232, SPI, I^2C - Introduction and interfacing to protocols like Blue-tooth and Zig-bee - LED, LCD and keyboard interfacing - Stepper motor interfacing - DC Motor interfacing - Sensor interfacing.

TOTAL: 45 PERIODS

OUTCOMES

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

- Find need & use of structure of 8085 & 8051.
- Differentiate the program and data memory.
- Write simple applications development with programming 8085 & 8051.
- Understand the importance of interfacing.
- Design the Microprocessor and Microcontroller based applications.

TEXT BOOKS

1. Sunil Mathur & Jeebananda Panda, "Microprocessor and Microcontrollers", PHI Learning Pvt. Ltd, 10th Edition, 2016.
2. R.S.Gaonkar, "Microprocessor Architecture , Programming and Application with 8085", Penram International Publishing, 6th Edition, 2013.

REFERENCES

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, 2nd Edition, 2013.
2. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051", Tata McGraw Hill, 2nd Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105102/ - (Microprocessors and Microcontrollers)
2. https://nptel.ac.in/courses/106/108/106108100/ - (Microprocessors and Microcontrollers)

19EEOX10 **SMPS AND UPS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Impart knowledge on low power switched mode power supply (SMPS).
- Acquire knowledge on low power uninterrupted power supply (UPS).
- Conceptual knowledge in modern power electronic converters.
- Know the various types of filters.
- Understand the applications of UPS, SMPS, Converters and Filters in electric power utility.

UNIT I: DC - DC CONVERTERS **9**

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

UNIT II: SWITCHING MODE POWER CONVERTERS **9**

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

UNIT III: RESONANT CONVERTERS **9**

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

UNIT IV: DC - AC CONVERTERS **9**

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

UNIT V: POWER CONDITIONERS, UPS & FILTERS **9**

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

TOTAL: 45 PERIODS

OUTCOMES

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

- Model the different converters.
- Draw the control circuits for converters.
- Design the various types of converters.
- Analyze various methodologies in filters.
- Construct a battery charging circuit foe a specific household application

TEXT BOOKS

1. M.H.Rashid, "Power Electronics Handbook", Butterworth-Heinemann, 3rd Edition, 2011.
2. Fang Lin Luo and Fang Lin Luo, "Advanced DC/DC Converters", CRC Press, 2nd Edition, 2016.

REFERENCES

1. Krein Philip T, "Elements of Power Electronics", Oxford University press, 2nd Edition, 2017.
2. Agarwal, "Power Electronics: Converters, Applications, and Design", Prentice Hall of India, 3rd Edition, 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/108/108/108108036/ - (Switched Mode Power Conversion)
2. https://nptel.ac.in/courses/108/108/108108035/ - (PWM for Power Converters)

GENERAL ELECTIVE

19NCCL01	**NCC AIRFORCE LEVEL-1**	**L T P C**
Course Prerequisites	**75% Attendance in First Year of NCC**	**2 0 2 3**

OBJECTIVES

The main objective of this course is to:

- learn about the basic structure of NCC and its organization, Incentives, duties of Cadets, imbibe the knowledge of various types of Camp.
- Motivate the cadets as confidence leaders by refining their personality and self awareness, with the help of Communication skills and aware of creative, critical thinking abilities.
- Create a pool of organized, trained and motivated youth with leadership qualities in all walks of life from the exposure of great leaders and their history.
- Inspire the cadets to take part in the Social Service Activities and also motivate them to know about their role in the society towards the development of Nation.
- Acquire knowledge about the basics of health and hygiene, yoga, environment cleanliness and motivate young Indians towards the path of clean India and acquaint about obstacle training.

UNIT-I NCC GENERAL **6**

Aims, objectives and Organization of NCC-incentives-duties of NCC Cadets-NCC camps- types - conduct.

UNIT-II PERSONALITY DEVELOPMENT **6**

Personality Development -Factors-Self Awareness-Communication skills-Empathy-Critical and Creative thinking-Decision making.

UNIT-III LEADERSHIP **6**

Leadership Capsule-Traits- Case studies-leaders like APJ Abdul Kalam, RatanTata, shivaji, Tipu Sultan, Rabindranath Tagore, N Narayana murthy.

UNIT-IV SOCIAL SERVICE **6**

Social Service Capsule-Basics-Rural development programmes-NGOs-Contribution of Youth - Swatch Bharath Abhiyan, Social evils-Drug Abuse-Digital Awareness-Waste Management-Women Health and Sanitation-Tree Plantation-Traffic Awareness-Pollution.

UNIT-V HEALTH AND HYGIENE **6**

Hygiene and sanitation – First Aid – Introduction to Yoga – Adventure – Environmental awareness and conservation – Obstacle Training -Adventure

PRACTICAL COMPONENT **10**

S.No.	Name of the Experiment	CO Mapping	RBT
1	Foot Drill	CO1	Apply
2	Rifle Drill	CO1	Apply
3	Ceremonial Drill	CO2	Understand
4	Social Service and Community Development	CO4	Apply

TOTAL:35+10=45 PERIODS

OUTCOMES

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

- Understand the basic organization of NCC and roles, responsibilities of cadets for the smooth functioning of all camps
- Develop the cadets personality and to think divergently to break functional fixedness
- Identify the Leadership traits from the admiration and qualities of great leaders
- Understand the concept and important of Social service and influence them to spread awareness about various activities
- Practice healthy practices to improve the personal sanitation and hygiene and get into the adventurous activities

TEXT BOOKS

1. Cadet Hand Book (Common Subjects), published by DGNCC.
2. Cadet Hand Book (Specialized Subjects), published by DGNCC.
3. ANO Handbook

REFERENCE BOOKS

1. Grooming tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG,NCC.
3. The Cadet, Annual Journal of the NCC.
4. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material.

E- RESOURCES

1. https://www.indiancc.nic.in
2. https://www.indiancc.mygov.in
3. https://www.play.google.com/MY_IAF
4. https://www.play.google.com/DGNCC_Training

19NCCL02	**NCC AIRFORCE LEVEL - 2**	**L T P C**
Course Prerequisites	**75% Attendance in Second Year Of NCC**	**2 0 2 3**

OBJECTIVES

The main objective of this course is to:

- Realize the importance of national security and threats for the nation and aware of National Integration.
- Create interest in cadet to develop into great leaders by teaching them about problem solving techniques, handling emotions, time management skills.
- Aware of disaster management and motivate the young minds to help during the time of disasters.
- Create a pool of organized, trained and motivated youth with authoritative qualities to serve in IAF and to know the significance of Airmanship, Air Campaigns
- To learn about the Aero Modelling for better understanding of flying and also to choose the Armed Forces as a career.

UNIT-I NATIONAL INTEGRATION AND AWARENESS 6

National Integration and Awareness - importance and necessity-factors affecting National integration-Unity in Diversity-Threats to National Security.

UNIT-II PERSONALITY DEVELOPMENT 6

Problem solving - Group discussions-Coping with stress and emotions-Change your mindset-Time management-Social skills-Team work-public speaking.

UNIT-III DISASTER MANAGEMENT 6

Disaster Management Capsule – Organization - Types -Essential services – Assistance - Civil Defence Organization. Initiative training-organizing skills-Dos and Don't's. Fire Services and Fire Fighting

UNIT-IV GENERAL SERVICE KNOWLEDGE ON AIRCRAFT AND AIRMANSHIP 6

Armed forces and IAF Capsule-Modes of Entry in IAF-Aircraft types, capabilities and role-Air Campaigns-Principle of Flight-Forces acting on Aircraft-Airmanship – Navigation.

UNIT-V AERO MODELLING 6

Introduction and Types of Aero Engine – Aircraft Controls – Introduction to Radars – Aero modelling capsule – Flying/Building of Aero models – Micro Light Flying – Simulator Flying.

PRACTICAL COMPONENT 10

S.No.	Name of the Experiment	CO Mapping	RBT
1	Foot Drill	CO1	Apply
2	Rifle Drill	CO1	Apply
3	Weapon Assembling and Reassembling	CO2	Understand
4	Basics of Aero modelling	CO4	Apply

TOTAL:35+10=45 PERIODS

OUTCOMES

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

- Realize the importance of National integration, threats and factors affecting the National Security.
- demonstrate their public speaking skills and problem solving techniques
- Identify the problems during Disaster type and to give solutions during the emergency periods with their divergent thinking
- Grasp the concept of IAF and its importance to the nation and detailed Knowledge on Aircraft and Airmanship
- Obtain knowledge on Aero Modelling, handle of radars and insight about Aircraft, Aero models and flying.

TEXT BOOKS

1. Cadet Hand Book (Common Subjects), published by DGNCC.
2. Cadet Hand Book (Specialized Subjects), published by DGNCC.
3. ANO Hand Book

REFERENCE BOOKS

1. Grooming tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG,NCC.
3. The Cadet, Annual Journal of the NCC.
4. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material.

E-RESOURCES

1. https://www.indiancc.nic.in
2. https://www.indiancc.mygov.in
3. https://www.play.google.com/MY_IAFs
4. https://www.play.google.com/DGNCC_Training

LIST OF HUMANITIES AND SOCIAL SCIENCES (HS) COURSES

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19HST101	Communicative Techno English - I	HS	3	0	0	3	40	60	100
2	19HST201	Communicative Techno English - II	HS	3	0	0	3	40	60	100
3	19CYT201	Environmental Science and Engineering	HS	3	0	0	3	40	60	100

LIST OF BASIC SCIENCES (BS) COURSES

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19MAT101	Engineering Mathematics - I	BS	3	1	0	4	40	60	100
2	19CYE101	Engineering Chemistry	BS	3	0	2	4	40	60	100
3	19PHE101	Engineering Physics	BS	3	0	2	4	40	60	100
4	19MAT201	Engineering Mathematics - II	BS	3	1	0	4	40	60	100
5	19PHT202	Solid State Physics and Nano Electronic Devices	BS	3	0	0	3	40	60	100
6	19MAT301	Transforms and Partial Differential Equations	BS	3	1	0	4	40	60	100
7	19MAT403	Numerical Methods	BS	3	1	0	4	40	60	100

LIST OF ENGINEERING SCIENCES (ES) COURSES

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19GET101	Engineering Graphics	ES	3	0	0	3	40	60	100
2	19GEE101	Computer Fundamentals and Python Programming	ES	3	0	2	4	40	60	100
3	19GET203	Basic Civil and Mechanical Engineering	ES	3	0	0	3	40	60	100
4	19CSE302	Programming in C and C++	ES	3	0	2	4	40	60	100

LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19EEC101	Life Skills for Engineers	EEC	0	0	2	0	100	-	100
2	19EEC203	Technical Skill (Hands on Training in Electrical and Electronics)	EEC	0	0	2	0	100	-	100
3	19EEC301	Communication Skills	EEC	0	0	2	0	100	-	100
4	19EEC402	Entrepreneurship Development Activity	EEC	0	0	2	0	100	-	100
5	19EEC501	Quantitative Aptitude Learning	EEC	0	2	0	0	100	-	100
6	19EEC604	Mini Project	EEC	0	0	2	1	100		100
7	19EEJ704	Project Work (Phase - I)	EEC	0	0	2	1	100		100
8	19EEJ804	Project Work (Phase - II)	EEC	0	0	20	10	40	60	100

LIST OF MANDATORY COURSES (MC)

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19MDC101	Induction Program (2 Weeks)	MC	-	-	-	-	-	-	-
2	19MDC201	NSS / YRC / RRC	MC	-	-	-	-	100	-	100
3	19MDC301	Leadership Enhancement Programme	MC	1	-	-	-	100	-	100
4	19MDC401	Value Added Course - I	MC	-	-	-	-	100	-	100
5	19MDC501	Value Added Course - II	MC	-	-	-	-	100	-	100
6	19MDC601	Constitution of India	MC	3	-	-	-	100	-	100

CREDIT SUMMARY

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Category	Credits Per Semester								Credit Total
	I	II	III	IV	V	VI	VII	VIII	
HS	3	6	-	-	-	-	-	-	9
BS	12	7	4	4	-	-	-	-	27
ES	7	3	4	-	-	-	-	-	14
PC	-	4	15	18	16	15	7	-	75
PE	-	-	-	-	3	6	3	6	18
OE	-	-	-	-	3	-	3	-	6
EEC	-	-	-	-	-	1	1	10	12
MC	-	-	-	-	-	-	-	-	0
Total	22	20	23	22	22	22	14	16	161

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION-2019

MINORDEGREE /HONOURS

ELECTRIC VEHICLES

CURRICULUM AND SYLLABI

CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2022-2023 onwards)

B.E.(Hons) Electrical and Electronics Engineering With Specialization in Electric Vehicles

Semester	Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
3	19EEET01	Electric & Hybrid Vehicles	PS	3	0	0	3	40	60	100
4	19EEET02	Energy Storage System and Management System	PS	3	0	0	3	40	60	100
5	19EEET03	Electric Drives and Controls for Electric Vehicles	PS	3	0	0	3	40	60	100
6	19EEEE01	Modelling and Simulation of EHV	PS	3	0	2	4	40	60	100
7	19EEEP01	Project Work	EEC	0	0	12	6	40	60	100
	TOTAL CREDITS			19						

PC : ProfessionalCore
EEC : Employability Enhancement Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

SEMESTER III

19EEET01 ELECTRIC & HYBRID VEHICLES LTPC
3 003

OBJECTIVES

Themainobjectiveofthiscourseisto:

- Understand the concept of electric vehicles.
- Study about the motors & drives for electric vehicles.
- Realize the electronics and sensors in electric vehicles.
- Know the concept of hybrid vehicles.
- Study about fuel cell for electric vehicles.

UNITI:INTRODUCTION TO ELECTRIC VEHICLES 9

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life.Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless &Solar**.**

UNITII:ELECTRIC VEHICLE MOTORS 9

Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

UNITIII:ELECTRONICS AND SENSOR-LESS CONTROL IN EV 9

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters.Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Selfdrive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase InductanceBased, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

UNITIV:HYBRID VEHICLES 9

Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV.Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components.Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

UNITV:FUEL CELLS FOR ELECTRIC VEHICLES **9**

Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

TOTAL:45PERIODS

OUTCOMES

Attheendofthecourse,thestudentswill beableto:

- Describe about working principle of electric vehicles.
- Explain the construction and working principle of various motors used in electric vehicles.
- Understand about working principle of electronics and sensor less control in electric vehicles.
- Describe the different types and working principle of hybrid vehicles.
- Illustrate the various types and working principle of fuel cells.

TEXTBOOKS

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007

REFERENCES

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.

E-RESOURCES

1 https://nptel.ac.in/courses/108103009 -(Hybrids and Electric Vehicle)

2 https://nptel.ac.in/courses/108102121 -(Electric Vehicle)

SEMESTER IV

19EEET02ENERGY STORAGESYSTEM AND MANAGEMENT SYSTEM **LTP C 3003**

OBJECTIVES

Themainobjectiveofthiscourseisto:

- Understand the different types of energy storage system.
- Study about the battery characteristic & parameters.
- Model the types of batteries.
- Know the concepts of battery management system and design the battery pack.
- Study about the battery testing, disposal and recycling.

UNIT I: ENERGY STORAGE SYSTEM **9**

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

UNITII:BATTERY CHARACTERISTICS & PARAMETERS **9**

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

UNIT III: BATTERY MODELLING **9**

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

UNITIV: BATTERY PACK ANDBATTERY MANAGEMENT SYSTEM **9**

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

UNITV:BATTERY TESTING, DISPOSAL & RECYCLING **9**

Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries, Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates. Ruptures: Mechanical stress and pressure tolerance

of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Environment and Human Health impact assessments of batteries, General recycling issues and drivers, methods of recycling of EV batteries.

TOTAL:45PERIODS

OUTCOMES

Attheendofthecourse,thestudentswill beableto:

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

TEXTBOOKS

1. Ibrahim Dinçer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley& Sons Ltd., 2016.
2. Chris Mi, AbulMasrur& David WenzhongGao, "Hybrid electric Vehicle- Principles & Applications with Practical Properties", Wiley, 2011.

REFERENCES

1. G. Pistoia, J.P. Wiaux, S.P. Wolsky, "Used Battery Collection and Recycling", Elsevier, 2001. (ISBN: 0-444-50562-8)
2. Guangjin Zhao, "Reuse and Recycling of Lithium-Ion Power Batteries", John Wiley & Sons. 2017. (ISBN: 978-1-1193-2185-9)

E-RESOURCES

1 https://nptel.ac.in/courses/113105102 - (Battery Modelling)

2 https://nptel.ac.in/courses/108102047 - (Energy Storage)

SEMESTER V

19EEET03 ELECTRIC DRIVES AND CONTROLS FOR ELECTRIC VEHICLES LT PC 3003

OBJECTIVES

Themainobjectiveofthiscourseis:

- To study about the motor & device characteristics & parameters.
- To know the various electric drive concepts.
- To have a knowledge of DC drive mechanism.
- To have a knowledge of AC drive mechanism.
- To understand about drives for special electrical machines.

UNITI:MOTOR AND DEVICE CHARACTERISTICS 9

Review of motor principles, motor load dynamics, starting, braking & speed control of dc and ac motorspower semiconductor SCRs, IGBTs and MOSFETs .

UNITII:ELECTRIC DRIVE CONCEPTS 9

Basic drive, choice of electric drives, advantages, nature and classification of drives, control and stability of electric drives, feedback control of drives, thermal effects in electrical machines, selection of motor and rating.

UNITIII:DC DRIVES 9

Transient analysis of separately excited dc motors, converter - single phase uncontrolled, half and fully controlled rectifiers, chopper control, closed loop control of solid-state DC drives.

UNITIV:AC DRIVES 9

Operation of induction and induction motor, direct torque and flux control of induction motor drives, starting methods and speed control of single-phase induction motors, self-controlled synchronous motor drive, selection of motor and rating vector control of synchronous motor.

UNITV:DRIVES FOR SPECIAL ELECTRICAL MACHINES 9

Drives for variable reluctance motors, microprocessor/ microcontroller –gate trigger signal generation applications to special electrical machines, switched reluctance motor drives, brushless DC motor drives, permanent magnet drives.

TOTAL:45PERIODS

OUTCOMES

Attheendofthecourse,thestudentswill beableto:

- Describe about the motor & device characteristics & parameters.
- Explain about various electric drive concepts .
- Understand the DC drive mechanism.
- Understand the AC drive mechanism.
- Explain about drives for special electrical machines.

TEXTBOOKS

1. Gopal K D, "Fundamentals of Electric Drives", Narosa Publishing House Pvt. Ltd., 2011.
2. Pillai S K, "A first course on Electrical Drives", Wiley Eastern Ltd, Bombay 2011.

REFERENCES

1. Ali Elamadi, "Handbook Automotive Power Electronics and Drives", CRC publishers, 2012.
2. Bimal K Bose, "Modern Power Electronics and Drives", Elsevier publishers, Butterworth Hinnemann, 2012.

E-RESOURCES

1 https://nptel.ac.in/courses/108104140 -(Electric Drives)

2 https://nptel.ac.in/courses/108102121-(Electric Vehicle)

SEMESTER VI

19EEEE01 **MODELLING AND SIMULATION OF EHV** **LTPC**

(LabEmbeddedTheory Course) **3024**

OBJECTIVES

Themainobjectiveofthiscourseisto:

- Understand the modelling of vehicle performance parameters.
- Model battery electric vehicles.
- Describe the drivetrain characteristics.
- Identify the concepts of energy management system.
- Know the vehicle dynamic control systems.
- Simulate the mathematical model of Electric Vehicle various aspects.

UNIT I: MODELLING IN PERFORMANCE PARAMETER **9**

Modelling Vehicle Acceleration - Acceleration performance parameters, modelling the acceleration of an electric scooter, modelling the acceleration of a small car.

UNIT II : MODELLING OF BATTERY ELECTRIC VEHICLES9

Electric Vehicle Modelling - Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling Electric Vehicle Range - Driving cycles, Range modelling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles.

UNIT III:DRIVE TRAIN CHARACTERISTICS **9**

Modelling and Characteristics of EV/HEV Powertrains Components- ICE Performance Characteristics, Electric Motor Performance Characteristics - Battery Performance Characteristics-Transmission and Drivetrain Characteristics-Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking - Longitudinal Dynamics Equation of Motion - Vehicle Propulsion Modelling and Analysis - Vehicle Braking Modelling and Analysis.

UNIT IV: ENERGY MANAGEMENT **9**

Handling Analysis of Electric and Hybrid Electric Vehicles - Simplified Handling Models Energy/Power Allocation and Management - Power/Energy Management Controllers - Rule-Based Control Strategies - Optimization-Based Control Strategies.

UNIT V : VEHICLE DYNAMIC CONTROL **9**

Control of Electric and Hybrid Electric Vehicle Dynamics - Fundamentals of Vehicle Dynamic Control (VDC) Systems, VDC Implementation on Electric and Hybrid Vehicles – Case Studies, Rechargeable Battery vehicles, Hybrid Vehicles, Fuel Cell Powered Bus. Simulation Tools: Matlab/Simulink, ADVISOR and AVL

Cruise.

LISTOFEXPERIMENTS

1. Various strategies for improving vehicle energy/fuel efficiency.
2. Vehicle chassis mathematical model in various operation conditions (steady motion, acceleration, regenerating braking, coasting, moving up and down a hill)
3. Series HE powertrain mathematical model.
4. Computer model of the HEV.
5. Computer Workshop. Fuel efficiency evaluation of a series HEV in city and high-way cycles: study and analyze two strategies for ICE/Battery power split.

TOTAL: 45+15=60PERIODS

OUTCOMES

Attheendofthecourse,thestudentswillbeableto:

- Understand the modelling of vehicle performance parameters.
- Model battery electric vehicles.
- Describe the drivetrain characteristics.
- Apply the concepts of energy management system.
- Explain the vehicle dynamic control systems.
- Model the Electric Vehicle .

TEXTBOOKS

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.
2. Amir Khajepour, Saber Fallah and AvestaGoodarzi, "Electric and Hybrid VehiclesTechnologies, Modelling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.

REFERENCES

1. AntoniSzumanowski, "Hybrid Electric Power Train Engineering and Technology: Modelling, Control, andSimulation", IGI Global, 2013.
2. MehrdadEhsani, YiminGao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition", CRC Press, 2010.

E-RESOURCES

1 https://nptel.ac.in/courses/108102121-(Electric Vehicle)

2 https://nptel.ac.in/courses/113105102 -(Battery Modelling)

SEMESTER VII

19EEEP01 PROJECTWORK LTP C

00126

OBJECTIVES

Themainobjectiveofthiscourseisto:

- Developskillstoformulatea technicalproject.
- Developtheabilityto solve specificproblem.
- Teachuseofnewtools,algorithms andtechniquesrequired to carryout theprojects.
- Giveguidanceonthevariousproceduresforvalidationoftheproductandanalyzethecosteffectiveness.
- Provide guidelinestoprepare technicalreportoftheproject.

GUIDELINEFORREVIEWANDEVALUATION

The students in a group of 3 works on a topic approved by the head of the department under theguidance of a faculty member and prepares a comprehensive project report after completing the work to thesatisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews.The review committee may be constituted by the Head of the Department. A project report is required at theend of the semester. The project work is evaluated based on oral presentation and the project report jointly byexternalandinternalexaminersconstituted bythe HeadoftheDepartment.

OUTCOMES

Attheendoftheproject,thestudentswill beableto:

- Formulate arealworldproblem,identifythe requirement anddevelopthedesign solutions.
- Identifytechnicalideas,strategiesandmethodologies.
- Testandvalidatethroughconformanceofthedevelopedprototypeandanalysisthecosteffectiveness.
- Preparetechnicalreportandoralpresentations.
- Oncompletion ofthe project work studentswill beina positiontotake up any challenging practicalproblemin thefield ofengineeringandfind bettersolutionstoit.

CURRICULUM

(MINORDEGREE /HONOURS - ELECTRIC VEHICLES)

CREDIT SUMMARY

B.E. –ELECTRICAL AND ELECTRONICSENGINEERING

Category	CreditsPer Semester								CreditTotal
	I	II	III	IV	V	VI	VII	VIII	
PC	-	-	3	3	3	4	-	-	13
EEC	-	-	-	-	-	-	6	-	6
Total	-	-	3	3	3	4	6	-	19

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION-2019

MINORDEGREE/HONOURS

SENSORS TECHNOLOGY

CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2022-2023 onwards)

B.E.(Hons) Electrical and Electronics Engineering With Specialization in Sensors Technology

Semester	Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
3	19EEST01	Nanomaterials and Sensors	PC	3	0	0	3	40	60	100
4	19EEST02	WirelessSensorNetworks	PC	3	0	0	3	40	60	100
5	19EEST03	Flexible and Wearable Sensors	PC	3	0	0	3	40	60	100
6	19EESE01	PrinciplesofSensors	PC	3	0	4	4	40	60	100
7	19EESP01	Project	EEC	0	0	12	6	40	60	100
	TOTAL CREDITS			19						

PC : ProfessionalCore
EEC : Employability Enhancement Courses
L : Lecture
T : Tutorial
P : Practical
C : Credit Point
CIA : Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

SEMESTER III

19EEST01NANOMATERIALSANDSENSORS **LT P C**

3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Provide an insight of nanomaterials and its synthesis and to expose the students to the different methods being used for nanomaterials characterization.
- Educate the students about the process involved in the fabrication of sensors using metallic nano particles and nanowires and the need for using special materials like CNTs for sensor development.
- Impart the knowledge of developing sensors using different nano structures of metal oxides.
- Ability to make the students to understand the developments in the nano polymers and its role in sensors.
- Provide an insight of quantum dots and its potential application in sensor development.

UNIT I:INTRODUCTIONTONANOTECHNOLOGY **9**

Definitionofnanotechnology-mainfeaturesofnano-materials-typesofnanostructures(0D,1D, and2Dstructures)–synthesisofnano-materialsandnano-composites-chemical/physical/electrical/opticalproperties ofnano-materialsand composites.

UNIT II:CHARACTERIZATIONOFNANOMATERIALS **9**

Methods for characterizing the nano-materials: Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and spectroscopy -spectrometry based surface analysis techniques.

UNIT III: METALNANOPARTICLEAND NANOWIREBASED SENSORS9

Definition of nanoparticle - features of nanoparticles - production of nanoparticles by physicalapproach and chemical approaches- Definition of nanowires- features of nanowires - fabricationofindividualnanowirebytop-downapproachesandbottom-upapproaches-fabricationof nanowirearrays(fluidic channel,blownbubblefilm,contactprinting,spraycoating, etc.).

UNIT IV:CARBONNANOTUBES-BASEDSENSORS **9**

Definitionofcarbonnanotube-featuresofcarbonnanotubes-synthesisofcarbonnanotubes–fabricationandworkingprinciplesofsensorsbasedonindividualcarbonnanotube–fabrication

andworkingprinciples ofsensors basedonrandom arrayofcarbonnanotubes.

UNITV: SENSORSBASEDONNANOSTRUCTURESOFMETAL OXIDE 9

Synthesisofmetaloxidestructuresbydryandwetmethods-Typesofmetaloxidegassensors(0D,1D,and2D)-defectchemistryofthemetaloxidesensors-sensingmechanismofmetal-oxidegas sensors-Porousmetal-Oxide structuresforimprovedsensingapplications.

TOTAL: 45PERIODS

OUTCOMES

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

- Willacquireaninsightofnanomaterialsanditssynthesis.
- Abletovisualizethedifferentmethodsbeingusedfornanomaterialscharacterization.
- Understandtheprocessinvolvedinthefabricationofsensorsusingmetallicnanoparticlesandnanowires.
- Abletodevelopsensorsusingdifferentnanostructuresofmetaloxidesformakingitmorespecific.

TEXTBOOKS

1. DieterVollath,"Nanomaterials:AnIntroductiontoSynthesis,PropertiesandApplications", 2014,2nd Edition,Wiley, NewJersey.
2. GuozhongCao,"Nanostructures &Nanomaterials: Synthesis,Properties& Applications",2011, 2nd Edition,ImperialCollegePress,London.

REFERENCES

1. MartinPumera,"NanomaterialsforElectrochemicalSensingandBiosensing",2014,1st Edition,PanStanford.
2. MichaelA.Carpenter,SanjayMathur,AndreiKolmakov,MetalOxideNanomaterialsfor ChemicalSensors,2013,1st Edition,Springer,NewYork.

E-RESOURCES

1. https://nptel.ac.in/courses/118104008-(nanomaterial)
2. https://nptel.ac.in/courses/108106173-(sensor)

SEMESTER IV

19EEST02 WIRELESSSENSORNETWORKS **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Identify and expose the students to the central elements in the design of communicationprotocolsforthe WSNs.
- Disseminatethedesignknowledgeinanalyzingthespecificrequirementsforapplications in WSNs regarding energy supply,memory, processing, and transmissioncapacity.
- Get the perception of mobile ad hoc networks, design, implementation issues, andsolutions.
- Impart the knowledge based on different algorithms and protocols for power management, sensor dataroutingand queryprocessing.
- Associate,hardwareplatformsandsoftwareframeworksusedtorealizedynamicWirelesssensor network.

UNIT I:NETWORKFOREMBEDDEDSYSTEMS **9**

RS232,RS485,SPI,I2C,CAN, LIN,FLEXRAY.

UNIT II:EMBEDDEDWIRELESSCOMMUNICATION AND IPBASED WSN **9**

Bluetooth, Zigbee,Wifi,UWB

Circuitswitching,packetswitching,conceptofIPV4,IPV6,6LOWPANandIP,IPbasedWSN,6LOWPANbasedWSN ,IOT

UNIT III: WIRELESSSENSORNETWORK(WSN) 9

Characteristicandchallenges,WSNvsAdhocNetworks,Sensornodearchitecture,Physicallayerandtransceiverde signconsiderationsinWSNs,Energyusageprofile,Choiceofmodulation scheme,Dynamicmodulationscaling,Antennaconsiderations.

UNIT IV:WSN(Mediumaccesscontrol) **9**

FundamentalsofMACprotocols-Lowdutycycleprotocolsandwakeupconcepts,Contention Basedprotocols,Schedule-basedprotocols-SMAC–BMAC,Traffic-adaptivemediumaccess protocol(TRAMA),The IEEE 802.15.4MACprotocol.

UNITV: SENSORNETWORKARCHITECTURE9

DataDissemination,FloodingandGossiping-DatagatheringSensorNetworkScenarios,OptimizationGoalsandFiguresofMerit,DesignPrinciplesforWSNs-GatewayConcepts,Need forgateway,WSNand InternetCommunication,WSNTunneling

TOTAL:45 PERIODS

OUTCOMES

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

- Assesstheapplicabilityandlimitationsofcommunicationprotocolsforarealtime WSNapplication.
- Confirmsthebehaviorofmobileadhocnetworks(MANETs)andcorrelatestheinfrastructure-basednetworks
- Proactiveinunderstating therouting protocolsfunctionandtheirimplicationsondatatransmissiondelayand bandwidth
- Abletoestablishnetworkswithanattempttoreduceissueofbroadcastandfloodingtechniques.
- Contributeappropriatealgorithmstoimproveexistingortodevelopnewwirelesssensornetworkapplications.

TEXTBOOKS

1. HolgerKarl,AndreasWillig,"ProtocolsandArchitecturesforWirelessSensorNetworks" 2011,1st ed., JohnWiley&Sons, NewJersey.
2. JunZheng,AbbasJamalipour,"WirelessSensorNetworks:ANetworkingPerspective", 2014,1sted.,Wiley-IEEEPress,USA.

REFERENCES

1. WaltenegusW.Dargie,ChristianPoellabauer,"FundamentalsofWirelessSensorNetworks: Theoryand Practice", 2014, 1st ed.,JohnWiley&Sons, NewJersey.
2. IanF.Akyildiz,MehmetCanVuran,"WirelessSensorNetworks",2011,1sted.,JohnWiley &Sons,NewJersey.

E-RESOURCES

1. https://nptel.ac.in/courses/106106167 - (Introduction to wireless communications)
2. https://nptel.ac.in/courses/106105160 -(wireless Ad Hoc and Sensor Network)

SEMESTER V

19EEST03 FLEXIBLEANDWEARABLESENSORS LT P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Provide the overview of flexible electronics technology and the issues with materialsprocessingforthin film electronics.
- Expose the students for the materials selection and patterning methods for thin filmelectronicsdevelopment.
- Describe the processinvolvedintransferring the flexible electronicsfromfoilstotextilesand alsothechallenges,opportunities andthe futureofwearabledevices.
- Expose the students to the design, challenges of wearable sensors employed for sensingthe physicaland biological parameters.
- Impart the knowledge on the process involved in the conversion ofconductingand semiconductingfibers to smart textiles.

UNIT I:OVERVIEWOFFLEXIBLEELECTRONICSTECHNOLOGY 9

Historyofflexibleelectronics-Materialsforflexibleelectronics:degreesofflexiblility,substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technologyforflexibleelectronics-Fabricationonsheetsbybatchprocessing,fabricationonwebbyRoll-to-Rollprocessing- Additiveprinting.

UNIT II: MATERIALSANDNOVELPATTERNING METHODSFOR FLEXIBLEELECTRONICS9

Materialsconsiderationsforflexibleelectronics:Overview,Inorganicssemiconductorsand dielectrics,organicsemiconductorsanddielectrics,conductors-Printprocessingoptionsfor devicefabrication:Overview,controloffeaturesizesofjetprintedliquids,jetprintingforetchmaskpatterning, methods forminimizingfeaturesize, printingactivematerials.

UNIT III: FLEXIBLEELECTRONICSFROMFOILSTOTEXTILES9

Introduction-Thinfilmtransistors:MaterialsandTechnologies-Reviewofsemiconductors employedinflexibleelectronics-ThinfilmtransistorsbasedonIGZO-Plasticelectronicsfor smart textiles - Improvements and limitations.

UNIT IV:WEARABLEHAPTICS **9**

Worldofwearables-Attributesofwearables-Textilesandclothing:ThemetawearableChallengesandopportunities-Futureofwearables-Needforwearablehapticdevices- Categoriesofwearablehapticandtactiledisplay.

UNIT V: KNITTEDELECTRONICTEXTILES 9

Fromfiberstotextilesensors-Interlacednetwork-Textilesensorsforphysiologicalstatemonitoring-Biomechanicalsensing-Noninvasivesweatmonitoringbytextilesensorsandother applications.FBGsensorin IntelligentClothingandBiomechanics.

TOTAL:45 PERIODS

OUTCOMES

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

- Realizethetechnologydevelopmentsinthe flexibleelectronicstechnology.
- Abilitytoidentifythesuitable materialsanditsprocessingfor thedevelopmentofthinfilmelectronics.
- Abilityto design the pattern and develop with suitablepatterningmethods.
- Realizetheprocessinvolvedinthetransformationofelectronicsfromfoilsto textiles
- Acquirethedesignknowledgefordevelopingwearablesensorsforphysicalandchemicalparameters

TEXTBOOKS

1. MichaelJ.McGrath,CliodhnaNiScanaill,DawnNafus,"SensorTechnologies:Healthcare, WellnessandEnvironmentalApplications",201,1st Edition,ApressMediaLLC,NewYork.
2. WilliamS.Wong,AlbertoSalleo,FlexibleElectronics:MaterialsandApplications,2011,1st Edition,Springer,New York.

REFERENCES

1. EdwardSazonov,MichaelR.Newman,"WearableSensors:Fundamentals, Implementation andApplications",2014, 1st Edition,AcademicPress,Cambridge.

2. KateHartman,"Make:WearableElectronics:Design,prototype,andwearyourown interactivegarments",2014,1st Edition,MarkerMedia,Netherlands.

E-RESOURCES

1. https://nptel.ac.in/courses/108108112-(Semiconductor Device)
2. https://nptel.ac.in/courses/108108031-(Electronics Systems)

SEMESTER VI

19EESE01 PRINCIPLESOFSENSORS LT P C

3 0 4 4

OBJECTIVES

The main objective of this course is to:

- Provide in depth knowledge in physical principles applied in sensing, measurement and acomprehensiveunderstandingonhowmeasurementsystemsaredesigned,calibrated,characterised,andanalysed.
- Ability to understand the various sources and detectors of various Optical sensing mechanisms.
- Provide in-depth understanding of the principle of measurement, and theory of instruments andsensorsfor measuringvelocityandacceleration.
- Impart the fundamental knowledge on the basic laws and phenomena on which operation of sensortransformationofenergyisbased.
- Impart a reasonable level of competence in the design, construction, and execution ofmechanical measurementsstrain,force,torque and pressure.

UNIT I:SENSORFUNDAMENTALSANDOPTICAL DETECTORS 9

SensorClassification,PerformanceandTypes,ErrorAnalysischaracteristics ElectronicandOpticalpropertiesofsemiconductorassensors,LED,Semiconductorlasers,Fiberopticsensors,Thermaldetectors,Photomultipliers,photoconductivedetectors,Photodiodes,Avalanchephotodiodes,CCDs.

UNIT II: INTENSITYPOLARIZATIONANDINTERFEROMETRIC SENSORS9

Intensitysensor,Microbendingconcept,Interferometers,Phasesensor:Phasedetection,Polarizationmaintainingfibers.

UNIT III: VELOCITYANDACCELERATIONSENSORS9

Electromagneticvelocitysensor,Dopplerwithsound,light,Accelerometercharacteristics,capacitive,piezo-resistive,piezoelectricaccelerometer,thermalaccelerometer,rotor,monolithic andoptical gyroscopes.

UNIT IV: POSITION,DIRECTION,DISPLACEMENTANDLEVEL SENSORS 9

Potentiometricandcapacitivesensors,Inductiveandmagneticsensor,LVDT,RVDT,eddy current,transverseinductive,Halleffect,magnetoresistive,magnetostrictivesensors.Fiberopticliquidlevel sensing, FabryPerot sensor,ultrasonicsensor,capacitive liquidlevel sensor.

UNIT V: FLOW,TEMPERATUREANDACOUSTICSENSORS **9**

Flowsensors:pressuregradienttechnique,thermaltransport,ultrasonic,electromagneticandLaseranemometer.microflow sensor, coriolismassflow anddrag flow sensor. Temperaturesensors-thermoresistive,thermoelectric,semiconductorandoptical.Piezoelectrictemperaturesensor.Acousticsensors-microphones-resistive,capacitive,piezoelectric,fiberoptic,solidstate- electrectmicrophone.

TOTAL:45 + 15 = 60 PERIODS

List of Experiments

1. Strain,Force,pressure,andtorquemeasurement
   StrainmeasurementwithBridgeCircuit

2. Developadisplacementmeasurementsystemwiththefollowingsensors:
   i. Inductivetransducer(LVDT)
   ii. Halleffect sensor

3. Afterstudyingthecharacteristicsoftemperaturesensorslistedbelow,developa temperaturemeasurement systemforaparticularapplicationusing thesuitablesensor.
   i. Thermocoupleprinciples
   ii. ThermistorandlinearizationofNTCThermistor

4. Developasensorsystemforforcemeasurementusingpiezoelectric transducer.

5. Measurementofshearstrainandangletwistusingstraingaugeisnotsuitableformanyapplications.Basedon othersensingexperimentscarried outsuggest a non-contactmethod and tryto completeits proofof concept.

OUTCOMES

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

- Useconceptsincommon methodsforconvertingaphysicalparameterintoanelectricalquantity
- Choose an appropriate sensor comparing different standards and guidelines to make sensitivemeasurementsofphysical parameters likepressure,flow, acceleration,etc
- Designanddevelopsensorsusingoptical methodswithdesiredproperties
- Evaluateperformancecharacteristicsofdifferent typesofsensors
- Locatedifferenttypeofsensorsusedinreal lifeapplicationsandparaphrasetheirimportance
- Createanalyticaldesignanddevelopmentsolutionsforsensors.

TEXTBOOKS

1. JacobFraden,"HandBookofModernSensors:physics,DesignsandApplications",2015,3rd edition,Springer,NewYork.
2. Jon.S.Wilson,"SensorTechnologyHandBook",2011,1stedition,Elsevier,Netherland.

REFERENCES

1. GerdKeiser,"OpticalFiberCommunications",2012,4thedition,McGraw-HillScience,Delhi.
2. JohnGWebster,"Measurement,InstrumentationandsensorHandbook",2014,2ndedition, CRCPress,Florida.

E-RESOURCES

1. https://nptel.ac.in/courses/105101206 (Remote sensing)
2. https://nptel.ac.in/courses/115107122 (Optical Sensor)

19EEESP01 **PROJECT** **LTPC**

00 126

OBJECTIVES

Themainobjectiveofthiscourseisto:

- Identifyaspecificproblemforthecurrentneedofthesocietyandcollectinginformationrelatedtothesamethrough detailedreviewofliterature.
- Buildupskillstoformulateatechnicalproject.
- Develop themethodologytosolve theidentifiedproblem.
- Teachuseofnewtools,algorithms andtechniquesrequired to carryout theprojects.
- Trainthestudents inpreparingprojectreportsandtofacereviews andviva-voceexamination.

GUIDELINEFORREVIEWANDEVALUATION

The students in a group of 3 works on a topic approved by the head of the department under theguidance of a faculty member who is familiar in this area of interest. The student can select any topic which isrelevant to the area of engineering design. The topic may be theoretical or case studies. At the end of thesemester, a detailed report on the work done should be submitted which contains clear definition of theidentified problem, detailed literature review related to the area of work and methodology for carrying out thework. The students will be evaluated through a viva-voce examination by a panel of examiners including oneexternalexaminer.

TOTAL:15PERIODS

OUTCOMES

Attheendoftheproject,thestudentswillbeableto:

- Formulate arealworldproblem,identifythe requirement anddevelopthedesign solutions.
- Identifytechnicalideas,strategiesandmethodologies.
- Utilize thenewtools,algorithms, techniquesthatcontribute toobtainthesolutionof theproject.
- Preparetechnicalreportandoralpresentations.
- AttheendofthecoursethestudentswillhaveaclearideaoftheirareaofworkandtheywillbeinapositiontocarryouttheremainingphaseIIworkinasystematicway.

CURRICULUM

FORB.E./B.Tech.DEGREEPROGRAMMES

(MINORDEGREE /HONOURS - SENSORS TECHNOLOGY)

CREDIT SUMMARY

B.E. –ELECTRICAL AND ELECTRONICSENGINEERING

Category	CreditsPer Semester								CreditTotal
	I	II	III	IV	V	VI	VII	VIII	
PC	-	-	3	3	3	4	-	-	13
EEC	-	-	-	-	-	-	6	-	6
Total	-	-	3	3	3	4	6	-	19