Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
DEEMED TO BE UNIVERSITY
University with Graded Autonomy Status
(An ISO 21001 : 2018 Certified Institution)
Periyar E.V.R. High Road, Maduravoyal, Chennai-95. Tamilnadu, India.

FACULTY OF ENGINEERING AND TECHNOLOGY

OUTCOME BASED EDUCATION

Curriculum and Syllabus

B.TECH (ELECTRICAL AND ELECTRONICS ENGINEERING)

(Part Time)

Regulation - 2022

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT VISION STATEMENT

To produce competent electrical engineers who can excel in education/research/entrepreneurship skills and thereby building an energy efficient society.

DEPARTMENT MISSION STATEMENT

M1	To involve students in practical engineering skills through quality education
M2	To inculcate creative, innovative paths for multidisciplinary research and higher education
M3	To enhance entrepreneurial skills in electrical engineering for the societal challenges
M4	To render services continuously to meet the requirements of changing world in the Electrical Engineering Industry by educating students for global competition

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1	To involve in challenging real time electrical engineering problems such as design, manufacturing and testing of electrical machines
PEO2	To exploit the areas of entrepreneurship to become effective entrepreneurs and managers for electrical industries
PEO3	To engage in solving complex problems by applying relevant tools, techniques and electrical softwares

PEO with MISSION STATEMENT

	M1	M2	M3	M4
PEO1	3	1	2	2
PEO2	2	3	3	2
PEO3	2	1	2	3

3/2/1 Indicates Strength of Correlation, 3 – High, 2- Medium, 1- Low

PROGRAMME OUTCOMES

PO1	**Engineering Knowledge:** Apply the Knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering Problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO3	**Design /development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental consideration.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team to manage projects and in multi-disciplinary environments
PO12	**Life –long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of Technological change

PEO-PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	2	3	3	2	2	2	2	2	2	3	2	1
PEO2	-	2	1	1	-	2	1	3	3	2	3	1
PEO3	2	3	2	2	3	2	2	3	3	2	1	2

3/2/1 Indicates Strength of Correlation, 3 – High, 2- Medium, 1- Low

PROGRAMME SPECIFIC OBJECTIVES

PSO1	To identify and investigate the problems in power system and provide solutions to the real time generation, transmission and distribution of power
PSO2	To analyze and develop the modern power electronic devices using latest software tools
PSO3	To design and manage the sustainable development in smart grid and electric vehicle technology.

PEO with PSO

	PSO1	PSO2	PSO3
PEO1	3	2	2
PEO2	2	2	3
PEO3	2	3	2

3/2/1 Indicates Strength of Correlation, 3 – High, 2- Medium, 1- Low

Faculty of Engineering and Technology

Regulation 2022 –Framework

Total Credits: 100

Credit for I TO VII Semester: 100 Credits (Maximum)

Program Components

• Basic Science (Mathematics) include according to program - 1		
• Program Core theory	-	15
• Program Core Laboratory	-	5
• Program Elective	-	5
• Open Elective	-	-
• Open Lab	-	-
• Foreign Language	-	-
• Audit course	-	-
• Universal Human values	-	-
• Inter disciplinary theory	-	2
• Inter disciplinary Lab	-	-
• ETL	-	4
• Technical Skills	-	-
• Soft skill	-	-
• Project /mini project	-	2

Curriculum - Electrical and Electronics Engineering (PT) 2022 Regulation

I SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBMA22009	Laplace and Fourier Transforms	Ty	3	1/0	0/0	4	BS
2	EBEE22002	DC Machines and Transformers	Ty	3	1/0	0/0	4	PC
3	EBEE22004	Electromagnetic Field Theory	Ty	3	0/0	0/0	3	PC
4	EBEE22ET2	Circuit Theory and Network Analysis	ETL	2	0/0	2/0	3	PC
PRACTICALS*								
1	EBEE22L11	Analog and Digital Electronics Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total : 15

II SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22005	AC and Special Machines	Ty	3	0/0	0/0	3	PC
2	EBEC22ID3	Communication Systems and IOT	Ty	3	0/0	0/0	3	ID
3	EBME22ID1	Thermodynamics and Fluid Mechanics	Ty	3	0/0	0/0	3	ID
4	EBEE22ET3	Linear and Digital Integrated Circuits	ETL	2	0/0	2/0	3	PC
PRACTICALS*								
1	EBEE22L12	Electrical Machines Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total : 13

Note:

Ty/Lb/ETL/IE: Theory/Lab/Embedded Theory and lab/Internal evaluation
L/T/SLr/P/R/C: Lecture/Tutorials/Supervised Learning/Practical/Research/Credit
HS: Humanities and Social Science, ES:Engg. Science. BS: Basic Science, PC:Program core, PE:Program Elective, OE:Open Elective, P:Project
HS: Humanities and Social Science, ES:Engg. Science. BS: Basic Science, PC:Program core, PE:Program Elective, OE:Open Elective, P:Project

III SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22006	Generation, Transmission and Distribution	Ty	3	0/0	0/0	3	PC
2	EBEE22008	Control System	Ty	3	0/0	0/0	4	PC
3	EBEE22003	Measurements and Instrumentation	Ty	3	0/0	0/0	3	PC
4	EBEE22ET4	Design of Electrical Machines	ETL	1	0/1	3/0	3	PC
PRACTICALS*								
1	EBEE22L13	Measurement and Control Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 14

IV SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22007	Power System Protection and Switchgear	Ty	3	0/0	0/0	3	PC
2	EBEE22009	Power Electronics	Ty	3	0/0	0/0	3	PC
3	EBXX22EXX	Program Elective I	Ty	3	0/0	0/0	3	PE
4	EBEE22ET5	Microprocessor Microcontroller and ARM Processor	ETL	3	0/0	0/0	3	PC
PRACTICALS*								
1	EBEE22L05	Power Electronics Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total: 13

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HS: Humanities and Social Science, ES:Engg. Science. BS: Basic Science, PC:Program core, PE:Program Elective, OE:Open Elective, P:Project

V SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22010	Power System Analysis	Ty	3	1/0	0/0	4	PC
2	EBEE22012	Electric Transients and High Voltage Engineering	Ty	3	0/0	0/0	3	PC
3	EBEE22EXX	Program Elective II	Ty	3	0/0	0/0	3	PE
4	EBEE22016	Energy Utilization and Conservation	Ty	3	0/0	0/0	3	PC
PRACTICALS*								
1	EBEE22L07	Power System Lab	Lb	0	0/0	3/0	1	PC

Credits Sub Total :14

VI SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22013	Power Quality and Control of Power system	Ty	3	0/0	0/0	3	PC
2	EBEE22EXX	Program Elective III	Ty	3	0/0	0/0	3	PE
3	EBEE22EXX	Program Elective IV	Ty	3	0/0	0/0	3	PE
4	EBEE22011	Solid State Drives	Ty	3	0/0	0/0	3	PC
PRACTICALS*								
1	EBEE22I05	Project Phase – 1	IE	0	0/0	3/3	2	P

Credits Sub Total :14

Note:

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HS: Humanities and Social Science, ES:Engg. Science. BS: Basic Science, PC:Program core, PE:Program Elective, OE:Open Elective, P:Project

VII SEMESTER								
S.NO.	**COURSE CODE**	**COURSE NAME**	**Ty/Lb/ ETL/IE**	**L**	**T/ SLr**	**P/R**	**C**	**Category**
1	EBEE22014	FACTs and HVDC Transmission	Ty	3	0/0	0/0	3	PC
2	EBEE22015	Smart Grid and Electric Vehicle Technology	Ty	3	0/0	0/0	3	PC
3	EBEE22EXX	Program Elective V	Ty	3	0/0	0/0	3	PE
PRACTICALS*								
1	EBEE22L10	Project Phase – II	Lb	0	0/0	16/16	8	P

Credits Sub Total :17

Note:

Ty/Lb/ETL/IE: Theory/Lab/Embedded Theory and lab/Internal evaluation
L/T/SLr/P/R/C: Lecture/Tutorials/Supervised Learning/Practical/Research/Credit
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HS: Humanities and Social Science, ES:Engg. Science. BS: Basic Science, PC:Program core, PE:Program Elective, OE:Open Elective, P:Project

Credit Summary

Semester : 1 : 15

Semester : 2 : 13

Semester : 3 : 14

Semester : 4 : 13

Semester : 5 : 14

Semester : 6 : 14

Semester : 7 : 17

Total Credits : 100

PROGRAM ELECTIVE –I								
S.NO.	COURSE CODE	COURSE NAME	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBEE22E01	Wind Energy Conversion Techniques	Ty	3	0/0	0/0	3	PE
2	EBEE22E02	IOT Applied to Electrical Engineering	Ty	3	0/0	0/0	3	PE
3	EBEE22E03	Mechatronics	Ty	3	0/0	0/0	3	PE
4	EBEE22E04	Fiber optics Communication	Ty	3	0/0	0/0	3	PE

PROGRAM ELECTIVE –II								
S.NO.	COURSE CODE	COURSE NAME	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBEE22E05	Solar Energy Conversion Techniques	Ty	3	0/0	0/0	3	PE
2	EBEE22E06	Green Building Technology	Ty	3	0/0	0/0	3	PE
3	EBEE22E07	Neural Networks and its Application	Ty	3	0/0	0/0	3	PE
4	EBEE22E08	Digital Signal Processing	Ty	3	0/0	0/0	3	PE

PROGRAM ELECTIVE –III								
S.NO.	COURSE CODE	COURSE NAME	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBEE22E09	Restructuring of Distribution System	Ty	3	0/0	0/0	3	PE
2	EBEE22E10	DG and Energy Storage Technology	Ty	3	0/0	0/0	3	PE
3	EBEE22E11	Material Science in Aviation	Ty	3	0/0	0/0	3	PE
4	EBEE22E12	Power Plant Instrumentation	Ty	3	0/0	0/0	3	PE

PROGRAM ELECTIVE –IV								
S.NO.	COURSE CODE	COURSE NAME	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBEE22E13	Safety for Electrical Engineers	Ty	3	0/0	0/0	3	PE
2	EBEE22E14	Wide Area Monitoring Protection and Control	Ty	3	0/0	0/0	3	PE
3	EBEE22E15	Robotics and Automation	Ty	3	0/0	0/0	3	PE
4	EBEE22E16	Image Processing	Ty	3	0/0	0/0	3	PE

PROGRAM ELECTIVE –V								
S.NO.	COURSE CODE	COURSE NAME	Ty/Lb/ ETL/IE	L	T/ SLr	P/R	C	Category
1	EBEE22E17	Substation Designing	Ty	3	0/0	0/0	3	PE
2	EBEE22E18	Industrial Control and Instrumentation	Ty	3	0/0	0/0	3	PE
3	EBEE22E19	Electric Traction	Ty	3	0/0	0/0	3	PE
4	EBEE22E20	Environmental Science and Engineering	Ty	3	0/0	0/0	3	PE

Table. 1: Components of Curriculum and Credit distribution for E&T Programmes

Course Component	Description	No. of Courses	Credits	Total	Credit Weightage (%)	Contact hours
Basic Science`	Theory	**1**	**4**			**60**
	Lab	**0**	**0**	**4**	**4**	**0**
	ETL	**0**	**0**			**0**
Engineering Science	Theory	**0**	**0**	**0**	**0**	**0**
	Lab					
	ETL					
Humanities and Social Science	Theory	**0**	**0**	**0**	**0**	**0**
	Lab					
	ETL					
Program Core	Theory	**15**	**48**			**720**
	Lab	**5**	**5**	**65**	**65**	**15**
	ETL	**4**	**12**			**240**
Program Electives	Theory	**5**	**15**	**15**	**15**	**225**
Open Elective	Theory	**0**	**0**	**0**	**0**	**0**
	Lab					
Inter-disciplinary	Theory	**2**	**6**			**90**
	Lab	**0**	**0**	**6**	**6**	**0**
	ETL	**0**	**0**			**0**
Skill Component		**0**	**0**	**0**	**0**	**0**
Internship/Project		**2**	**10**	**10**	**10**	**450**
Others if any NPTEL/SWAYAM Online Courses		**0**	**0**	**0**	**0**	**0**
	TOTAL	**35**	**100**	**100**	**100%**	**1800**

Note:

Basic Science: Mathematics, Physics and Chemistry.

Engineering Science: Engineering Graphics, Basics of Mechanical and Civil Engineering, Basics of Electrical and Electronics Engineering, C Programming and MS office tools, Python Programming

Humanities and Social sciences:

English, Foreign language, Environmental Studies, Management, Entrepreneurship, Indian Constitution and Indian Traditional Knowledge, Universal Human Values.

Skill Component:

Technical Skill, Soft Skill, internship.

Note:

Following categories should be available in the mapping page of each subject

Table 2: Revision/modification done in syllabus content:

S.No	Course (Subject) Code	Course (Subject) Name	Concept/ topic if any, removed in current curriculum	Concept/topic added in the new curriculum	% of Revision/ Modification done
1.	EBEE22001	Basic Electrical, Electronic and Instrumentation Engineering	Basics of power system	Sensors and Transducers	20%
2.	EBEE22ET2	Circuit Theory and Network Analysis	S-domain Analysis and network synthesis (poles and zeros transforms already learnt in BEE22001)	Resonance and three phase circuits **Lab component included** 1.Determination of self, mutual inductance and coefficient of coupling 2.Design and Simulation of low pass and high pass passive filters 3.Design and Simulation of series resonance circuit. 4.Design and Simulation of parallel resonant circuits 5.Simulation of three phase balanced and unbalanced star, delta networks	50%
3.	EBEE22003	Measurements and Instrumentation	Transducers and converters	Current, power and energy measurements	20%

3.	EBEC22IL3	Communication Systems and IOT Lab	Signal processing experiments were removed	IOT experiments were added	50%
4.	EBEE22006	Generation, Transmission and Distribution	Faults & Protection	Mechanical design of lines and Insulators (Unit II) Underground cables: Construction, Classification, Capacitance of 2 core and 3 core cables	30%
5.	EBEE22L02	Measurement and Instrumentation Lab	1.Ramp response Characteristic of filled in system thermometer. 2.P/I and I/P converter 3. Hall effect transducers	Study of CRO	20%
6.	EBEE22007	Power System protection and switchgear	Modeling of power system components	Protection schemes	20%
7.	EBEE22008	Control System		Conversion of state variable models to transfer function and vice versa	20%
8.	EBEE22009	Power Electronics	AC and DC drives	1. DC to DC converters 2. AC to AC converters	40%
9.	EBEE22L05	Power Electronics Lab	Dives experiments		20%

Table3:

List of New courses/ value added courses//life skills/Electives/interdisciplinary /courses focusing on employability/entrepreneurship/skill development.

S. No	New courses (Subjects)	Value added courses	Life skill	Electives	Inter Disciplinary	Focus on employability/entrepreneurship/ skill development
1.	EBMA22009/Laplace and Fourier Transforms				Yes	
2.	EBCS22ID2/ Artificial Intelligence and Expert systems				Yes	Employability
3.	EBEE22011/Solid State Drives					Employability
4.	EBEE22010/Power System analysis					Employability
5.	EBEE22012/Electric Transients and high voltage Engineering					Employability
6.	EBEE22014/FACTs and HVDC Transmission					Employability
7.	EBEE22015/Smart grid and Electric Vehicle Technology					Skill development/ Employability
8.	EBEE22E04/Fiber Optics Communication			Yes	Yes	
9.	EBEE22E15/Robotics and Automation					Employability
10.	EBEE22E20/Environmental Science and Engineering			Yes	Yes	

Course Code: EBMA22009	Course Name: LAPLACE AND FOURIER TRANSFORMS	Ty/Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: First year Engineering Mathematics	**Ty**	**3**	**1/0**	**0/0**	**4**

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Project R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES :

The student should be made to:

- To be able to understand concepts in Laplace Transforms
- To be able to apply Laplace Transforms
- To be able to understand concepts in Fourier series
- To understand the concepts in Fourier and Z Transforms

COURSE OUTCOMES (COs) :

CO1	To be able to understand the concepts in Laplace Transforms
CO2	To be able to apply Laplace Transforms
CO3	To be able to find fourier series solutions
CO4	To be able to apply Fourier transforms
CO5	To be able to apply Z transforms

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	1	1	2	2	1	1	2
CO2	2	2	1	3	1	2	1	2	3	1	1	2
CO3	3	2	1	3	2	3	2	1	1	2	1	3
CO4	3	2	1	2	1	3	2	1	1	1	1	2
CO5	3	3	1	2	1	2	2	1	1	2	2	3

COs / PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
	√											

Course Code: EBMA22009	Course Name: LAPLACE AND FOURIER TRANSFORMS	Ty/Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: First year Engineering Mathematics	**Ty**	**3**	**1/0**	**0/0**	**4**

UNIT I LAPLACE TRANSFORMS 12

Transforms of simple functions – Properties of Transforms – Inverse Transforms – Transforms of Derivatives and Integrals.

UNIT II APPLICATIONS OF LAPLACE TRANSFORMS 12

Periodic functions – Initial and final value theorems – Convolution theorem –Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients and Linear simultaneous differential equations of first order with constant coefficients.

UNIT III FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Half range Sine & Cosine series – Complex form of Fourier series – Parseval's identity –Harmonic Analysis.

UNIT IV FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pairs – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's theorem.

UNIT V Z TRANSFORMS AND DIFFERENCE EQUATION 12

Z-transforms – Elementary properties – Inverse Z transforms – Partial fraction – Residue method – Convolution theorem – Solution of difference equation using Z transform (simple problems).

Total no. of Periods: 60

REFERENCE BOOKS

1) Veerarajan T., Engineering Mathematics (for first year), Tata McGraw Hill Publishing Co., (2008).
2) Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw Hill Publishing Co., (2005).
3) Singaravelu, Transforms and Partial Differential Equations, Meenakshi Agency, (2017).
4) Kreyszig E., Advanced Engineering Mathematics (9 th ed.), John Wiley & Sons, (2011).
5) Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, (2012).

Course Code: EBEE22002	Course Name: DC MACHINES AND TRANSFORMERS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: **Basic Electrical, Electronics and Instrumentation Engineering**	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To provide the knowledge on the basic concepts of the rotating circuits.
- To familiarize and understand the working principle of the DC machines, transformers and their performance characteristics
- To provide knowledge on transformer connections
- To provide knowledge on starting and methods of speed control of motors.
- To study the various losses and different testing methods for DC machines and Transformers

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Evoke the principles behind Electrical machines
CO2	Comprehend the working of Generators, Transformers and Motors
CO3	Articulate the characteristics of Generators, Transformers and Motors
CO4	Analyze and design of the Electrical machines
CO5	Scrutinize and test the dc machines & transformers

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	3	2	2	1	3	2	1
CO2	3	2	2	2	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	3	3	3	3	3	2	1
CO5	3	3	3	3	3	3	3	3	3	3	2	2

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	2	2	1
CO3	3	1	2
CO4	2	2	3
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22002	Course Name: DC MACHINES AND TRANSFORMERS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	1/0	0/0	4

UNIT I ELECTROMECHANICAL ENERGY CONVERSION 12

Principles of electromechanical energy conversion – Energy, Co-energy – Elementary concepts of rotating machines – – Rotating magnetic field – generated voltage–Torque –Magnetic Leakage

UNIT II DC GENERATORS 12

Constructional features of DC machine – Principle of operation of DC generator – EMF equation – Methods of excitation and types of DC generators – Characteristics of Series, Shunt and Compound DC generators –Armature reaction – Commutation – Methods of improving commutation – Parallel operation of DC shunt and compound generators

UNIT III DC MOTORS 12

Principle of operation of DC motors–Back EMF and its significance–Torque equation–Types of DC motors– Voltage Equation – Characteristics of DC series, shunt and compound motors– Starting of DC motors–Types of starters–Speed control of DC series and shunt motors– Power flow, losses and efficiency

UNIT IV TRANSFORMERS 12

Principle of operation – Constructional features of single phase and three phase shell type and core type transformers– EMF equation–Transformer on No load and Load–Phasor diagram–Parameters referred to HV/ LV windings – Equivalent circuit – three phase transformers-connections – Scott Connection-Regulation —Autotransformers

UNIT V TESTING OF DC MACHINES & TRANSFORMERS 12

Losses and efficiency in DC Machines and transformers – Condition for maximum efficiency – Testing of DC machines – Brake test, Swinburne's test, Retardation test and Hopkinson's test – Testing of transformers –Polarity test, load test, open circuit and short circuit tests, Sumpner's test–All day efficiency.

Total No. of Periods :60

TEXT BOOKS

1. Kothari, D.P, Nagrath, I.JN (2010) Electrical Machines. Tata McGraw Hill Publishers.
2. Murugesh Kumar, K. (2003) DC Machines & Transformers. Vikas Publishing House Pvt Ltd.
3. Theraja, B.L. Chand, S. (2011) Electrical Technology Volume. II AC/DC Machines.

REFERENCE BOOKS

1. Fitzgerald, A. E, Charles Kingsley Jr, Stephen, D. Umans (2020) Electric Machinery. 7th Ed, McGraw Hill Companies.
2. Hill Stephen, J. Chapman, (2012) Electric Machinery Fundamentals, 5th Ed, McGraw Hill Companies, New Delhi
3. Bimbhra, P.S. (2003) Electrical Machinery. Khanna Publishers.
4. Gupta, JB. (2015) Theory & Performance of Electrical Machine, S.K. Kataria & Sons

Course Code: EBEE22004	Course Name: ELECTROMAGNETIC FIELD THEORY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

OBJECTIVE:

- To acquire knowledge in Electromagnetic field theory
- To provide a solid foundation in Electrostatics such as Dipole, Capacitance
- To attain familiarity in Boundary conditions and Magnetic field
- To understand the relation between field theory and circuit theory
- To identify the electromagnetic wave propagation in medium

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Recall the basics of electromagnetic field theory
CO2	Realize the concepts like Electrostatics such as Dipole, Capacitance and electric potential etc
CO3	Investigate the Boundary conditions in Electric and Magnetic field
CO4	Analyze the various concepts in Electric and magnetic fields
CO5	Inspect the wave propagation in various media

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	3	2	2	1	3	2	1
CO2	3	2	2	2	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	3	3	3	3	3	2	1
CO5	3	3	3	3	3	3	3	3	3	3	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	2	3
CO3	2	2	2
CO4	3	3	2
CO5	1	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22004	Course Name: ELECTROMAGNETIC FIELD THEORY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	0/0	0/0	3

UNIT I ELECTROSTATIC FIELD 9

Introduction- Concepts of different co-ordinate systems –Electric field intensity– Electric flux density-electric fields due to charge distributions– Electric potential – potential gradient –Gauss law & Coulomb's law with Application

UNIT II ELECTROSTATICS 9

Field due to dipoles – Dipole moment – Current and Current density, Boundary conditions at dielectric and conductor surfaces – Capacitor - Capacitance– Energy stored and energy density – Capacitance due to Spherical shell, Coaxial cable

UNIT III MAGNETOSTATICS 9

Introduction to Magnetic materials- Magnetic field intensity- Magnetic flux density (B) – B in free space, conductor, magnetic materials. Magnetization and Permeability – Boundary conditions- Lorentz Law of force– Biot-Savart Law – Ampere's Law –Magnetic field– Scalar and vector potential – Magnetic force –Torque– Inductance

UNIT IV ELECTRODYNAMICFIELDS 9

Faraday's law, induced EMF – transformer and motional EMF, Maxwell's equations (differential and integral forms) – Displacement current - Relation between field theory and circuit Theory.

UNIT V ELECTROMAGNETIC FIELDS AND WAVE PROPAGATION 9

Generation – electromagnetic wave equations – Wave parameters- velocity, intrinsic impedance, propagation constant – Wave propagation in free space, loss and lossless dielectrics, conductors – skin depth, Poynting vector

Total No. of Periods: 45

TEXT BOOKS

1. William Hayt, (2005) Engineering Electromagnetics.7th Edn, McGraw Hill.
2. Matthew. N.O. Sadiku, (2007) Elements of Electromagnetics.4th Edn, First Indian Edition, Oxford University Press.
3. Ashutosh Pramanik, (2006) Electromagnetism – theory and application, Prentice Hall of India Private Ltd.

REFERENCE BOOKS

1. David K. Cheng, (2004) Field and Wave Electromagnetics, 2nd Edn, Pearson Education.
2. William H. Hayt Jr, John A. Buck, (2006) Engineering Electromagnetics, 7th Edn, Tata McGraw Hill Publishing Company Ltd.
3. Edminister, J.A. Schaum's, (2006) Theory and problems of Electromagnetics, 2nd Edn, Special Indian Edition, Tata McGraw hill.

Course Code: EBEE22ET2	Course Name: CIRCUIT THEORY AND NETWORK ANALYSIS	Ty/ Lb/ ETL/IE	L	T/S Lr	P/ R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	ETL	2	0/0	2/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the basics of Electric Circuits
- To impart knowledge on network theorems
- To impart knowledge on the concepts of transient response of circuits
- To understand Network graphs, cut sets and Duality of the network
- To understand and solving the two port networks, various types of filters and Attenuators

COURSE OUTCOMES (Cos): (3-5)

CO1	Apply the knowledge of circuital laws and reduce any given electrical network
CO2	Ability to solve simplest to complex circuits by applying circuital laws and theorem
CO3	Knowledge about Coupled circuits and Transient Response of Circuits
CO4	Familiarization of Network graphs and solve two port networks
CO5	Ability to build electric circuits and analyze voltage, current & power flow through the circuit

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	2	3	2	3	2
CO2	2	1	1	2	2	1	1	2	3	2	3	2
CO3	2	1	2	1	1	2	2	1	3	2	3	1
CO4	1	2	1	2	2	2	3	1	2	3	3	1
CO5	3	3	3	3	2	3	2	1	2	2	3	1

COs / PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	2	2	2
CO3	3	1	1
CO4	3	2	3
CO5	2	3	2

3/2/1 Indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22ET2	Course Name: CIRCUIT THEORY AND NETWORK ANALYSIS	Ty/ Lb/ ETL/IE	L	T/S Lr	P/ R	C
	Prerequisite: Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	ETL	2	0/0	2/0	3

UNIT I BASIC CIRCUIT CONCEPTS 9

Basic circuit elements-Ideal sources-Ohm's law-Kirchoff's voltage laws-Network reduction: Voltage and Current division, Source Transformation-Series and Parallel combination of R, L and C – Mesh and Nodal analysis for D.C and A.C circuits

UNIT II NETWORK THEOREMS AND COUPLED CIRCUITS 9

Network theorems (Analysis of DC and AC Circuits): Thevenin, Norton, Superposition, Maximum power transfer and Reciprocity.

UNIT III NETWORK TOPOLOGY AND TRANSIENT ANALYSIS 9

Graph theory -Branch Nodal Analysis-Link loop Analysis-Tie set and Cut set matrices- Duality. Transients: Behavior of circuit elements under switching conditions and their representation- Forced and free Response of RL, RC, RLC circuits with DC and AC excitations.

UNIT IV TWO PORT NETWORKS, FILTERS AND ATTENUATORS 9

Characterization of two port networks in terms of Z, Y, H and T parameters-network equivalents -Relation between Network parameters- Analysis of T, Ladder, Bridged T and Lattice Networks - Filters

UNIT V RESONANCE AND THREE PHASE CIRCUITS 9

Series and parallel resonance – their frequency response – Quality factor and Bandwidth - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced-power measurement in three phase circuits

LAB COMPONENT: 15

1. Experimental verification of Kirchhoff's voltage and current laws and Current and Voltage Division and Source Transformation
2. Verification of Nodal and Mesh Analysis.
3. Experimental verification of theorem.
4. Experimental determination of time constant of series R-C electric circuits
5. Experimental determination of frequency response of RLC circuits.
6. Determination of two port network parameters.
7. Experimental determination of power in three phase circuits by two-wattmeter method
8. Simulation of three phase balanced and unbalanced star, delta networks circuits

Total No. of Periods: 60

TEXT BOOKS

1. Sudhakar, A. Shyammohan, S. and Palli (2015) Circuits and Networks: Analysis and Synthesis,5th Edn, Tata McGraw-Hill
2. A. Chakrabarthy (2010), Circuit Theory. 5th Ed. Dhanpat Rai & Sons Publications, New Delhi.
3. Smith, K.A. and. Alley, R.E (2014) Electrical Circuits, Cambridge University Press

Course Code: EBEE22L11	Course Name: ANALOG AND DIGITAL ELECTRONICS LAB	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Diploma basic Electronics	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To know the basic knowledge of logic gates
- Design knowledge on implementation of Boolean Function
- Students able to design Counters, Registers using flip-flops
- Students acquire knowledge in programming of very log HDL
- To study about multiplexers and de multiplexers

COURSE OUTCOMES (Cos): (3-5)

CO1	Understand the basic concepts of logic gates
CO2	Familiarization to the Design and implementation of Boolean Function
CO3	Understand about Counters, Registers using flip-flops
CO4	Understand the concepts in programming of very log HDL
CO5	Capable to understand about multiplexers and de multiplexers

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	2	3	3	2	1	2
CO2	2	2	2	2	3	3	2	2	2	1	2	3
CO3	3	3	3	2	2	2	3	3	2	3	2	1
CO4	3	3	2	2	1	1	2	3	2	2	3	2
CO5	2	2	2	2	1	2	2	3	2	1	2	2

COs / PSOs	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	2	2	3
CO3	3	2	2
CO4	3	2	1
CO5	3	2	1

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Science	Humanities & Social	Program Core	Program Elective	Open Elective	Practical/ Project	Internships/Technical skills	Soft skills
				✓					

Course Code: EBEE22L11	Course Name: ANALOG AND DIGITAL ELECTRONICS LAB	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Diploma basic Electronics	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS

1. Study of Logic Gates & Digital Logic families
2. Implementation of Boolean functions
3. Adders & Subtractors
4. Multiplexers and de-multiplexers
5. Study of Flip-flops
6. Study of Registers
7. Study of Counters
8. Design and Testing of RC Phase shift, LC Oscillators
9. Single phase half wave and full wave rectifiers with inductive and capacitive filters
10. A stable and Mono stable Multi vibrators

Total No. of Periods: 45

Course Code: EBEE22005	Course Name: AC AND SPECIAL MACHINES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: DC Machines and Transformers	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- Understands the construction and operation of Synchronous generator
- Acquires Knowledge about synchronous motors used in the Power system
- Able to learn about three phase induction motor and to draw the circle diagram of Induction machine
- Gains knowledge in starting and speed control of three phase induction motor
- Understand the concepts of various special machines involved in the power system network

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Recognize the AC and Special machines
CO2	Demonstrate the working principle of Synchronous Generator, Induction Motors and various Special Machines
CO3	Apply the concept learn about the machines in real time to exhibit a cost-effective solution
CO4	Analyze the complex issues in using the synchronous generators, induction motors and special machines and provide a suitable solution to meet the requirement
CO5	Simplify the structure and design of Synchronous generators, induction motors and Special machines

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	3	2	3	2	2	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	2	2	2	3	2	2	3	2	3	2	2	3
CO4	3	3	3	2	3	3	2	3	2	3	3	2
CO5	2	2	2	3	2	2	3	2	3	2	2	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	2	2	3
CO4	3	1	2
CO5	2	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22005	Course Name: AC AND SPECIAL MACHINES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: DC Machines and Transformers	Ty	3	0/0	0/0	3

UNIT I SYNCHRONOUS GENERATOR 9

Types & Constructional Features of Synchronous Generators– EMF Equation – Synchronous reactance – Armature reaction – Voltage regulation – EMF, MMF and ZPF methods – Change of excitation and mechanical input - Application

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – Construction – Equivalent Circuit and phasor diagram – Power and Torque – Power flow – Power developed by synchronous motors – Speed-Torque characteristics – Effect of change in excitation – V curves and inverted V curves – Hunting & suppression - Application

UNIT III THREE PHASE INDUCTION MOTOR 9

Construction – Types of rotors – Cage and wound rotor machines – Principle of operation – Production of rotating magnetic field – Equivalent circuit – Torque and Power output – Torque-slip characteristics – Condition for maximum efficiency – Testing – Load Test – No load and Blocked rotor test – Circle diagram.

UNIT IV STARTING & SPEED CONTROL OF INDUCTION MOTORS 9

Necessity for Starters – Starting methods of three phase induction motor – Types of Starters – Stator resistance and reactance – Rotor resistance starter- **s**tar-delta starter – Cogging & Crawling – Speed control – Voltage control –Rotor resistance control.

UNIT V SPECIAL MACHINES 9

Single phase induction motor – Constructional details – Double revolving field theory – Equivalent circuit –Speed-torque characteristics – Starting methods – Split-phase motor - shaded-pole induction motor – Universal motor – Variable Reluctance motor, Switched Reluctance Motor, Stepper Motor, Permanent Magnet Motors - Application

Total No. of Periods: 45

TEXT BOOKS

1. Nagrath, I.J. Kothari, D.P. (2005) Electric Machines.7th Ed. New Delhi: T.M.H publishing Co Ltd.
2. Bhimbhra, P.S. (2007) Generalised Theory of Electrical Machines, Khanna Publishers.
3. E.G. Janardanan (2014) Special electrical machines, PHI learning Private Limited, Delhi.
4. Bhimbhra, P.S. (2003) Electrical Machinery. Khanna Publishers.

REFERENCE BOOKS

1. Fitzgerald, Kingsley, Umans, (1990) Electric Machinery. 5th Ed. New Delhi: McGraw Hill Books co.
2. Stephen J. Chapman, (1985) Electric Machinery Fundamentals. New Delhi: McGraw Hill Book Co.
3. Say, M.G. (1980) Alternating current Machines.4th Ed. ELBS & Pitman. London:
4. Sen, S.K. (1984) Electrical Machinery. New Delhi: Khanna Publishers.
5. Mukherjee, P.K. and Chakravorty, S (2004) Electrical Machines, Dhanpat Rai& Sons.

Course Code: EBEC22ID3	Course Name: COMMUNICATION SYSTEMS AND IOT	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To understand the Analog & Digital Communication.
- To study about the methods to convert Analog to Digital communication using code theory.
- To study about different modulation techniques
- To introduce various media for digital communication
- To apply the concept of Internet of Things in the real-world scenario

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Understand the concept of Analog and Digital Communication
CO2	Relate various communication techniques, modulation scheme and IOT
CO3	Illustrate the application of IOT, modulation and information theory
CO4	Paraphrase the concept of communication system and IOT
CO5	Connect various communication devices with modern tool for better sustainability

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	3	1	2	1	3	3	3
CO2	3	2	2	2	3	3	1	2	3	2	2	2
CO3	2	3	3	2	3	2	1	2	3	1	2	2
CO4	3	2	3	2	3	3	3	2	2	3	2	1
CO5	3	3	2	1	3	3	3	3	1	2	3	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	3	2	3
CO4	2	1	2
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
							✓		

Course Code: EBEC22ID3	Course Name: COMMUNICATION SYSTEMS AND IOT	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: **Basic Electrical, Electronics and Instrumentation Engineering**	Ty	3	0/0	0/0	3

UNIT I SIGNALS & NOISE 9

Periodic & Aperiodic Signals – Noise - External Noise – Thermal Agitation – Shot Noise – Noise Figure – Signal to Noise ratio – Equivalent Noise resistance.

UNIT II INTRODUCTION TO COMMUNICATION 9

Basic Communication systems – Need for Modulation in communication systems – Amplitude Modulation – Double Side Band Amplitude Modulation – Single sideband and VSB modulation – modulators. AM Transmitter and Receiver, FM transmitter and Receiver.

UNIT III MODULATION TECHNIQUES AND PULSE MODULATION 9

Phase modulation – Noise triangle – Pre-emphasis and de-emphasis – Stereophonic FM multiplex system – comparison of wideband and narrow band FM – AFC – Sampling theorem –Quantization, Quantization Error, PAM, PWM, PPM, PCM.

UNIT IV DIGITAL MODULATION & INFORMATION THEORY 9

ASK, FSK, PSK, Transmitter and Receiver. Introduction-Information & Entropy, Source Coding Theory, Discrete Memory less Channel, Mutual Information Channel Capacity, Channel Coding Theory.

UNIT V INTERNET OF THINGS 9

Introduction – Block diagram of IoT- IoT Architecture – Communication Technologies in IoT – Cloud Storage in IoT-Data Storage in IoT – Applications of IoT – Smart Home, Smart City, Smart Agriculture, Health Monitoring System.

Total No. of Periods: 45

TEXT BOOKS

1. Roy Blake, (2002) Electronic Communication systems. 2nd Edn, Thomson Learning.
2. George Kennedy, (1992) Electronic communication systems, Tata McGraw Hill publications.
3. Michael Miller, (2015) The Internet of Things, Que Publishing

REFERENCE BOOKS

1. Bruce Carlson, A. Taub & Schilling, (1986) Principles of Communication Systems, Tata McGraw Hill.
2. Simon Haykins, (2001) Principles of Communications, Prentice Hall of India.
3. Arshdeep Bahga, Vijay Madisetti (2015) Internet of Things – A hands-on approach, Universities Press

Course Code: EBME22ID1	Course Name: THERMODYNAMICS AND FLUID MECHANICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: **Basic Mechanical & Civil Engg**	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To understand the basic Laws of Thermodynamics and the working principle of IC Engines.
- To understand the design of Turbines and boilers.
- To understand the properties of Fluids and implementation of Hydraulic machinery & Pumps.
- To know the importance, application and inter relationship of various properties of fluid
- To study about various types of pumps and turbines

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Capable to understand the basic Laws of Thermodynamics and the working principle of IC Engines
CO2	Students are capable to design turbines and boilers.
CO3	Students can demonstrate the properties of Fluids and implementation of Hydraulic machinery & Pumps.
CO4	Acquire knowledge on the importance, application and inter relationship of various properties of fluid
CO5	Acquire knowledge on various types of pumps and turbines

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	3	3	2	3	1	2	1
CO2	2	2	2	2	1	3	3	2	2	1	1	1
CO3	3	1	2	1	2	2	2	2	3	1	2	1
CO4	2	2	2	3	2	3	3	2	2	2	1	1
CO5	3	2	1	2	1	2	2	2	3	2	1	1

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	3
CO3	3	2	2
CO4	3	2	3
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
							√		

Course Code: EBME22ID1	Course Name: THERMODYNAMICS AND FLUID MECHANICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: **Basic Mechanical & Civil Engg**	**Ty**	**3**	**0/0**	**0/0**	**3**

UNIT I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 9

Thermodynamics systems, Concepts of continuum, Thermodynamics properties, Equilibrium, Process, Cycle, Work, Heat, Temperature, Zeroth law of thermodynamics. First law of thermodynamics – Applications to closed and open systems – Steady flow Energy Equations – Simple Problems

UNIT II SECOND LAW OF THERMODYNAMICS 9

Statements, Reversibility, causes of irreversibility, Carnot Cycle, Reversed Carnot Cycle, Heat Engines, Refrigerators, Heat Pumps - Clausius Inequality – Entropy - Principles of increase of entropy - Carnot theorem.

UNIT III POWER CYCLES 9

Air cycles – Assumptions - Otto, Diesel, Dual and Brayton cycle – Air standard efficiency – Mean effective pressure – Working of two stroke and Four Stroke Petrol and Diesel Engines.

UNIT IV FLUID MECHANICS 9

Fluid properties; fluid statics, manometer, control-volume analysis of mass, momentum and energy; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

UNIT V FLUID MACHINERY 9

Introduction, types of pumps – reciprocating pump – centrifugal pump - construction details – working principles, Pelton-wheel, Francis and Kaplan turbines – construction and working principles.

Total No. of Periods :45

TEXT BOOKS

1. Nag, P.K. Engineering Thermodynamics,2nd Edn, Tata McGraw Hill Publishing Company Ltd.
2. Rajput R.K., Fluid Mechanics and Hydraulic Machines, S. Chand and Co., India

REFERENCE BOOKS

1. Holman, J.P. (1995) Thermodynamics, McGraw Hill.
2. Yunus A. Cengel, Thermodynamics-An Engineering Approach. , Tata Mc.Graw Hill.
3. Bansal R.K., A Text Book of Fluid Mechanics and Hydraulic Machines, S. Chand and Co., India

Course Code: EBEE22ET3	Course Name: LINEAR AND DIGITAL INTEGRATED CIRCUITS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	ETL	2	0/0	2/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study the IC fabrication procedure.
- To study characteristics, realize circuits and design for signal analysis using Op-amp ICs.
- To study internal functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits, ADC
- Familiarity of different types of gates using truth table with logic circuits.
- Familiarity to use logic gates in sequential and combinational circuits.

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Understands the Electronics Devices in integrated form
CO2	Describe the constructional feature of Regulators, Op-Amp, ICs
CO3	Apply the basic concept and can fabricate special ICs for better application and reduce the cost
CO4	Choose the appropriate IC for the best solution and infer the societal needs
CO5	Modify the design of combinational circuits and apply the ICs and Op. Amp to build a sustainable Society

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	2	2	2	2	2	2	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	3
CO3	3	3	3
CO4	2	2	3
CO5	3	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22ET3	Course Name: LINEAR AND DIGITAL INTEGRATED CIRCUITS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	ETL	2	0/0	2/0	3

UNIT I IC FABRICATION 9

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities. Realization of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance and FETs

UNIT II CHARACTERISTICS AND APPLICATIONS OF OP AMP 9

Ideal OP-Amp characteristics, offset voltage and current, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp – summer, differentiator and integrator - Instrumentation amplifier, comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit

UNIT III SPECIAL IC'S 9

555 Timer circuit – Functional block, characteristics & applications; 566-voltage controlled oscillator circuit; 565-phase lock loop circuit functioning and applications, Analog multiplier ICs

UNIT IV 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, - Deriving a Boolean equation from truth table - simplification of Boolean functions using K-map & Quine McCluskey method, Implementation of a Boolean function using Logic gates and universal gates.

UNIT V COMBINATIONAL CIRCUITS AND SEQUENTIAL CIRCUITS 9

Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and de-multiplexers - Function realization multiplexers - Latches-Flip flops - Mealy and Moore Models- Design of Shift Registers and counters (Synchronous and Asynchronous Sequential Circuits)-Hazards

LAB COMPONENT: 15

1. Measurement of Op-Amp Characteristics.
2. Op-amp applications I – Inverting & Non-inverting amplifier, summer, Multiplier, logarithmic and differential amplifiers, Integrator.
3. Op-amp applications –II –Wave form generation, multi-vibrators.
4. Voltage controlled oscillator.
5. A/D & D/A converters.
6. Study and Implementation of Logic gates.
7. Design and implementation of code converters using logic gates.
8. Design and implementation of 3-bit synchronous up/down counter.
9. Implementation of SISO, SIPO, PISO and PIPO shift registers using flip-flops.

Total No. of Periods: 60

TEXT BOOKS

1. Ramakant, A. Gayakward, (2003) Op-amps and Linear Integrated Circuits, 6th Edn, Pearson Education PHI.
2. Roy Choudhary, D. SheilB. Jani, (2003) Linear Integrated Circuits, 2nd Edn, NewAge.
3. Morris Mano, M. (2002) Digital Logic and Computer Design, Prentice Hall of India

REFERENCE BOOKS

1. Jacob Milman, Christos C. Halkias, (2003) Integrated Electronics- Analog and Digital circuits system, Tata McGraw Hill.
2. Robert F. Coughlin, Fredrick F. Driscoll, (2002) Op-amp and Linear ICs. 4th Edn, Pearson Education, PHI.
3. Charles H. Roth, (2002) Fundamentals Logic Design, 4th Edn, Jaico Publishing.
4. Floyd, (2003) Digital Fundamentals,8th Edn, Pearson Education.
5. John F. Wakerly, (2002) Digital Design Principles and Practice,3rd Edn, Pearson Education

Course Code: EBEE22L12	Course Name: ELECTRICAL MACHINES LAB	Ty /Lb/ ETL/IE	L	T / S.Lr	P / R	C
	Prerequisite: DC Machines and Transformers, AC and Special Machines	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To analyze the Internal and External Load Characteristics for DC Generators and Motors
- To determine the speed control using different methods for DC Motor and Generator
- To find the constant loss and copper loss of DC Machines
- To analyze the Load Characteristics of Synchronous machines
- To find Voltage Regulation of Synchronous machines.
- To study the effect of frequency and voltage control action of Three phase induction machines.

COURSE OUTCOMES (Cos): (3-5)

CO1	Analyze the Load Characteristics of DC Generators and Motors
CO2	Determine different methods of speed control for DC Machines
CO3	Understand the losses incorporated in DC Machines
CO4	Determine the characteristics of transformers and induction motors.
CO5	Understand the basic knowledge of alternators

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	1	2	3	2	3	2	3	2
CO2	2	2	3	2	1	3	2	2	3	2	3	2
CO3	3	3	2	2	1	2	3	1	3	2	3	3
CO4	3	3	3	2	2	2	3	2	2	2	3	1
CO5	3	3	3	3	3	3	3	2	3	2	3	3

COs / PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	2
CO3	3	2	1
CO4	2	3	2
CO5	3	2	3

3/2 /1 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project			
				√								

Course Code: EBEE22L12	Course Name: ELECTRICAL MACHINES LAB	Ty /Lb/ ETL/IE	L	T / S.Lr	P / R	C
	Prerequisite: DC Machines and Transformers, AC and Special Machines	**Lb**	**0**	**0/0**	**3/0**	**1**

LIST OF EXPERIMENTS

1. Open Circuit Characteristics Of DC Shunt Generator
2. Load Characteristics of DC Compound Generator
3. Load test on DC Shunt Motor
4. Load test on DC Series Motor
5. Swinburne's Test
6. OC and SC test on Single Phase Transformer
7. Load test on Single Phase Transformer
8. Load Test on Three Phase Alternator
9. Load Test on Three Phase Induction Motor
10. Load Test on Single Phase Induction Motor

Total No. of Periods: 45

Course Code: EBEE22006	Course Name: GENERATION, TRANSMISSION AND DISTRIBUTION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: **Electromagnetic field theory**	Ty	3	0/0	0/0	3

L:Lecture T:Tutorial SLr: Supervised Learning P:Project R: Research C: CreditsT/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To learn about Power system
- To know about transmission line parameters
- To model the transmission lines
- To learn about distribution and substation
- To know about the fault and protection

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Recognise the various methods of power generation and its functional component
CO2	Identify the performance parameters for the power generation and transmission systems
CO3	Analyze various factors which effect the power system structure
CO4	Describe the mechanical design, electrical design and the performance of the transmission line along with the supporting equipments
CO5	Examine electrical faults and different protective equipments in power system

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	2	3	2	3	2
CO2	2	2	2	3	2	3	1	3	3	2	3	3
CO3	3	3	2	3	2	3	3	3	2	3	3	2
CO4	2	2	2	3	3	3	3	2	3	2	3	2
CO5	3	3	3	2	3	2	2	3	2	3	2	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	1	2	3
CO4	2	1	2
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22006	Course Name: GENERATION, TRANSMISSION AND DISTRIBUTION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Electromagnetic Field Theory	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO POWER SYSTEM 9

Conventional sources of energy – Thermal, Nuclear, Diesel, Gas etc – Non-conventional Sources of Energy – Solar, Wind, Biomass, Geothermal, Tidal – Structure of Electrical Power System – Different operating Voltages

UNIT II MECHANICAL DESIGN OF LINES, CABLES AND INSULATORS 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: Construction, Classification, Capacitance of 2 core and 3 core cables

UNIT III TRANSMISSION LINE PARAMETERS 9

Parameters of Resistance, Inductance and Capacitance calculations - Single and three phase transmission lines - Single and Double circuits - Solid, Stranded and Bundled Conductors - Symmetrical and Unsymmetrical Spacing – Transposition of Lines - Concepts of GMR and GMD - Skin and Proximity Effects

UNIT IV MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Classification of 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, surge impedance loading, methods of voltage control; Ferranti effect

UNIT V DISTRIBUTION SYSTEM AND SUBSTATIONS 9

Feeders, distributors and service mains – DC distributor – 2-wire and 3-wire, radial and ring main distribution - AC distribution – single phase and three phase 4-wire distribution – Substation - Classification, functions and major components - sample substation layout

Total No. of Periods:45

TEXT BOOKS

1. V. K. Mehta, “Principles of Power Systems”, S. Chand, New Delhi, 2005
2. S.N. Singh, ‘Electric Power Generation, Transmission and Distribution’, Prentice Hall of India Pvt. Ltd, New Delhi, 2002
3. Arun Ingole (2017) Power Transmission and distribution. Pearson Education.
4. Chakrabarti, A. Soni, M.L. Gupta, P.V. Bhatnagar, U.S. (2002) A Text Book on Power System Engineering. Dhanpat Rai & Co. Pvt. Ltd

REFERENCE BOOKS

1. Patra, S.P. Basu, S.K. and Chowduri, S. (1983) Power systems Protection. Oxford and IBH
2. Sunil S. Rao, (1986) Switchgear and Protection. New Delhi: Khanna Publishers
3. Central Electricity Authority (CEA), ‘Guidelines for Transmission System Planning’, New Delhi

Course Code: EBEE22008	Course Name: CONTROL SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Laplace and Fourier Transforms	Ty	3	1/0	0/0	4

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- Understand the basic components of control systems
- Capable to solve problems in time domain & frequency domain
- Understand the frequency response for the stability of the system
- Understand the concept of Compensators
- Understand the State space Analysis of different variables

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Summarize the fundamental concepts of control systems
CO2	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions
CO3	Illustrate the time and frequency-domain responses of any control system and will be able to focus on stability of a closed-loop control system
CO4	Identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system.
CO5	Create various control system applications related to industries

Mapping of Course Outcome with Program Outcome (Pos)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	1	2	2	2	3	3
CO2	3	3	3	3	3	2	2	2	2	1	1	2
CO3	3	3	3	3	3	2	1	2	1	1	1	2
CO4	2	2	2	3	3	2	1	1	2	1	1	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	3
CO3	2	2	3
CO4	3	3	2
CO5	2	2	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium ,1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22008	Course Name: CONTROL SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Laplace and Fourier Transforms	Ty	3	1/0	0/0	4

UNIT I INTRODUCTION TO CONTROL SYSTEMS COMPONENTS 12

Open and closed loop Systems - mathematical models of physical systems – differential equations - transfer function – armature control - field control – block diagram reduction - signal flowgraphs

UNIT II TIME RESPONSE ANALYSIS 12

Standard test signals – time response of first order – second order systems-steady state errors and error constants

UNIT III FREQUENCY RESPONSE AND CONCEPT OF STABILITY 12

Bode plot, polar plot, Nyquist Stability-Concept of stability-necessary conditions-Hurwitz stability criterion-Routh stability criterion-relative stability analysis.

UNIT IV INTRODUCTION TO DESIGN OF COMPENSATORS 12

Realization of basic compensators-lag, lead, lag-lead. Introduction to P, PI, PD, PID controllers, tuning of PID controllers

UNIT V STATE SPACE REPRESENTATION 12

Concept of state-State Variable representation-conversion of state variable models to transfer functions- Conversion of transfer function to state variable models – Solution of state equations – Concepts of controllability and observability.

Total No. of Periods:60

TEXT BOOKS

1. Nagrath,L.J.Gopal,M.(2017) Control System Engineering. 6th Ed. Newage International (P) Ltd Publishers.
2. Ogata, K. Modern Control Engineering-analysis of system dynamics, system design using Root Locus. 4thEd. Prentice Hall for practice and solutions.

REFERENCE BOOKS

1. www.GaliLMc.com-GALIL we move the world-featured tutorials–motion controllers, tuning servo systems, adjustment of PID filter.

Course Code: EBEE22003	Course Name: MEASUREMENTS AND INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/S Lr	P/ R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the Measurement and control concepts.
- Students will obtain knowledge about different types of Transducers, bridges and its Characteristics.
- To calibrate energy meters in a single phase, three phase and measure the power, iron loss and power factor
- To familiarize the students with different instruments and make accurate and meaningful measurements
- To familiarize the students with different storage and display devices.

COURSE OUTCOMES (Cos): (3-5)

CO1	Ability to understand the concept of measurement and control
CO2	Understand the operation of different measuring instruments
CO3	Knowledgeable on different types of transducers, bridges and amplifiers
CO4	Acquire knowledge on different types of oscilloscopes
CO5	Apply the knowledge of various instruments to measure the physical quantities in the field of science, engineering and technology

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	2	3	2	3	3
CO2	2	2	2	2	2	2	2	2	2	1	3	1
CO3	3	3	3	3	3	3	3	2	2	2	3	1
CO4	2	2	2	2	2	2	2	2	2	2	2	3
CO5	3	3	3	3	3	3	3	2	3	2	3	1

COs/PSOs	PSO1	PSO2	PSO3
CO1	2	2	3
CO2	2	1	1
CO3	1	1	2
CO4	3	3	2
CO5	2	2	3

3/2/1 Indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project	
				√						

Course Code: EBEE22003	Course Name: MEASUREMENTS AND INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/S Lr	P/ R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO MEASUREMENTS 9

Basic elements of Instruments–Principles and types of analog and digital voltmeters, ammeters– Static and dynamic characteristics – Errors in measurements – Standards and calibration

UNIT II CURRENT, POWER AND ENERGY MEASUREMENTS 9

Power and Energy measurement – Instrument transformers – Current and Potential Transformers – Dynamometer and Instruments, kVAh and kVARh meters

UNIT III METHODS OF MEASUREMENTS 9

D.C& A.C potentiometers - D.C & A.C bridges – transformer ratio bridges – self – balancing bridges– PMMC, moving iron – Electrostatic and Electromagnetic interference–Grounding techniques - Calibration

UNIT IV BRIDGES AND THEIR APPLICATIONS 9

D.C bridges: Wheatstone, Kelvin and Kelvin Double bridge – A.C bridges: Maxwell, Wein, Anderson and Schering bridges – Errors, limitations and applications of each bridge.

UNIT V STORAGE AND DISPLAY DEVICES 9

Magnetic disc and Tape Recorders –Digital plotters and printers - CRT displays - Digital CRO – LED, LCD and Dot matrix displays – Data Loggers.

Total No. of Periods: 45

TEXT BOOKS

1. A.K. Sawhney (2015) A Course in Electrical and Electronic Measurements and Instrumentation. 9th Ed. Dhanpat Rai & Co.
2. Kalsi H.S. (2010) Electronic Instrumentation. 3rd Ed. Tata McGraw Hill Publications.
3. Bouwens A.J (2010) Digital instrumentation. 16th Reprint, Tata McGraw Hill Publications.

REFERENCE BOOKS

1. Rangan C.S (2009) Instruments Devices and System. 2nd Ed. Tata McGraw Hill Publications.
2. W.D. Cooper (2009) Electronic Instrumentation and Measurement Techniques. 1st Ed. Prentice Hall of India Publications.

Course Code: EBEE22ET4	Course Name: DESIGN OF ELECTRICAL MACHINES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: DC Machines and Transformers, AC and Special Machines	ETL	2	0/0	2/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- The graduate will be capable of designing the transformers
- To understand the designing the rotor bars & slots.
- The graduate will be capable of designing machine parameters related to the Industrial needs.
- The graduate will be capable of designing the Electrical machines
- To understand the characteristics like speed, torque etc. of different electrical machines.

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Classify and design proper materials for electrical machines
CO2	Design of basic dimensions for the electrical machines in cost effective manner
CO3	Estimate the performance characteristics of various electrical machines for the complex engineering problems
CO4	Acquire knowledge to carry out a detailed design of a electrical machines and estimate the performance indices
CO5	Design a simple machine to cater the temperature rise issue in design of high rated and highly efficient machines

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	3	3	3	3	2	2	3
CO2	2	3	2	2	3	3	2	3	3	2	2	3
CO3	3	2	3	3	2	3	3	3	3	2	3	3
CO4	3	3	2	2	3	2	2	2	2	3	2	2
CO5	2	1	1	2	1	3	1	3	3	2	3	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	3	2
CO3	2	3	3
CO4	3	2	2
CO5	1	3	1

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22ET4	Course Name: DESIGN OF ELECTRICAL MACHINES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: DC Machines and Transformers, AC and Special Machines	ETL	2	0/0	2/0	3

UNIT I INTRODUCTION 9

Major considerations–Limitations–Space factor temperature gradient–Heat flow in two dimensions–Thermal resistivity of winding– Temperature gradient in conductors placed in slots

UNIT II DC MACHINES 9

Magnetic circuit calculations–Net length of Iron–Real & Apparent flux densities–D.C machines output equations –Design of shunt and series field windings–Design of Commutator and brushes.

UNIT III TRANSFORMERS 9

KVA output for single and three phase transformers–Window space factor–Temperature rise of Transformers -Design of Tank with & without cooling tubes–Conservator-Breather

UNIT IV INDUCTION MOTORS 9

Magnetic leakage calculations–Leakage reactance of poly-phase machines-Output equation of Induction motor —circle diagram–Dispersion co-efficient– relation between D&L for best power factor.

UNIT V SYNCHRONOUS MACHINES 9

Runaway speed–construction–output equations–choice of loadings–Design of salient pole machines–Short circuit ratio–Introduction to computer aided design–Program to design main dimensions of Alternators.

Lab Components: 15

1. Case study and Design of any one of the machines with prototype.

Total No. of Periods:60

TEXT BOOKS

1. Sawhney, A.K.& Chakrabarti, A (2010) A Course in Electrical MachineDesign.6th Ed. Dhanpat Rai & Sons, New Delhi.
2. Deshpande M V (2011) Design and testing of Electrical Machines, PHI learning Pvt. Ltd.

REFERENCE BOOKS

1. Sen, S.K. (2006) Principles of Electrical Machine Designs with Computer Programmes. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Shanmuga sundaram et. al (2011) Design data Handbook, 1st Ed. New Age International

Course Code: EBEE22L13	Course Name: MEASUREMENT AND CONTROL LAB	Ty/ Lb/ ETL/IE	L	T / S.Lr	P / R	C
	Prerequisite: Measurements and Instrumentation, Control Systems	Lb	0	0/0	3/0	1

L : Lecture T : Tutorial SLr : Supervised Learning P : Project R : Research C: Credits
T/L/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVE:

- To understand the Measurement and control concepts
- Students will obtain knowledge about different types of Transducers, bridges and its characteristics.
- To calibrate energy meters in single phase, three phase and measure the power, iron loss and power factor.
- To familiarize the students with the measurement of low resistance, inductance and capacitance-factor using simulation package such as LABVIEW /MATLAB etc.

COURSE OUTCOMES (Cos): (3-5)

CO1	Students get familiarized about different types of Transducers, bridges and its characteristics.
CO2	Understands the concept of calibration of energy meters in single/three phase and measure the power
CO3	The students gets familiarized with the measurement of low resistance, inductance and capacitance-factor using simulation packages etc.
CO4	Attained knowledge on P/I and I/P Converters
CO5	Attained knowledge on Smart Transducers

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	2	3	2	3	2	3	2	3	3
CO2	2	1	2	3	3	3	3	2	2	1	3	2
CO3	1	2	3	3	3	3	3	3	3	3	3	1
CO4	2	3	3	3	3	3	3	3	3	3	3	2
CO5	3	2	3	3	3	1	3	1	3	2	3	2

COs / PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	1	2	3

3/2/1IndicatesStrength OfCorrelation,3–High,2-Medium,1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	√ Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
				√								

Course Code: EBEE22L13	Course Name: MEASUREMENT AND CONTROL LAB	Ty/ Lb/ ETL/IE	L	T / S.Lr	P / R	C
	Prerequisite: Measurements and Instrumentation, Control Systems	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS:

1. Study of temperature measuring transducers (Thermocouples).
2. Study of displacement and pressure transducers (LVDT)
3. Measure the stress and strain using strain gauge.
4. AC Bridges.
5. DC Bridges.
6. Calibration of Single-phase Energy meter.
7. Calibration of Three-phase Energy meter.
8. Transfer function of self-excited DC Generator
9. Transfer function of Armature controlled DC Motor.
10. Transfer function of Field controlled DC Motor.
11. Transfer function of AC Servomotor.

Total No. of Periods: 45

Course Code: EBEE22007	Course Name: POWER SYSTEM PROTECTION AND SWITCHGEAR	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution	**Ty**	**3**	**0/0**	**0/0**	**3**

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain knowledge about the basic principles of Relay
- To know about the apparatus protection
- To attain knowledge on Numerical relays, Circuit breakers
- To model the power system components
- To learn about the working principle of relays, circuit breakers and various power system components

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Recognize the Protection circuits and power system components
CO2	Summarize the operation of relays, circuit breakers and power system components
CO3	Model the protective devices, Generator, Transformer, Transmission line, Load representation etc.
CO4	Design the relays and power system components
CO5	Paraphrase the working principle of relays, circuit breakers and various power system components

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	2	2	3	3	3	3	3
CO2	2	2	3	2	3	2	2	3	2	3	3	3
CO3	2	3	2	2	3	3	3	2	1	2	2	2
CO4	3	2	3	3	3	2	2	3	2	3	3	3
CO5	2	3	2	3	2	3	3	3	3	2	2	2

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	2	2	3
CO3	3	3	2
CO4	2	2	3
CO5	3	3	1

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22007	Course Name: POWER SYSTEM PROTECTION AND SWITCHGEAR	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution	Ty	3	0/0	0/0	3

UNIT I PROTECTION SCHEMES 9

Principles and need for protection schemes-nature and causes of faults- types of faults-Methods of grounding-Zones of protection and essential qualities of protection-protection scheme

UNIT II RELAYS 9

Operating Principles of relays - Common relay terms - Universal Torque Equation. – Electromagnetic relays, Induction relays –Over current relays-Directional, Distance, Differential and negative sequence relays

UNIT III APPARATUS PROTECTION 9

Generator Protection - Motor protection - Bus bar protection and Transmission line and Feeder protection – CT and PT protection

UNIT IV STATIC AND NUMERICAL RELAYS 9

Static relays - **c**omponents of static relays – over current relays, differential protection and distance protection – Microprocessor based relays-Block diagram of Numerical relays

UNIT V CIRCUIT BREAKERS 9

Arc phenomena– arc interruption– Current zero interruption theories– recovery voltage and restriking voltage - RRRV – current chopping – Resistance switching- Various types of circuit breakers – selection and Testing of circuit breakers – Fuses– HRC fuses

Total No. of Periods:45

TEXT BOOKS

1. V.K. Mehta, “Principles of Power Systems”, S. Chand, NewDelhi,2005
2. Ravindranath, B.and Chander, N. (2011) Power System Protection and Switchgear, New Age International (P) Ltd
3. Chakrabarti, A. Soni, M. L. Gupta, P. V. Bhatnagar, U. S. (2002) A Text Book on Power System Engineering. Dhanpat Rai & Co. Pvt. Ltd
4. Arun Ingole (2017), Switch Gear and protection, Pearson Education.

REFERENCE BOOKS

1. Patra, S.P. Basu, S.K. and Chowduri, S. (1983) Power systems Protection. Oxford and IBH
2. SunilS. Rao, (1986) Switchgear and Protection. New Delhi: Khanna Publishers
3. Central Electricity Authority (CEA), ‘Guidelines for Transmission System Planning’, New Delhi

Course Code: EBEE22009	Course Name: POWER ELECTRONICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L: Lecture T: Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain Power Electronic Devices and its characteristics.
- To design the triggering of firing circuits.
- To learn the inverters, choppers and Industrial drives.
- To attain knowledge on DC & AC Drives

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the various Power Electronic Devices and its switching characteristics
CO2	Understand various operation and characteristics performance of power converter circuits
CO3	Analyze and design various power convert or circuits and to select suitable devices by assessing the requirement of application field
CO4	Examine power electronic design at the system level and assess the performance
CO5	Articulate the usage of Power Electronic Devices in commercial and industrial applications.

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	2	2	3	1	2	3	3
CO2	3	2	2	2	1	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	3

COs/PSOs	PSO1	PSO2	PSO3
CO1	2	2	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22009	Course Name: POWER ELECTRONICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	0/0	0/0	3

UNIT I POWER SEMICONDUCTOR DEVICES 9

Power semiconductor devices Overview: Characteristics of power Structure, operation, Static characteristics and switching characteristics (Turn on and Turn off) of SCR, TRIAC, BJT, MOSFET and IGBT– Two transistor model of SCR – Series and Parallel operation of SCR – Turn on circuits for SCR – Different techniques of commutation– Protection of Thyristors against over voltage, over current, dv/dt and di/dt

UNIT II PHASE CONTROLLED CONVERTERS 9

Single phase and three phase half controlled and fully controlled rectifiers with R, RL and RLE loads–Waveforms of load voltage and line current – Inverter operation of fully controlled converter – harmonic factor, power factor, ripple factor, distortion factor – operation with freewheeling diode – effect of source inductance –dual converter.

UNIT III INVERTERS 9

Voltage and current source inverters – Single phase and three phase inverters (both 120º mode and 180º mode) inverters – PWM techniques: Sinusoidal PWM, modified sinusoidal PWM -multiple PWM – Resonant series inverter –current Source Inverter – UPS

UNIT IV DC TO DC CONVERTERS 9

Step-down and step-up chopper- control strategy-Introduction to types of choppers-A, B, C, D and E-switched mode regulators-Buck, Boost and Buck-Boost regulator, Introduction to Resonant converters, Applications-Battery operated vehicles.

UNIT V AC TO AC CONVERTERS 9

Single phase and Three Phase AC voltage controllers- Control strategy- Power Factor control-Multi stage sequence control- single phase and three phase cyclo converters- Introduction to Matrix converters, Applications-Welding.

Total No. of Periods: 45

TEXT BOOKS

1. Rashid, M.H. (2017) Power Electronics-Circuits Devices and Applications. 4th Ed. Prentice Hall of India.
2. Bimbhra, P.S. (2018) Power Electronics. 4th Ed. Khanna Publishers.

REFERENCE BOOKS

1. Singh, M.D. Kanchandani, (2002) Power Electronics. New Delhi: Tata McGraw Hill & Hill publication Company Ltd.
2. Dubey, G.K. Doradia, S.R. Joshi, A. Sinha, R.M. (1986) Thyristorised Power Controllers. Wiley Eastern Limited.
3. Lander, W. (1993) Power Electronics. 3rd Ed. McGrawHill and Company.

Course Code: EBEE22ET5	Course Name: MICROPROCESSOR, MICROCONTROLLER AND ARM PROCESSOR	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	**ETL**	**2**	**0/0**	**2/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To understand program, the Assembly language in Microprocessor
- Interfacing of peripheral devices using 8085.
- To know the program Assembly language in Microcontroller
- To understand simple programming using ARM processor
- To make program using KEIL software.

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Estimate Simple arithmetic operations using 8085
CO2	Employ the concepts of microprocessor 8085 with Interfacing devices
CO3	Explain Simple arithmetic operations using 8051 microcontrollers
CO4	Categorize various applications of microprocessor
CO5	Organize the concept of ARM processors & its interfacings

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	3	3	3	1	3	3
CO2	3	2	3	2	3	3	3	3	3	2	3	3
CO3	3	2	2	2	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	2	3	3
CO3	2	3	3
CO4	3	3	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22ET5	Course Name: MICROPROCESSOR, MICROCONTROLLER AND ARM PROCESSOR	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	ETL	2	0/0	2/0	3

UNIT I 8085 PROCESSOR **9**

Functional block diagram - Signals – Memory interfacing – I/O ports and data transfer concepts – Timing Diagram – Interrupt structure Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions, subroutine and stack

UNIT II PERIPHERAL INTERFACING **9**

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8253 Timer/ Counter – Interfacing with 8085 - A/D and D/A converter interfacing

UNIT III MICRO CONTROLLER 8051 **9**

Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer –I/O ports – Serial communication. Data Transfer, Manipulation, Control & I/O instructions

UNIT IV MICRO CONTROLLER PROGRAMMING & APPLICATION **9**

Simple programming exercises: key board and display interface- interfacing an LCD- ADC and DAC interfacing - Sensors – Closed loop control of servo motor- interfacing a stepper motor

UNIT V INTRODUCTION TO ARM PROCESSORS **9**

Basic ARM architecture – ARM assembly language program – ARM organization and implementation– The ARM instruction set - The thumb instruction set – ARM CPU cores

LAB COMPONENTS: **15**

1. Multi precision addition / subtraction / multiplication / division.
2. Programming with control instructions
3. Increment / Decrement, Ascending / Descending order, Maximum / minimum of numbers.
4. A/D Interfacing, D/A Interfacing, Traffic light controller Step motor and key board interfacing.
5. Simple Arithmetic Operations using ARM processor
6. Programming with control instructions using ARM processor (ARM926 kit)
7. Seven segment display interfacing using ARM processors. (ARM926 kit)
8. LED display Interfacing using ARM processors. (ARM926 kit)

Total No. of Periods: 60

TEXT BOOKS

1. Gaonkar, R.S (2002) Microprocessor Architecture Programming and Application. New Delhi: Wiley Eastern Ltd
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, (2003) The 8051 Micro Controller and Embedded Systems. 5th Indian reprint, Pearson Education
3. Steve Furber, (2000) ARM System –On –Chip architecture. Addison Wesley

REFERENCE BOOKS

1. William Kleitz, (2006) Microprocessor and Micro Controller Fundamental of 8085 and 8051 Hardware and Software. Pearson Education
2. Daniel Tabak, Advanced Daniel Microprocessors. McGraw Hill Inc

Course Code: EBEE22L05	Course Name: POWER ELECTRONICS LAB	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Electronics	**Lb**	**0**	**0/0**	**3/0**	**1**

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To obtain an over view of different types of power semi-conductor devices and their switching characteristics with different triggering methods.
- To understand the operation, characteristics and performance parameters of controlled Rectifiers and Inverters.
- To understand the techniques to control the speed of Brushless DC Motor and SR Motor
- To understand the operation of AC Voltage Controllers
- To understand the applications of Power Electronic devices and Electric drives in Power System

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	Recall the operation of power electronics devices and gain knowledge of the comparative study of different devices based on their switching characteristics
CO2	Summarize the operation of AC Voltage Controllers
CO3	Relate the techniques to control the speed of Brushless DC Motor and SR Motor
CO4	Infer the operation, characteristics and performance parameters of controlled Rectifiers and Inverters
CO5	Compare the operation of different converters and incorporate in designing the HVDC Transmission System

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	c	3	3	3	2	3	2	2	3
CO2	3	2	2	2	2	3	2	2	2	3	2	3
CO3	3	2	2	2	3	2	2	3	2	2	2	2
CO4	3	2	2	2	3	3	3	3	2	2	2	3
CO5	3	3	3	3	3	2	3	2	2	2	2	3

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	2	3	3
CO4	3	2	2
CO5	2	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
									√

Course Code: EBEE22L05	Course Name: POWER ELECTRONICS LAB	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Electronics	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS

1. Characteristics of SCR, MOSFET, IGBT and TRIAC
2. Gate Pulse Generation using R, RC and UJT
3. Single phase half controlled and fully controlled bridge converter with R load and RL loads
4. Single phase AC voltage controller using TRIAC, DIAC with RANDRL loads
5. IGBT based Chopper
6. IGBT Based PWM Inverter
7. Single phase parallel inverter
8. Single phase Series inverter
9. Forced commutation circuits (Class A, Class B, Class C, Class D & Class E).
10. Single phase cyclo-converter with R and RL loads
11. Step down and step up MOSFET based choppers
12. Simulation of Single Phase and Three phase cycloconverters.

Total No. of Periods:45

Course Code: EBEE22010	Course Name: POWER SYSTEM ANALYSIS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution	Ty	3	1/0	0/0	4

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain basic knowledge and apply iterative techniques for power flow analysis
- To model and carry out short circuit studies on power system
- To model and analyze stability problems in power system
- To model the power system under steady state operating condition
- To learn power system models based on nodal admittance and impedance matrices for the analysis of large –scale power networks.

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	To comprehend and analyze the power system analysis in steady state operation
CO2	To model generators, transformers, lines and cables in the positive, negative and zero sequence systems
CO3	To analyze symmetrical and asymmetrical faults
CO4	To establish and solve equations for AC, DC and optimal power flow.
CO5	To use power system models based on nodal admittance and impedance matrices for the analysis of large –scale power networks.

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	3	3	3	3	2
CO2	2	3	3	2	1	3	2	3	3	2	1	3
CO3	3	3	2	3	2	2	3	3	2	3	2	2
CO4	2	2	2	2	3	3	2	2	2	2	3	3
CO5	3	3	2	1	2	2	3	3	2	1	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	1	3	2
CO3	2	2	3
CO4	3	3	2
CO5	2	2	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22010	Course Name: POWER SYSTEM ANALYSIS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation Transmission and Distribution	Ty	3	1/0	0/0	4

UNIT I POWER SYSTEM 12

Need for system planning and operational studies – Power scenario in India – Power system components – Representation – Single line diagram – per unit quantities – p.u. impedance diagram – p.u. reactance diagram – Network graph, Bus incidence matrix, Primitive parameters, Bus admittance matrix from primitive parameters – Representation of - nominal transformer – Formation of bus admittance matrix of large power network.

UNIT II POWER FLOW ANALYSIS 12

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 12

Assumptions in short circuit analysis – 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 12

Symmetrical components – Sequence impedances – Sequence networks – Analysis of unsymmetrical faults at generator terminals: LG, L and LG – 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 12

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 No. of Periods :60

TEXT BOOKS

1. Hadi Saadat (2007) Power system analysis. 11th Reprint. Tata McGraw Hill Publishing Company, New Delhi,
2. P. Kundur (1994) Power System Stability and Control. Tata McGraw Hill Publishing Company, New Delhi,

REFERENCE BOOKS

1. Kothari, D.P. and Nagrath, I. J. (2003) Modern Power System Analysis. 3rd.Tata Mc Graw Hill Publishing Company Limited
2. M.A. Pai, (2003) Computer Techniques in power system Analysis. Tata McGraw – Hill publishing company, New Delhi.
3. C.A. Gross, (2011) Power System Analysis," Wiley India

Course Code: EBEE22012	Course Name: ELECTRIC TRANSIENTS AND HIGH VOLTAGE	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution, Power Electronics	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain basic knowledge on Power Quality and power System operation
- To plot load duration curve and understand the need for regulation
- To impart knowledge on Frequency control and Voltage Control
- To study the economic operation of power system and Unit commitment
- To know the importance of System Monitoring and Power Quality Measurement Equipment

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Acquire knowledge on Power Quality and power System operation
CO2	Understanding of load duration curve and regulation needs
CO3	Familiar to Frequency control and Voltage Control
CO4	Knowledge on economic operation of power system and Unit commitment
CO5	Understand the importance of System Monitoring and Power Quality Measurement Equipment

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	3	3	3	3	2
CO2	2	3	3	2	1	3	2	3	3	2	1	3
CO3	3	3	2	3	2	2	3	3	2	3	2	2
CO4	2	2	2	2	3	3	2	2	2	2	3	3
CO5	3	3	2	1	2	2	3	3	2	1	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	1	3	2
CO3	2	2	3
CO4	3	3	2
CO5	2	2	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22012	Course Name: ELECTRIC TRANSIENTS AND HIGH VOLTAGE	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution, Power Electronics	Ty	3	0/0	0/0	3

UNIT I SWITCHING TRANSIENTS 9

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients - ferro resonance.

UNIT II 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 III 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.

UNIT IV GENERATION OF HIGH VOLTAGES AND CURRENTS 9

Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.

UNIT V 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.

Total No. of Periods :45

TEXT BOOKS

1. Allan Greenwood (1991) Electrical Transients in Power Systems. 2nd Ed. Wiley Inter Science, New York.
2. C.S. Indulkar, D.P. Kothari, K. Ramalingam (2010) Power System Transients – A statistical approach. 2nd Ed. PHI Learning Private Limited, Second Edition.
3. M.S. Naidu and V. Kamaraju (2013) High Voltage Engineering. 5th Ed. McGraw Hill.

REFERENCE BOOKS

1. Y. Hase (2012) Handbook of Power System Engineering, Wiley India, 2012.
2. Akihiroametani, (2013) Power System Transient theory and applications. CRC press

Course Code: EBEE22016	Course Name: ENERGY UTILIZATION AND CONSERVATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution	Ty	3	0/0	0/0	3

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits T/L/ETL: Theory /Lab/Embedded Theory and Lab

OBJECTIVES

- To study the energy conservation on buildings
- The analyze the heating and cooling of buildings
- Understand the energy efficient equipment
- Understands and analyze energy auditing
- Design the house wiring

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	Recall the fundamentals of Heating and Welding, Illumination, Electric Drives, HEVs and Energy Conservation principles
CO2	Comprehend and impart knowledge on Heating, Welding, Illumination, Electric Drives, HEVs and Energy Conservation principles
CO3	Analyze the Heating and Welding, Illumination, Electric Drives, HEVs and Energy Conservation principles
CO4	Design and study various techniques involved in Heating and Welding, Illumination, Electric Drives, HEVs and Energy Conservation principles
CO5	Scrutinize the architecture and features of various Heating and Welding, Illumination, Electric Drives, HEVs and Energy Conservation principles

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	3	2	2	1	3	2	1
CO2	3	2	2	2	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	2	3	3	3	3	2	1
CO4	3	3	3	3	3	3	2	3	3	3	2	1
CO5	3	3	3	3	3	3	3	3	3	3	2	2

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	3	3
CO3	2	3	3
CO4	3	2	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22016	Course Name: ENERGY UTILIZATION AND CONSERVATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution	Ty	3	0/0	0/0	3

UNIT I HEATING AND WELDING 9

Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace - heating of building. Electric welding, resistance and arcwelding, control devices

UNIT II ILLUMINATION 9

Importance of lighting– properties of good lighting scheme– laws of illumination –photometry - types of lamps – lighting calculations – basic design of illumination schemes for residential, commercial, street lighting and sports ground –energy efficiency lamps.

UNIT III ELECTRIC DRIVES 9

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization

UNIT IV INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES 9

Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement and energy consumption

UNIT V ENERGY CONSERVATION 9

Principle of energy conservation - waste heat recovery - Heat pump – Economics of energy conservation, cogeneration, combined cycle plants, electrical energy conservation opportunities

Total No. of Periods:45

TEXT BOOKS

1. Epenshaw Taylor, (2009) Utilization of Electric Energy. 12th Impression. Universities Press.
2. Mehrdad, Ehsani, Yimin Gao, Sabastien E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles. CRC Press.
3. Wadhwa, C.L. (2003) Generation, Distribution and Utilization of Electrical Energy. New Age International Pvt. Ltd.
4. Gupta, B.R. (2003) Generation of Electrical Energy. NewDelhi: Eurasia Publishing House(P)Ltd.

REFERENCE BOOKS

1. Soni Gupta, Bhatnager- Dhanapat Rai & sons A Course in Electrical Power.
2. Uppal, S. L. Electrical Power. Khanna Publications

Course Code: EBEE22L07	Course Name: POWER SYSTEM LAB	Ty/Lb/ ETL/IE	L	T/S.Lr	P/R	C
	Prerequisite: Power System Analysis	**Lb**	**0**	**0/0**	**3/0**	**1**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know about the transmission lines
- To understand Load Flow Analysis
- To understand about Fault Analysis
- To gain knowledge on Power Electronic Circuits
- To familiar about Simulation of Electrical drives using Electrical Software

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Recognize the Power system components
CO2	Conduct load flow analysis using various methods
CO3	Perform the experiment on various types of relays
CO4	Simulate various fault analysis in the power system network
CO5	Analyze the power network on regular basis

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	3	2	3	2	3	2	2
CO2	3	3	3	3	3	2	3	3	2	2	2	2
CO3	2	3	3	3	2	3	2	2	3	3	3	2
CO4	3	2	3	3	3	2	3	3	2	2	2	3
CO5	3	3	3	3	3	3	2	2	3	3	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	3	2
CO3	3	2	3
CO4	3	3	2
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
									✓

Course Code: EBEE22L07	Course Name: POWER SYSTEM LAB	Ty/Lb/ ETL/IE	L	T/S.Lr	P/R	C
	Prerequisite: Power System Analysis	Lb	0	0/0	3/0	1

LIST OF EXPERIMENTS

1. Experimentation on Performance of Over Voltage Relay.
2. Experimentation on Performance of Under Voltage Relay.
3. Experimentation on Performance of Earth Fault Relay.
4. Experimentation on Performance of Differential Protection of transformer.
5. Experimentation on Dielectric Testing of transformer oil.
6. Experimentation on Performance of Over Current Relay using Electromagnetic and Digital Type.
7. Computation of Parameters and Modeling of Transmission Lines
8. Formation of Bus Admittance and Impedance Matrices and Solution of Networks.
9. Simulation on Load Flow Analysis-I: Solution of Load Flow and Related Problems Using Gauss-Seidel Method
10. Simulation on Load Flow Analysis-II: Solution of Load Flow and Related Problems Using Newton-Raphson and Fast-Decoupled Methods
11. Simulation on Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
12. Simulation on SLG fault in a power system network
13. Simulation on DLG fault in a power system network
14. Study the characteristics of MCB & HRC Fuse.

Total No. of Periods: 45

Course Code: EBEE22013	Course Name: POWER QUALITY AND CONTROL OF POWER SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power System Analysis	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain basic knowledge on Power Quality and power System operation
- To plot load duration curve and understand the need for regulation
- To impart knowledge on Frequency control and Voltage Control
- To study the economic operation of power system and Unit commitment
- To know the importance of System Monitoring and Power Quality Measurement Equipments

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Acquire knowledge on Power Quality and power System operation
CO2	Understanding of load duration curve and regulation needs
CO3	Familiar to Frequency control and Voltage Control
CO4	Knowledge on economic operation of power system and Unit commitment
CO5	Understand the importance of System Monitoring and Power Quality Measurement Equipment

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	3	3	3	3	2
CO2	2	3	3	2	1	3	2	3	3	2	1	3
CO3	3	3	2	3	2	2	3	3	2	3	2	2
CO4	2	2	2	2	3	3	2	2	2	2	3	3
CO5	3	3	2	1	2	2	3	3	2	1	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	1	3	2
CO3	2	2	3
CO4	3	3	2
CO5	2	2	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22013	Course Name: POWER QUALITY AND CONTROL OF POWER SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power System Analysis	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO POWER QUALITY AND SYSTEM OPERATION 9

Power Quality Terms- Overloading- Under Voltage- Over Voltage-Voltage Sag- Voltage Swell – Voltage imbalance-Voltage fluctuation-Power Frequency Variation – Harmonics - System load Characteristics–load curves and load-duration curve - load factor - diversity factor - Need for Voltage regulation and frequency regulation in power system - Basic P-F and Q-V control loops

UNIT II REAL POWER - FREQUENCY CONTROL 9

Fundamentals of AGC-Fundamentals of Speed Governing mechanisms and modeling-Speed-Load characteristics - regulation of two Synchronous Machines in parallel- Control areas - LFC of single & Multi areas Static & Dynamic Analysis of uncontrolled and controlled cases –Tie line with frequency bias control –Steady state instabilities

UNIT III REACTIVE POWER – VOLTAGE CONTROL 9

Excitation system Modeling - Static & Dynamic Analysis - stability Compensation-Principles of transmission line compensation-Effect of Generator loading–static VAR System Modeling-System Level Voltage control

UNIT IV ECONOMIC DISPATCH AND UNIT COMMITMENT 9

Need for Economic Dispatch-Characteristics curve for Steam and hydroelectric Units - Co-ordination Equation with Loss and without losses-Base point and Participation Factor-Constraints and solutions in Unit Commitment -Priority List Methods-Forward Dynamic Programming approach

UNIT V MONITORING & COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions-Control Strategies – Power quality Measurement Equipment – Harmonic Analyser – Flicker meter

Total No. of Periods :45

TEXT BOOKS

1. Allen. J. Wood and Bruce F. Wollen berg, (2003) Power Generation, Operation and Control. John Wiley & Sons. Inc
2. Chakrabarti & Halder, (2004) Power System Analysis: Operation and Control. Ed. Prentice Hall of India
3. Kundur, P, (1994) Power System Stability and Control. USA: MC Graw Hill Publisher

REFERENCE BOOKS

1. Kothari, D.P. and Nagrath, I.J. (2003) Modern Power System Analysis. 3rd. Tata Mc Graw Hill Publishing Company Limited
2. Grigsby, L.L. (2001) The Electric Power Engineering, Hand Book. CRC Press & IEEE Press
3. Hadi Saadat, (2007) Power System Analysis.11th Reprint
4. N.V. Ramana, (2011) Power System Operation and Control, Pearson
5. C.A. Gross, (2011) Power System Analysis, Wiley India

Course Code: EBEE22011	Course Name: SOLID STATE DRIVES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Electronics	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To impart knowledge on the AC and DC drives
- Analyze the operation of converter/ chopper fed dc drive, both qualitatively and quantitatively
- Analyze and design the current and speed controllers for a closed loop solid state DC motor drive
- Steady state operation and transient dynamics of a motor load system.
- To understand and suggest a converter for solid state drive

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Ability to select suitability drive for the given application
CO2	Ability to analyze the operation of the converter/chopper fed dc drive.
CO3	Ability to analyze the operation and performance of AC motor drives.
CO4	Ability to study about the steady state operation and transient dynamics of a motor load system.
CO5	Ability to understand and suggest a converter for solid state drive

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	2	2	3	1	2	3	3
CO2	3	2	2	2	1	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	3

COs/PSOs	PSO1	PSO2	PSO3
CO1	2	2	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				✓					

Course Code: EBEE22011	Course Name: SOLID STATE DRIVES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Electronics	Ty	3	0/0	0/0	3

UNIT I DRIVE CHARACTERISTICS 9

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

UNIT II CONVETER/CHOPPER FED DC MOTOR DRIVE 9

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

UNIT III INDUCTION MOTOR DRIVES 9

Stator voltage control–V/f control– Rotor Resistance control-qualitative treatment of slip power recovery drives-closed loop control– vector control- Applications.

UNIT IV SYNCHRONOUS MOTOR DRIVES 9

V/f control and self-control of synchronous motor: Margin angle control and power factor control- Three phase voltage/current source fed synchronous motor- Applications.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 9

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

Total No. of Periods:45

TEXT BOOKS

1. G.K. Dubey (2001) Fundamentals of electric drives. 2nd ed. Narosa publishing house
2. Bimal K. Bose (2002) Modern Power Electronics and AC Drives, Pearson Education.
3. R. Krishnan (2001) Electric Motor & Drives: Modeling, Analysis and Control, Pearson.

REFERENCE BOOKS

1. Vedam Subramanyam (2016) Electric Drives Concepts and Applications 2nd Ed. McGraw Hill.
2. John Hindmarsh and Alasdain Renfrew (2012) Electrical Machines and Drives System, Elsevier
3. Theodore Wildi (2015) Electrical Machines Drives and power systems, 6th edition, Pearson Education.

Course Code: EBEE22014	Course Name: FACTS AND HVDC TRANSMISSION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Quality and Control of Power System	Ty	3	0/0	0/0	3

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain knowledge on HVDC
- To model the HVDC system
- To know about FACTS Controllers
- To model the Power flow system
- To model the HVDC system, FACTS controllers in a cost-effective manner

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the Power electronics components
CO2	Classify the Power electronic components, HVDC system and FACTS devices
CO3	Summarize importance of HVDC, FACTS for a power flow modeling with modern tool
CO4	Analyze the HVDC cables, FACTS controllers and devices for a sustainable environment
CO5	Model the HVDC system, FACTS controllers in a cost-effective manner

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3	3	2	2	3	3	2
CO2	2	3	3	2	3	2	3	3	3	2	3	3
CO3	3	2	3	3	2	3	2	3	3	3	2	3
CO4	2	3	2	2	3	2	3	2	3	2	3	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	2	3
CO3	2	3	2
CO4	3	2	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22014	Course Name: FACTS AND HVDC TRANSMISSION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Quality and Control of Power System	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO HVDC 9

Introduction of DC Power transmission technology – Classification of HVDC links- Components of HVDC transmission system-Comparison of AC and DC-Planning and Modern trends in DC transmission.

UNIT II HVDC CABLES AND MODELING OF HVDC SYSTEMS 9

Introduction of DC cables – Basic physical phenomenon arising in DC insulation – Practical dielectrics –Dielectric stress consideration – Economics of DC cables compared with AC cables- Introduction to converter model of HVDC

UNIT III INTRODUCTION TO FACTS 9

The concept of flexible AC transmission - reactive power control in Electrical power transmission lines -uncompensated transmission line – series and shunt compensation. Overview of FACTS devices - Static VAR Compensator (SVC) – Thyristors Switched Series capacitor (TCSC) – Unified Power Flow controller (UPFC) -Integrated Power Flow Controller (IPFC).

UNIT IV EMERGING FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – operating principle – V-I characteristics – Unified Power Flow Controller (UPFC) –Principle of operation -modes of operation– applications

UNIT V POWER FLOW MODELING 9

Power flow modeling of SVC, TCSC, STATCOM and UPFC.

Total No. of Periods: 45

TEXT BOOKS

1. Mohan Mathur, R. Rajiv K. Varma, Thyristor–Based Facts Controllers for Electrical Transmission Systems. IEEE press and John Wiley & Sons, Inc.
2. ACHAetal, E. Power Electronic Control in Electrical Systems. Newness Power Engineering Series.
3. Padiyar, K.R. (1990) HVDC power transmission system. 1st Ed. NewDelhi: Wiley Eastern Limited.
4. Edward Wilson Kimbark, (1971) Direct Current Transmission. Vol.I. Wiley interscience. NewYork: London: Sydney:

REFERENCE BOOKS

1. John, A.T. (1999) Flexible AC Transmission System. Institution of Electrical and Electronic Engineers (IEEE).
2. Narain G. Hingorani, Laszio, Gyugyl, (2001) Understanding FACTS Concepts and Technology of Flexible AC Transmission System. Delhi: Standard Publishers.

Course Code: EBEE22015	Course Name: SMARTGRID AND ELECTRIC VEHICLE TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution, Power System Analysis	Ty	3	0/0	0/0	3

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To introduce basic concepts of smart grid
- To impart knowledge on smart grid designing
- To introduce basic concepts of electric vehicle technology
- To learn the principle and operation of Electric Vehicles
- Knowledge about E-mobility business.

COURSEOUTCOMES(Cos)
Students completing this course were able to

CO1	Understand issues, opportunities & challenges in Smart grid
CO2	Designing and develop skills required for smart grid planning
CO3	To understand the basic concepts of electric vehicle technology
CO4	To understand the principle and operation of Electric Vehicles
CO5	Acquire knowledge on E-Indian electricity business on Indian roadmap perspective

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	3	2	3	2	2	3	3
CO2	2	3	3	3	2	3	3	2	3	3	2	3
CO3	3	2	3	3	3	2	3	2	3	3	3	2
CO4	2	3	2	3	2	3	2	3	2	3	2	3
CO5	3	3	3	3	3	3	3	2	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	2	3	3
CO3	3	2	3
CO4	2	3	2
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
				√					

Course Code: EBEE22015	Course Name: SMARTGRID AND ELECTRIC VEHICLE TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Generation, Transmission and Distribution, Power System Analysis	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO SMART GRID 9

Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers.

UNIT II DESIGNING SMARTGRID 9

Barriers and solution to smart grid development- General Level Automation- Power System Automation at Transmission Level- Distribution Level Automation- End user level- Applications for adaptive control and optimization.

UNIT III VEHICLES 9

Vehicle resistance, Types: Rolling resistance, grading resistance, Aerodynamic drag vehicle performance, calculating the acceleration force, Maximum speed, finding the total tractive effort, torque required on the drive wheel. Transmission: Differential, clutch & gear box, Braking performance.

UNIT IV HYBRID VEHICLES 9

Types of Evs, Hybrid electric drive- train, Tractive effort in normal driving – Energy consumption concept of hybrid electric drive trains, Architecture of Electric Drive Trains, Series and parallel hybrid electric drive trains

UNIT V BATTERY MANAGEMENT SYSTEM 9

Need of BMS-Rule based control and optimization-based control- Software based high level supervisory control – Mode power – Behavior of motor – Advance Features.

Total No. of Periods: 45

TEXT BOOKS

1. Gilbert N. Sorebo & Michael C. Echols, Smart Grid Security-An end-to-end view of security in the new Electrical grid. CRC Press.
2. James Momoh, Smart Grid-Fundamentals of Design and Analysis. CRC Press.
3. Janaka B. Ekanayake, Kithsiri Liyanage, JianzhongWu, Akihiko Yokoyama, NickJenkins Smart Grid Technology & Application. In Wiley.
4. James Larminie, J. Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd. 2003.
5. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
6. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

REFERENCE BOOKS

1. David Gao (2015) Energy Storage for Sustainable Microgrid,1st Ed, Elsevier
2. Emadi, A. (Ed.), Miller, J., Ehsani, M., “Vehicular Electric Power Systems” Boca Raton, CRC Press, 2003.
3. Tariq Muneer and Irene Illescas García, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017.

Course Code: EBEE22E01	Course Name: WIND ENERGY CONVERSION TECHNIQUES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Energy Utilization and Conservation	**Ty**	**3**	**0/0**	**0/0**	**3**

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know the basics of Wind Energy Conversion System
- To solve the Energy crisis.
- To know the Power Electronic Devices and its characteristics.
- To understand different converters
- To design wind Energy conversion system such as sub systems and its components

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recollection of basics for Wind Energy Conversion System
CO2	Recognize and solve the Energy crisis
CO3	Convey the characteristics Power Electronic Devices and its characteristics
CO4	Analyze and design the characteristics for different converters
CO5	Explore and design wind Energy conversion system such as sub systems and its components

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	2	2	3	1	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3	2	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	2	3	1
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E01	Course Name: WIND ENERGY CONVERSION TECHNIQUES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Energy Utilization and Conservation	Ty	3	0/0	0/0	3

UNIT I MODELLING OF THE DOUBLY FED INDUCTION GENERATOR(DFIG) 9

Mechanical and three phase electrical models. "Quadrature-Phase Slip-Ring (QPSR) model. Expression of the DFIG and QPSR model in a single generic reference frame. Particularization to the stator flux/voltage –oriented reference frame for vector control (VC).

UNIT II MODELLING OF PERMANENT MAGNET SYNCHRONOUS GENERATOR (PMSG) 9

Rotor flux-oriented model of the PMSG: Analogy with the stator flux/voltage-oriented DFIG model. Arrangement of the global electromechanical model in state equations for simulation.

UNIT III WIND TURBINE SUB SYSTEMS & COMPONENTS 9

Design of WECS components–Stall, pitch & yaw control mechanisms–Brake control mechanisms-Theoretical simulation of wind turbine characteristics; Test methods

UNIT IV APPLICATION OF WIND ENERGY 9

Wind pumps - Performance analysis, design concept and testing - Principle of Wind Energy Generators - Standalone, grid connected and hybrid applications of WECS- Economics of wind energy utilization-Wind energy in India

UNIT V OVERVIEW OF SMALL HYDRO POWER SYSTEM 9

Overview of micro, mini and small hydro systems- Hydrology- Elements of pumps and turbine - Selection and design criteria of pumps and turbines-Site selection and civil works-Speed and voltage regulation-Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India.

Total No. of Periods: 45

TEXT BOOKS

1. Manwell, J.F. Mcgowan, J.G. Rogers, A. L (2002) Wind Energy Explained–Theory, Design & Application. John Wiley &Sons
2. GrayL.Johnson (1985) Wind Energy Systems. Prentice Hall Inc
3. Bose, B.K. (2001) Modern Power Electronics & AC Drives. Prentice Hall

REFERENCE BOOKS

1. Vaughn Nelson, (2009) Wind Energy– Renewable Energy & the Environment. CRC Press
2. S.T. Rama, E. Sheeba Percis, A. Nalini, S. Bhuvaneswari (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No 978-93-87374-12-6

Course Code: EBEE22E02	Course Name: IOT APPLIED TO ELECTRICAL ENGINEERING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study IoT in Electric Engineering
- To study Telematics Devices
- To Study IoT Sensors
- To Study Smart grid and Microgrid
- To Study Smart Space Security System

COURSE OUTCOMES(Cos)
Students completing this course were able to

CO1	Recognize the IOT devices
CO2	Classify the methods to incorporate IOT for a sustainable and smart society
CO3	Summarize the Telematics, Smart energy and various security measures
CO4	Design an innovative smart system based on IOT in a cost-effective manner
CO5	Interpret the industrial IOT and improve the security measures

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	2	2	3	3	2
CO3	3	3	3	3	3	3	3	3	1	3	3	3
CO4	2	3	1	3	3	3	2	2	3	3	3	2
CO5	3	3	3	3	3	2	3	3	2	3	2	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	2	2	2
CO3	3	3	1
CO4	2	2	3
CO5	3	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E02	Course Name: IOT APPLIED TO ELECTRICAL ENGINEERING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO IOT **9**

Introduction–Need of IOT in Electrical Engineering–Challenges in Implementation of IOT–Trends in Electrical Engineering – Configuration and Scalability– Efficiency– Quality of Service

UNIT II TELEMATICS **9**

Smart Devices–Smart Apps–Wearable Technology–Vehicle Telemetry–Smart Homes and Building Automation–Vehicle Charging Station

UNIT III SMART ENERGY **9**

Generation–Transmission–Distribution and Metering–Storage–Smart Monitoring and Diagnostics System at Major Power Plants–Micro grid and Virtual Power

UNIT IV INDUSTRIAL IOT **9**

Real-Time Monitoring and Control of Processes–Deploying Smart Machine–Smart Sensor–Smart Controllers – SCADA– Proprietary Communication

UNIT V SECURITY MEASURES **9**

Securing Smart Spaces and Smart Grid–Smart Grid–Service that need to be Secure- Security Requirement–Security Smart Spaces–Smart Tracking Firewall – Crypto graphic Key in the IoT

Total No. of Periods: 45

TEXT BOOKS

1. George Mastorakis, (2016), Internet of Things (IoT) in 5G Mobile Technologies, 1st ed. Edition, Publisher SPRINGER

REFERENCE BOOKS

1. Enterprise IoT: Strategies and Best Practices for Connected Products and Services, DirkSlama, FrankPuhlmann, JimMorrish, RishiM Bhatnagar, Publisher O'REILLY

Course Code: EBEE22E03	Course Name: MECHATRONICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Control Systems	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To understand the concepts of sensors and transducers
- To learn interface programming
- To apply control system problems
- To learn the design of sensors, actuators with the use of modern tool
- To understand the recent trends and advancement in Mechatronics

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize various sensors, actuators etc
CO2	Summarize the design control techniques of Actuators
CO3	Interpret the design analysis in Mechatronics
CO4	Design the sensors, actuators with the use of modern tool
CO5	Paraphrase the recent trends and advancement in Mechatronics

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	2	3	2	3	2	2
CO3	3	3	3	3	3	3	1	3	3	3	3	3
CO4	1	3	3	3	2	2	3	3	2	3	2	2
CO5	3	3	3	2	3	3	2	3	2	2	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	2	2
CO3	3	3	3
CO4	3	2	2
CO5	2	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E03	Course Name: MECHATRONICS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Control Systems	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

Mechatronics–definition and key issues–evolution–elements–mechatronics approach to modern Engineering design.

UNIT II SENSORS AND TRANSDUCERS 9

Types–displacement, position, proximity and velocity sensors–signal processing–data display.

UNIT III ACTUATION SYSTEMS 9

Mechanical types–applications–electrical types–applications–pneumatic and hydraulic systems–applications –selection of actuators

UNIT IV CONTROL SYSTEMS 9

Types of controllers–programmable logic controllers–applications–ladder diagrams–microprocessor applications in mechatronics– programming interfacing– computer applications

UNIT V RECENT ADVANCES 9

Manufacturing mechatronics –automobile mechatronics—medical mechatronics–office automation–case studies.

Total No. of Periods:45

TEXT BOOKS

1. Bulton, N. (1995) Mechatronics: Electronic Control system for Mechanical and Electrical Engineering, Long man.
2. Dradly, D.A. Dawson, D. Burd, N. C. and Loader, A.J. (1993) Mechatronics: Electronics in products and processes, Chapman & Hall.

REFERENCE BOOKS

1. HMT Mechatronics. NewDelhi: Tata McGraw-Hill.
2. GalipUlsoyA., and Devices, W.R. (1989) Microcomputer Applications in Manufacturing. USA: John wiley.
3. James Harter, (1995) Electromechanics: Principles, concepts and devices. New Jersey: Prentice Hall.

Course Code: EBEE22E04	Course Name: FIBER OPTICS COMMUNICATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures
- To learn fiber optics receivers such as PIN APD diodes
- To learn the fiber optical network components, variety of networking aspects
- To learn the factors that affect the optical fiber communication systems
- To design optical networks and understand non-linear effects in optical fibers

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Explain the principles of various optical fiber communication systems
CO2	Understand the properties of the optical fiber and optical components
CO3	Analyze the performance of optical communication systems
CO4	Understands the factors that affect the optical fiber communication systems
CO5	Design optical networks and understand non-linear effects in optical fibers

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	2	3	2	3	2	2
CO3	3	3	3	3	3	3	1	3	3	3	3	3
CO4	1	3	3	3	2	2	3	3	2	3	2	2
CO5	3	3	3	2	3	3	2	3	2	2	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	2	2
CO3	3	3	3
CO4	3	2	2
CO5	2	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E04	Course Name: FIBER OPTICS COMMUNICATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Communication Systems and IOT	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

General system- transmission link-advantage of optical fiber communication-basic structure of optical fiber waveguide-ray theory transmission-optical fiber modes and transmission-optical fiber modes and configuration-step index and graded index fiber-single mode fiber-fiber materials-photonic crystal, fiber optic cables specialty fibers.

UNIT II OPTICAL TRANSMISSION AND RECEIVER 9

Introduction-Attenuation-absorption-scattering losses-bending loss-dispersion-intra model dispersion-inter model dispersion -Optical receiver operation-receiver sensitivity-quantum limit-eye diagrams-coherent detection-burst mode receiver-Analog receivers.

UNIT III ANALOG LINKS 9

Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links, microwave photonics.

UNIT IV DIGITAL LINKS 9

Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, transmission distance for single mode fibers, Power penalties, nodal noise and chirping.

UNIT V DIGITAL TRANSMISSION SYSTEMS 9

Point to point links-system considerations-link power budget-modulation formats for analog communication system-Introduction to WDM concept -Introduction to advanced multiplexing strategies.

Total No. of Periods:45

TEXT BOOKS

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
3. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
4. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.

REFERENCE BOOKS

1. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
2. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
3. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York, 1990.

Course Code: EBEE22E05	Course Name: SOLAR ENERGY CONVERSION TECHNIQUES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Energy Utilization and Conservation	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study about Solar Radiation and the collector types
- To impart knowledge on the Application of Solar thermal Technology
- To understand the fundamentals of Solar Photo voltaic cells
- To design the Solar cells in cost effective manner.
- To learn about the solar passive Architecture

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recollect the basics of solar radiation, principles of collectors, applications of solar energy, design the PV cells and its architecture
CO2	Realize the applications of collectors, applications of solar energy, design the PV cells and its architecture
CO3	Analyze and design the collectors, applications of solar energy, design the PV cells and its architecture
CO4	Examine the PV system design and applications of solar energy, design the PV cells and its architecture
CO5	Articulate the usage of solar passive architecture and its applications collectors, applications of solar energy, design the PV cells and its architecture

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	2	3	2	2	1	3	2	1
CO2	3	2	2	2	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	2	1
CO4	3	3	3	3	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3	3	3	2	2

COs/PSOs	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E05	Course Name: SOLAR ENERGY CONVERSION TECHNIQUES	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Energy Utilization and Conservation	Ty	3	0/0	0/0	3

UNIT I SOLAR RADIATION AND COLLECTORS 9

Solar Radiation- Solar angles - Sun path diagrams - shadow determination – Solar Collectors - flat plate collector thermal analysis - heat capacity effect - testing methods-evacuated tubular collectors – concentrator collectors–classification-tracking systems-compound paraboli concentrators-parabolic trough concentrators -concentrators with point focus-Heliostats – performance of the collectors

UNIT II APPLICATIONS OF SOLAR THERMAL TECHNOLOGY 9

Principle of working, types - design and operation of - solar heating and cooling systems - solar water heaters –thermal storage systems–solar still–solar cooker –domestic, community– solar pond – solar drying

UNIT III SOLAR PV FUNDAMENTALS 9

Solar cells - p-n junction: homo and hetro junctions - metal-semiconductor interface - dark and illumination characteristics -efficiency limits- variation of efficiency with band-gap and temperature -efficiency measurements-high efficiency cells -preparation of metallurgical, electronic and solar grade Silicon-production of single crystal Silicon: Czokralski(CZ)and Float Zone(FZ) method

UNIT IV SOLAR PHOTO VOLTAIC SYSTEM DESIGN AND APPLICATIONS 9

Solar cellar ray system analysis and performance prediction- Shadow analysis: reliability- solar cellar ray design concepts-PV system design-design process and optimization-voltage regulation-maximum tracking - use of computers in array design - quick sizing method - array protection and troubleshooting - standalone -hybrid and grid connected system - System installation - operation and maintenances - field experience – PV market analysis and economics of SPV systems

UNIT V SOLAR PASSIVE ARCHITECTURE 9

Thermal comfort - heat transmission in buildings- bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling -application of wind, water and earth for cooling; shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel. – energy efficient landscape design - thermal comfort – concept of solar temperature and its significance- calculation of instantaneous heat gain through building envelope

Total No. of Periods:45

TEXT BOOKS

1. Sukhatme SP, (1984), Solar Energy, TataMcGraw Hill
2. Kreider, J.F. and Frank Kreith, (1981), Solar Energy Handbook, McGrawHill

REFERENCE BOOKS

1. Garg HP., PrakashJ., (2000), Solar Energy: Fundamentals & Applications, TataMcGrawHill
2. S.T. Rama, E. Sheeba Percis, A. Nalini, S. Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1stEdn, Research India Publication ISBN No 978-93-87374-12-6
3. AlanLFahrenbruch and Richard H Bube, (1983), Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press
4. Larry D Partain, (1995), Solar Cells and their Applications, John Wiley and Sons, Inc.

Course Code: EBEE22E06	Course Name: GREEN BUILDING TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	**Ty**	**3**	**0/0**	**0/0**	**3**

L: Lecture T: Tutorial SLr: Supervised Learning P: Project R: Research C: Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To educate the concept of Green Building
- To understand the Design concepts of Green Building
- To attain knowledge on reduction of carbon footing
- To impart the importance of Environmental issues
- To explore the future trends in Green Building and to revamp the ecological design.

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	Understand the concept of green building
CO2	Summarize the importance of green building and reduction of carbon footing
CO3	Solve the issues in the green building to meet the demand
CO4	Implement the concept of green building in the places required in a cost-effective manner
CO5	Design a Green building with the use of latest tools

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	2	3	3	3	2	3	3	3
CO2	3	2	2	2	2	2	3	2	2	2	2	3
CO3	3	3	2	3	2	2	3	3	2	2	2	3
CO4	3	2	2	2	3	2	2	2	3	2	2	2
CO5	3	2	2	2	2	3	3	2	2	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	2	3	2
CO3	2	3	3
CO4	2	2	2
CO5	3	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E06	Course Name: GREEN BUILDING TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO GREEN BUILDING 9

Basics of Green-Sustainable Design–ecological Design–Green Design–Green Buildings-Progress & Obstacles-High Performance Green Buildings

UNIT II DESIGN OF GREEN BUILDING 9

Foundations of Green Building-Environmental Concerns-Assessment-Design process-green building –execution project-Heat Island Mitigation–Sustainable sites

UNIT III REDUCTION OF CARBON FOOTING 9

Building energy Issues – Design Strategy – Renewable Energy Systems- Smart Building & energy Management Systems -Reducing the Carbon footprint

UNIT IV ENVIRONMENTAL ASPECTS 9

Hydrological cycle-Sustainable storm water management-Construction Operations and commissioning of Green Building –Construction & Demolition Waste Management- Indoor Environmental Quality

UNIT V FUTURE TRENDS 9

Economics in Green Building–Managing First costs–Financial Barriers-Articulating Performance goals for future Green Buildings– Revamping Ecological Design

Total No. of Periods: 45

TEXT BOOKS

1. Charles J. Kibert Sustainable Construction: Green Building Design and Delivery, 3rd Edition Wiley Publisher, (2012) ISBN:978-0-470-90445-9
2. Francis D, K, Ching, IanM, Shapiro, Green Building Illustrated, Wiley

REFERENCE BOOKS

1. Sam Kubba, Handbook of Green Building Design, and Construction, Elsevier Publisher (2012) ISBN:978-0-12-385128-4
2. Charles J. Kibert, Martha C. Monroe, Anna L. Peterson, Richard R. Plate, Leslie Paul Thiele, WorkingToward Sustainability: Ethical Decision –Making in a Technological World, Wiley Publisher, ISBN :978-0-470-53972-9
3. S. T. Rama, E. SheebaPercis, A. Nalini, S. Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No 978-93-87374-12-6

Course Code: EBEE22E07	Course Name: NEURAL NETWORKS AND ITS APPLICATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know the fundamentals of Neural network
- To learn the theories of Neural network
- To learn the architechture of neural network
- To learn the control using Neural Network
- To apply the Neural network for control of various parameters for different application

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the fundamental of neural network
CO2	Classify the theories on Neural network
CO3	Implement the know the architecture of neural network
CO4	Implement the control mode using Neural network theory
CO5	Apply the Neural network for control of various parameters for different application

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	1	3	2	3	3
CO2	2	3	3	3	3	3	2	2	2	2	2	3
CO3	3	3	3	3	3	3	3	2	3	2	2	3
CO4	2	3	3	3	3	3	2	2	2	3	2	3
CO5	3	3	3	3	3	3	2	2	2	2	3	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	3	2
CO3	3	3	3
CO4	3	3	2
CO5	3	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E07	Course Name: NEURAL NETWORKS AND ITS APPLICATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	Ty	3	0/0	0/0	3

UNIT I FUNDAMENTALS OF NEURAL NETWORKS 9

Introduction- Basic Structure of a Neuron- Model of Biological Neurons-Elements of Neural Networks Weighting Factors-Threshold-Activation Function.

UNIT II NEURAL NETWORKS THEORY 9

ADALINE- Linear Separable Patterns- Single Layer Perceptron- General Architecture- Linear Classification-Perceptron Algorithm-Multi-Layer Perceptron General Architecture-Input-Output Mapping.

UNIT III NEURAL NETWORK ARCHITECTURE 9

Introduction- NN Classifications- Feed forward and feedback networks- Supervised and Unsupervised Learning Networks- Back Propagation Algorithm- Delta Training Rule-Radial Basis Function Network (RBFN)-Kohonen Self Organization Network-Hopfield Network.

UNIT IV NEURAL NETWORKS FOR CONTROL 9

Schemes of neuro-control – identification and control of dynamical systems – adaptive neuro controller – casestudy.

UNIT V APPLICATION OF NEURAL NETWORKS 9

Introduction -Application of neural network in Design of digital filters- computer networking –Electrical Fault Diagnosis.

Total No. of Periods:45

TEXT BOOKS

1. AliZilouchian MoJamshidi, (2000) Intelligent Control Systems Using Soft Computing Methodologies.
2. Englewoodcliffs, N.J. Laurance Fausett, (1992) Fundamentals of Neural Networks. Prentice Hall.

REFERENCE BOOKS

1. Tsoukala, L.H. and RobertE.Uhrig, (1997) Fuzzy and Neural approach in Engineering. John Wiley and Sons.
2. JacekM.Zurada, (1997) Introduction to artificial Neural Systems. Mumbai: Jaico Publishing House.
3. Millon, W.T. Sutton, R.S. and Webrose, P.J.(1992) Neural Networks for control.MIT: Press.

Course Code: EBEE22E08	Course Name: DIGITAL SIGNAL PROCESSING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Control Systems	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To understand the fundamentals of signals & systems.
- Impart knowledge on Z-transform concepts.
- To Understand the Designing of signals using filters.
- To avail the knowledge on design IIR and FIR filters with Fourier series method
- To understand the Architecture and features of various signal processing chips

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recall the fundamentals of signals & systems.
CO2	Comprehend and impart knowledge on Z-transform concepts
CO3	Analyze the power spectrum using various signal processing techniques
CO4	Design and study of various techniques involved in filters
CO5	Scrutinize the architecture and features of various signal processing chips

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**1**
CO2	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**

COs /PSOs	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E08	Course Name: DIGITAL SIGNAL PROCESSING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Control Systems	Ty	3	0/0	0/0	3

UNIT I DISCRETE TIME SIGNALS AND SYSTEMS 9

Periodic and pulse signals– examples of sequences–pulse step, impulse, ramp, sine and exponential–differential equations –linear time in variant–stability, causality –DT systems –time domain analysis

UNIT II Z-TRANSFORM AND DFT 9

Z-transform and its properties – convolution – inverse Z-transform – discrete Fourier series – properties –sampling the Z-transform – Discrete Fourier Transform – properties for frequency domain analysis – linear convolution using discrete Fourier transform– overlap add method, overlap save method

UNIT III FAST FOURIER TRANSFORM (FFT) 9

Introduction to Radix 2 FFT's – decimation in time FFT algorithm – decimation in frequency FFT algorithm – computing inverse DFT using FFT– mixed radix FFT algorithm

UNIT IV IIR AND FIR FILTER DESIGN 9

Classification – reliability constrains– IIR design – bilinear transform method – impulse invariant method–step– in variance method–FIR design– Fourier series method– window function method

UNIT V PROGRAMMABLED SP CHIPS 9

Architecture and features of TMS320C50, TMS3201 and ADSP2181 signal processing chips

Total No. of Periods: 45

TEXT BOOKS

1. OpenheimA.V., and SchaferR.W., Discrete Time Signal Processing, Prentice Hall of India, NewDelhi,1992
2. ProakisJ.G. and Manolakis, D.G., Digital Signal Processing Principles, Algorithms and Applications, Prentice Hall of India, New Delhi,1997

REFERENCE BOOKS

1. Antonian A., Digital Filters analysis and Design, TataMcGraw-Hill PublishingCo., NewDelhi,1988
2. Stanley W.D., Digital Signal Processing, Restion Publishing House, 1989.
3. ADSP2181 Datasheet

Course Code: EBEE22E09	Course Name: RESTRUCTURING OF DISTRIBUTION SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Transmission and Distribution	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study about Distribution system and Load Pattern
- To impart knowledge on the Distribution feeder
- To restructure the Distribution network and extent control for Low voltage network
- To understand the self-healing control techniques
- To attain confidence on Automation in Distribution field

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the distribution network including the feeder, mains
CO2	Classify the various feeders and self-healing control methods
CO3	Analyze the fault in the distribution feeder and restructure the network and automize the distribution network
CO4	Design a distribution system in the path of smart grid with use of modern tool
CO5	Simulate their structured distributed network and identify the issues involved in it

Mapping of Course Outcome with Program Outcome (Pos)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3	3	2	3	3	3	2
CO2	2	3	3	2	2	2	3	3	2	2	3	3
CO3	3	3	2	3	3	3	3	2	3	3	3	2
CO4	2	3	2	2	2	2	3	2	2	2	3	2
CO5	2	2	3	3	3	2	2	3	3	2	2	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	2	2	3
CO3	3	3	3
CO4	2	2	3
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E09	Course Name: RESTRUCTURING OF DISTRIBUTION SYSTEM	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Transmission and Distribution	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO DISTRIBUTION SYSTEM 9

Development of Power Distribution Network –Load Growth and Diversified Demands – Load Modeling- Load Demand Forecasting -Self healing Techniques – Line parameters- Overhead lines, Insulators and Supports-Cables- Insulation Resistance– Voltage drop and Power loss in Conductor

UNIT II DISTRIBUTION FEEDER 9

Primary Distribution system – Secondary Distribution system – Design Considerations - Substation location and planning–Feeder Loading–Voltage drop considerations–Drop with different loadings–Voltage drop constant with different loading

UNIT III RESTRUCTURING THE NETWORK 9

Design of Network – Voltage selection – Sizing –Voltage control- Current loading- Earthing –Cost Factor – LV Distribution Networks – Switchgear for Distribution Substation and LV Networks– Extended Control of Distribution Substations and LV Network

UNIT IV SELF HEALING CONTROL 9

Self-Healing –Principle –Characteristics- Control method – Urban Distribution network self-healing control method based on Quantity of State–Based on Distributed Power and Microgrid- Based on Coordination Control model

UNIT V AUTOMATION IN DISTRIBUTION SYSTEM 9

Implementation of Distribution Network self-healing – Relay Protection Units – Basic Requirements – Self Adaption – SCADA / RTU- History and Development of SCADA -Principle and Operation – Automation of Distribution System– PMU/WAMS and SCADA/EMS–Application of PMU or WAMS

Total No. of Periods: 45

TEXT BOOKS

1. Kamaraju, V (2009), Electrical power Distribution System, Tata McGrawHill
2. Abdelhay A, Sallam, Om, P, Malik, (2011), Electric Distribution Systems, Wiley

REFERENCE BOOKS

1. XinxinGu, NingJiang (2017), Self-Healing Control Technology for Distribution Networks, Wiley
2. James Northcote-Green, Robert Wilson, Control and Automation of electrical Power Distribution Systems, Taylor & Francis

Course Code: EBEE22E10	Course Name: DG & ELECTRICAL STORAGE TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Smart grid and Electric Vehicle Technology	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study about the Energy Storage Technology
- To know the working Principle of Batteries and its types
- To impart knowledge on Fuel Cells along with its advantage and disadvantages
- To analyze various types of energy storage devices.
- To have a wide spread knowledge on Electric Vehicle

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the various energy resource available and its abundance
CO2	Summarize the concept of Distributed Generation, Batteries, Fuel Cell and Electric Vehicle
CO3	Model a Microgrid and design an electric storage technology
CO4	Paraphrase the alternate energy source in Distributed Generation
CO5	Demonstrate the operation of the Distributed generation and various types of energy storage system

Mapping of Course Outcome with Program Outcome (POs)

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

COs /PSOs	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**2**	**2**	**3**
CO3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO5	**3**	**2**	**2**

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E10	Course Name: DG & ELECTRICAL STORAGE TECHNOLOGY	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Smart Grid and Electric Vehicle Technology	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

Conventional Power generation – Advantages and disadvantages – energy crisis – non-conventional energy resources –review of solar, Wind energy system, biomass, tidal sources

UNIT II DISTRIBUTED GENERATION 9

Concept of distributed generation – topologies – selection of sources – regulatory standards – Security issues in DG implementation – Energy storage element - Necessity of energy storage – types of energy storage –comparison of energy storage technologies-Application

UNIT III BATTERIES & FUEL CELL 9

Batteries – Measurement – Storage and types - Fuel Cell – History of fuel cell – Principle of electro chemical Storage – Types – Hydrogen oxygen cells, Hydrogen air cell – Hydrocarbon air cell–alkaline fuel cell –detailed analysis– advantage and drawback of each cell.

UNIT IV ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

Flywheel – Super Capacitors – Principles & applications, Compressed Air Energy Storage- Concept of Hybrid Storage–Microgrid Economics-Applications

UNIT V ELECTRIC VEHICLE 9

Electric Vehicle – Types – Hybrid Vehicle – Battering Charging – Usage of batteries in Hybrid vehicle – Fundamentals of Electric vehicle modeling– Types of PHEVs and Automotive system

Total No. of Periods:45

TEXT BOOKS

1. Ibrabim Dincer, marcA, Rosen, (2011) Thermal Energy Storage Systems and Applications, 2nd Ed, JohnWiley
2. James Larminie, John Lowry (2003), Electric Vehicle Technology Explained, John Wiley & Sons
3. Sumedha Rajakaruna, Farhad Shahnia, Arindham Ghosh, “Plug-in-Electric Vehicles in Smart Grid – Integration Techniques”, Springer,2015

REFERENCE BOOKS

1. SethLeitman, BobBrant (2013) Build Your Own Electric Vehicle,3rd Ed, McGrawHill
2. S.T. Rama, E. SheebaPercis, A. Nalini, S. Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No978-93-87374-12-6

Jameslarminie, Andrew Dicks, (2003), Fuel Cell Systems Explained, Wiley

Course Code: EBEE22E11	Course Name: MATERIAL SCIENCE IN AVIATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To gain basic knowledge on Cryogenic Technology
- To impart knowledge on Super Alloy and its Applications
- To know the importance of Flexible Electronics
- To have a wide spread knowledge about Nano science and nano material
- To learn about Drone

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the materials used in Aviation
CO2	Summarize the use of super alloy, flexible Electronics
CO3	Model the material for flexible electronics with Nanotechnology
CO4	Design Drone or any simple kind of Air Vehicle
CO5	Associate the material science in Aviation

Mapping of Course Outcome with Program Outcome (POs)

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

COs /PSOs	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**2**	**2**	**2**
CO3	**3**	**3**	**3**
CO4	**2**	**2**	**2**
CO5	**3**	**3**	**2**

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E11	Course Name: MATERIAL SCIENCE IN AVIATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Electrical, Electronics and Instrumentation Engineering	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO CRYOGENIC TECHNOLOGY 9

Terms & Phenomena associated with Cryogenic Systems – Prominent contributors- Critical Aspects and Issues involved – Benefits from Integration – Early applications of Cryogenic Technology- Gas Separation process – Industrial Applications of Cryogenic fluid technology

UNIT II SUPER ALLOY 9

Introduction-Basic Metallurgy–characteristics & Facts–Properties–Microstructure–Strengthening–Melting & Conversion– Investment casting- Corrosion & Protection of Super Alloy-Applications

UNIT III FLEXIBLE ELECTRONICS 9

History – Materials for Flexible Electronics – Degrees – Substrates – Backplanes Electronics – Front plane Technologies – Encapsulation - Fabrication Technology – Sheets by batch Processing and Web by Roll-to-Roll Processing

UNIT IV NANOSCIENCE AND NANOTECHNOLOGY 9

Nano – Current Technologies – Energetics – Implications – Electron Microscopes – Optical Microscopes – Photoelectron Spectroscopy for the study of nano materials – Metal clusture and nano particles – nano crystals – Raman Scattering– Basics of nanomaterials

UNIT V DRONE AND AIR VEHICLE 9

Introduction–Types of flying drones–Current Uses–Drone Components–Concept sand Systems–Regulations & Safety – Applications– Future Trends

Total No. of Periods :45

TEXT BOOKS

1. Jha, AR, (2006), Cryogenic Technology and Applications, Elsevier
2. John, KTien, Super alloys, Super composites and Super ceramics, Elsevier
3. WilliamS, Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, Springer
4. Pradeep, T, (2012) Nanoscience and Nanotechnology, McGrawHill

REFERENCE BOOKS

1. Mattew, JD, StephenJD, Superalloys, A Technical guide,2nd Ed, ASM International.
2. MurtyBS, Shankar. P, Baldev Raj, BBRath, James Murday, Nanoscience and Nanotechnology, Springer
3. Robo kingdom LLC, (2016) Drone Book

Course Code: EBEE22E12	Course Name: POWER PLANT INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Measurements and Instrumentation	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- Familiarity to Building blocks and boilers.
- Capable to measure Electrical parameters.
- Capable to analyze various parameters in power plants
- Understand the control loops in boiler
- Capable to monitor and control their new able energy systems

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the various Power Plants, Measurements, control loops, turbine monitoring and Control
CO2	Classify the various types of Power plants based on the analyze rand control techniques
CO3	Paraphrase the measurement techniques, and analyse the impurities, boiler operation and speed control.
CO4	Model the power plant based on the current need for a sustainable society in a cost-effective manner.
CO5	Apply the modern techniques required to solve the complex issues in the field

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	3	3	2	3	3	3
CO2	2	2	3	2	3	2	2	3	3	2	2	3
CO3	3	3	2	3	2	3	3	3	2	3	3	3
CO4	2	2	3	2	2	2	2	3	2	2	2	3
CO5	3	3	3	3	3	3	2	2	3	3	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	2	2	3
CO3	3	3	3
CO4	2	2	3
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E12	Course Name: POWER PLANT INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Measurements and Instrumentation	Ty	3	0/0	0/0	3

UNIT I OVERVIEW OF POWER GENERATION 9

Brief survey of methods of power generation – hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation– thermal power plants– building blocks– details of boiler process UP & I diagram of boiler– cogeneration.

UNIT II MEASUREMENTS IN POWER PLANTS 9

Electrical measurements – current, voltage, power, frequency, power factor etc. – non electrical parameters –flow of feed water, fuel, air and steam with correction factor for temperature – steam pressure and steam temperature– drum level measurement–radiation detector–smoke density measurement–dust monitor.

UNIT III ANALYZERS IN POWER PLANTS 9

Flue gas oxygen analyzer – analysis of impurities in feed water and steam – dissolved oxygen analyzer – chromatography–PH meter – fuel analyzer– pollution monitoring instruments.

UNIT IV CONTROL LOOPS IN BOILER 9

Combustion control – air/fuel ratio control – furnace draft control – drum level control – main stem and reheat steam temperature control – super heater control – attemperator – de aerator control – distributed control system in power plants–inter lock sin boiler operation.

UNIT V TURBINE– MONITORING AND CONTROL 9

Speed, vibration, shell temperature monitoring and control – steam pressure control – lubricant oil temperature control– cooling system

Total No. of Periods:45

TEXT BOOKS

1. Sam G. Dukelow, (1991) The control of Boilers, instrument Society of America
2. Modern Power Station Practice.Vol.6. Instrumentation, Controls and Testing. Pergamon Press. Oxford

REFERENCE BOOKS

1. Elonka, S. M. and Kohal, A. L. (1994) Standard Boiler Operations. NewDelhi: McGraw-Hill
2. Jain, R.K. (1995) Mechanical and industrial Measurements. Delhi: Khanna Publishers

Course Code: EBEE22E13	Course Name: SAFETY FOR ELECTRICAL ENGINEERS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Electrical Engineering Practise lab	**Ty**	**3**	**0/0**	**0/0**	**3**

L:LectureT:Tutorial SLr: Supervised Learning P:Project R: Research C: Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To attain knowledge on Electrical Safety
- To know about the operation of Electrical Safety Equipments
- To learn about the safety procedures
- To know about the electrical safety codes
- To train the students on the Safety training.

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Understand the basics of electrical safety
CO2	Summarize the operation of safety equipment
CO3	Interpret the safety procedure and training methods for a sustainable society
CO4	Perform safety experiments to create awareness among people
CO5	Analyze the Hazards in the electricity and safety training methods throughout the life

Mapping of Course Outcome with Program Outcome (POs)

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

COs /PSOs	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**2**	**2**	**3**
CO3	**3**	**3**	**3**
CO4	**2**	**2**	**3**
CO5	**3**	**2**	**2**

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E13	Course Name: SAFETY FOR ELECTRICAL ENGINEERS	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Electrical Engineering Practise lab	Ty	3	0/0	0/0	3

UNIT I GENERAL PRINCIPLES OF ELECTRIC SAFETY 9

Electricity and Human Body – Earthing – Grounding – General Inspection and testing requirement for electrical safety equipment–Flash and thermal production– head and Eye Protection – Electricians Safety kits

UNIT II HAZARDS IN ELECTRICITY 9

Lighting Hazards - Hazardous area –Hazard Analysis – shock effect -Electrical Insulation – Electrical fires –Arc Flash–Arc energy –arcing voltage–Injury and death–Protective Strategies-Electrical safety in hospitals

UNIT III REGULATORY OF SAFETY REQUIREMENT AND STANDARDS 9

Standard Guidelines of Electrical Safety - Risk assessment and Management – Safety against over voltage, extra-low and residual voltages – safety practice – Safety Audits – ANSI-IEEE Electrical safety code – Electrical standards at work place – Accident prevention

UNIT IV SAFETY PROCEDURES AND EQUIPMENTS 9

Residual current detectors - effects of electric and magnetic fields and electromagnetic radiation – electrosurgical hazards – Ground Rods and ground mats - electrical fires and their investigation –wind energy Area Classification –Safety issues with emerging energy sources

UNIT V SAFETY TRAINING METHODS 9

Introduction – Elements of a Training Program – On the Job Training – Training Consultants and Vendors-Training Program Setup–Step by Step Method electrical safety

Total No. of Periods 45

TEXT BOOK:

1. Electrical safety handbook – John Cadick -McGRAW -HILL, Third Edition

Course Code: EBEE22E14	Course Name: WIDE AREA MONITORING PROTECTION AND CONTROL	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power quality and Control of Power System	**Ty**	**3**	**0/0**	**0/0**	**3**

L:LectureT:Tutorial SLr: Supervised Learning P:Project R: Research C: Credits
T/L/ETL:Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know about the Phasor Measurement Unit and its importance
- To impart knowledge on State Estimation and the Optimal placement of PMU
- To attain familiarity on Wide Area Measurement System
- To have a wide spread knowledge about the Protection schemes and the Dynamic model of Power System
- To apply the learnt concept for the real time issues.

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the Phasor Measurement Unit
CO2	Summarize the state estimation, PMUS, Wide Area Measurements, Smart Grid
CO3	Design a Smart Grid for the sustainable society
CO4	Demonstrate the operation of the PMU there by the monitoring of Substation
CO5	Analyze the transmission and distribution optimization in the Smart Grid

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	2	3	2	3	2	3
CO2	3	3	3	3	2	3	3	3	2	3	3	3
CO3	3	2	3	3	3	3	2	3	3	3	2	3
CO4	3	3	2	3	2	3	3	2	2	3	3	2
CO5	2	2	2	3	3	2	2	2	3	2	2	2

COs /PSOs	PSO1	PSO2	PSO3
CO1	2	3	2
CO2	2	3	3
CO3	3	3	2
CO4	2	3	3
CO5	3	2	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E14	Course Name: WIDE AREA MONITORING PROTECTION AND CONTROL	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power Quality and Control of Power System	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

PMU –History of PMU–Basic definition of Synchrophasor, Frequency, Accuracy Indexes–Sensors of PMUs - PMU Architecture-Data Acquisition System–Communication & Data Collector-Distributed PMU-International Standards.

UNIT II STATE ESTIMATION AND PMUS 9

Introduction – Formulation of the SE problem – SE measurement Model – SE Classification – Role & Impact of PMU in SE – PMU based Transmission System SE and Distribution SE - Optimal PMU Placement – SE Applications – Automation Architecture with integrated PMU Measurement for SE

UNIT III WIDE AREA MEASUREMENT SYSTEMS 9

WAMS – Definition, Data resource, Communication Systems, Applications- Monitoring System Components – Substation Configuration and Communication – Substation Monitoring System- Voltage Stability Assessment – Adaptive load shedding-

UNIT IV SMART GRID 9

Smart Transmission grid–Demands & Requirement–Wide Area Disturbances–SIPS Architecture–Components and Applications - Dynamic Model of large Power system- Eigen Values & Eigen vectors –Optimization model for equilibrium tracing–Q-V Sentivity –Small Signal Stability Analysis

UNIT V WAMPAC APPLICATION 9

WAMPAC Application in Frequency Stability, Voltage Stability, Transient Stability, Small Signal Stability

Total No. of Periods:45

TEXT BOOKS

1. Antonello Monti, Carlo Muscas, Ferdinanda Ponci, Phasor Measurement Units and Wide Area Monitoring Systems, Elsevier
2. Alfredo Vaccaro, Ahmed Faheem Zobaa, Wide Area Monitoring, Protection and Control Systems, IET

REFERENCE BOOKS

1. Begovic, Miroslav, M, Electrical Transmission Systems and Smart Grids, Springer
2. Fahd Hashiesh, Mansour, MM, Hossam E Mostafa (2011), Wide Area Monitoring, Protection and Control, Lambert

Course Code: EBEE22E15	Course Name: ROBOTICS AND AUTOMATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Mechanical and Civil Engineering	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To introduce the basic concepts and parts of robots.
- To understand the working of robots and various types of robots.
- To make the students familiar with the various drive systems of robots, sensor sand their applications in robots and programming of robots.
- To discuss the various application of robots, justification and implementation of robots.
- To study about the manipulators, activators and grippers and their design considerations

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the Robots and its parts
CO2	Classify the different types of Robots based on Application
CO3	Illustrate the various application of Robots and compile program
CO4	Interpret the actuators, sensors for the sustainable society
CO5	Summarize the manufacturing application, cell design, use of Electric Drives

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	3	2	3	2	3	3
CO2	3	3	3	3	3	3	3	2	3	3	3	3
CO3	3	3	2	3	2	3	3	3	3	2	3	3
CO4	2	3	3	3	3	2	3	2	3	3	2	3
CO5	2	3	2	2	2	2	3	3	2	2	2	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	3	3	2
CO3	3	3	3
CO4	2	3	2
CO5	2	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E15	Course Name: ROBOTICS AND AUTOMATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Basic Mechanical and Civil Engineering	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

Anatomy of robotics–History & Terminology of Robotics–various generations of robots–degrees of freedom – Asimov's laws of robotics

UNIT II SENSORS IN ROBOTICS 9

Position sensors–optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors–Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque Sensors.

UNIT III MANIPULATORS, ACTUATORS AND GRIPPERS 9

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits– end effectors– U various types of grippers–design considerations

UNIT IV ROBOTICS IN MATERIAL HANDLING 9

General considerations in robot material handling– material transfer application–pick & place operations–machine loading & unloading–characteristics of robot application–Robot cell design–processing operations-Spot welding, Spray painting, Plastic moulding, forging

UNIT V ROBOTICS IN FUTURE 9

Robot intelligence, Advanced Sensors, Capabilities, Telerobotics, Mechanical design Features, Mobility, locomotion and Navigation-the universal Hand Systems Integration and Networking

Total No. of Periods:45

TEXT BOOKS

1. Mikell P. Weiss G. M., Nagel R. N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore,
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai,1998.

REFERENCE BOOKS

1. Deb. S. R., (1992), Robotics technology and flexible Automation, John Wiley.
2. Asfahl C.R., (1992), Robots and manufacturing Automation, John Wiley.
3. Klafter R.D., Chimielewski T.A., Negin M., (1994)., Robotic Engineering–An integrated approach, Prentice Hall of India.
4. Mc Kerrow P.J.(1991)., Introduction to Robotics, Addison Wesley.
5. Issac Asimov (1986.), I Robot, Ballantine Books, New York.

Course Code: EBEE22E16	Course Name: IMAGE PROCESSING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits
T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To apply transformation techniques in Digital Image Processing
- To apply techniques in image enhancement, restoration, compression, segmentation etc
- To learn image restoration and image compression
- To learn the fundamentals of image fundamental and use of filters for image enhancement
- To implementing different algorithm in image processing

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Understand the basic of Image processing
CO2	Apply the techniques in image enhancement, and to process and restore images
CO3	Illustrate the image compression, segmentation and representation
CO4	Paraphrase the fundamentals of image fundamental and use of filters for image enhancement
CO5	Perform experiment on implementing different algorithm in image processing

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	3	2	3	2	3	3	2
CO2	3	3	3	3	3	3	3	3	3	3	3	2
CO3	3	2	3	2	3	3	2	3	2	3	3	3
CO4	3	3	3	3	2	3	3	3	3	2	3	2
CO5	2	2	2	2	2	3	2	2	2	2	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	3	3	3
CO3	3	3	2
CO4	2	3	3
CO5	2	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E16	Course Name: IMAGE PROCESSING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	Ty	3	0/0	0/0	3

UNIT I DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS 9

Elements of visual perception – Image sampling and quantization Basic relationship between pixels – Basic geometric transformations-Introduction to Fourier Transform and DFT –properties of 2D Fourier Transform –FFT– Separable Image Transforms-Walsh–Hadamard–Discrete Cosine Transform, Haar, Slant–Karhunen–Loeve transforms.

UNIT II IMAGE ENHANCEMENT TECHNIQUES 9

Spatial Domain methods: Basic grey level transformation– Histogram equalization– Image subtraction–Image averaging –Spatial filtering: Smoothing, sharpening filters – Laplacian filters – Frequency domain filters: Smoothing–Sharpening Filters-Homomorphic filtering.

UNIT III IMAGE RESTORATION 9

Model of Image Degradation/restoration process– Noise models– Inverse Filtering-Least mean square filtering –Constrained least mean square filtering–Blind image restoration–Pseudo inverse–Singular value decomposition.

UNIT IV IMAGE COMPRESSION 9

Lossless compression: Variable length coding – LZW coding – Bit plane coding- predictive coding-DPCM. Lossy Compression: Transform coding – Wavelet coding – Basics of Image compression standards: JPEG, MPEG, Basics of vector quantization.

UNIT V IMAGE SEGMENTATION AND REPRESENTATION 9

Edge detection – Thresholding - Region Based segmentation – Boundary representation: chair codes- Polygonal approximation – Boundary segments – boundary descriptors: Simple descriptors-Fourier descriptors – Regional descriptors –Simple descriptors- Texture- Implementation of various algorithms in image processing using related simulation packages.

Total No. of Periods:45

TEXT BOOKS

1. Rafael CGonzalez, Richard E. Woods, (2003) Digital Image Processing.2nd Ed. Pearson Education.

REFERENCE BOOKS

1. William K. Pratt, (2001) Digital Image Processing. John Willey.
2. Chanda Dutta Magundar, (2000) Digital Image Processing and Applications. Prentice Hall of India:
3. Millman Sonka, Vaclavhlavac, Roger Boyle, Broos, colic, (1999) Image Processing Analysis and Machine Vision. Thompson Learning
4. Jain, A.K. (1995) Fundamentals of Digital Image Processing. NewDelhi: PHI.

Course Code: EBEE22E17	Course Name: SUBSTATION DESIGNING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power System Protection and Switchgear	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To study about the importance of Substation and its types
- To impart knowledge on Gas Insulated Substation and its working Principle
- To know the working principle and characteristics of Air- Insulated Substations
- To have a wide spread knowledge about High voltage Power Electronics Substation such as HVDC station
- To understand the Integration and Automation of Substations

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Identify the components in the Substation
CO2	Classify the various types of Substations and identify the faults related to it
CO3	Paraphrase the importance of Gas insulated, Air insulated substation and substation integration
CO4	Illustrate the different Substation and design as per the need for a sustainable society
CO5	Design the substation with all the requirements for a sustainable society

Mapping of Course Outcome with Program Outcome (POs)

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

COs /PSOs	PSO1	PSO2	PSO3
CO1	**3**	**2**	**3**
CO2	**3**	**3**	**2**
CO3	**3**	**2**	**3**
CO4	**3**	**3**	**2**
CO5	**2**	**3**	**3**

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E17	Course Name: SUBSTATION DESIGNING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Power System Protection and Switchgear	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION TO SUBSTATION AND ITS TYPES 9

Need for Substation–Budgeting–Traditional & Innovative Substation Design–Site Selection and Acquisition-Station Design–Station Construction–Station Commissioning- bas bar arrangements in Switch yard

UNIT II GAS INSULATED SUBSTATION 9

Sulfur Hexafluoride – Construction – Circuit Breaker – Current and Voltage Transformers – Disconnect and Ground Switches – Interconnecting Bus – Air, Power Cable and Direct Transformer Connections – Surge Arrester – Control System – Gas monitoring System – Gas compartments and Zones – Electrical & Physical Arrangement– Grounding– Testing–Installation – Operation and Interlocks – Economics.

UNIT III AIR- INSULATED SUBSTATIONS 9

Introduction – Single and Double Bus Arrangement – Main and Transfer Bus Arrangement – Double Bus-Single Breaker Arrangement – Ring Bus Arrangement – Breaker and a Half Arrangement – Comparison of Configurations .

UNIT IV HIGH VOLTAGE POWER ELECTRONIC SUBSTATION 9

High Voltage Power Equipment - Converter Station (HVDC) – FACTS Controllers – Control & Protection System – Health monitoring and thermal energy, Losses and cooling –Civil works – Reliability and Availability – Future Trends

UNIT V SUBSTATION INTEGRATION AND AUTOMATION 9

Definitions and Terminology – Open Systems- Architecture Functional Data paths – Substation Integration and Automation Systems–New Vs Existing Substations–Equipment conditioning Monitoring– Substation Integration and Automation Technical issues – Protocol Fundamentals and Considerations – Communication Protocol Application Areas

Total No. of Periods:45

TEXT BOOKS

1. John D, Mc Donald (2007), Electric Power Substations Engineering, 2nd Ed, CRC Press
2. Sunil. S, Rao (2010), Switchgear Protection and Power Systems, 4th Ed. Khanna Publishers

REFERENCE BOOKS

1. Khedkar MK, Dhole GM, Electric Power Distribution Automation, University Science Press
2. Satnam PS and Gupta PV, Substation Design & Equipment, Dhanpat Rai Publications

Course Code: EBEE22E18	Course Name: INDUSTRIAL CONTROL INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Measurements and Instrumentation	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know about force, torque, velocity
- To learn the measurement of acceleration, vibration, density and viscosity
- To understand the Pressure and Temperature measurement
- To learn about the Controllers and Converters, Thermocouple with the use of modern tools
- To solve the issues in the industry by giving suitable solution in a cost-effective manner.

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Recognize the basic regulatory power supply, thermocouple, Industrial Application
CO2	Summarize the need for the Industrial Control Instrumentation
CO3	Interpret the PLC, various converters, pressure measurement and various application in Industries
CO4	Analyze the Controllers and Converters, Thermocouple with the use of modern tools
CO5	Solve the issues in the industry by giving suitable solution in a cost-effective manner.

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	3	3	2	3	2	3
CO2	2	2	3	2	3	2	2	3	3	2	3	2
CO3	3	3	2	3	2	3	3	3	2	3	2	3
CO4	2	2	3	2	2	2	2	3	3	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	2	2
CO3	2	3	3
CO4	2	2	2
CO5	3	3	2

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E18	Course Name: INDUSTRIAL CONTROL INSTRUMENTATION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Measurements and Instrumentation	Ty	3	0/0	0/0	3

UNIT I REGULATORY POWER SUPPLY 9

Overview of Switching Regulators and switch mode power supplies – Uninterrupted Power Supplies – Solid state circuit breakers-PLC

UNIT II CONTROLLERS AND CONVERTERS 9

Analog Controllers – Proportional controllers – Proportional Integral Controllers – PID Controllers – Feed forward Controllers – Signal Conditioners – Instrumentation Amplifiers – Voltage to Current, Current to Voltage, Voltage to Frequency, Frequency to Voltage Converters – Isolation Circuits

UNIT III PRESSURE MEASUREMENT 9

Units of pressure - Manometers – Different types – Elastic type pressure gauges – Bourdon type bellows – Diaphragms – Electrical methods – Elastic elements with LVDT and strain gauges – Capacitive type pressure gauge– Piezo resistive pressure sensor–Resonator pressure sensor–Measurement of vacuum–McLeod Gauge-Thermal conductivity gauges – Ionization gauge, cold cathode and hot cathode types – Testing and calibration of pressure gauges– Dead weight tester.

UNIT IV THERMOCOUPLE 9

Thermocouples – Laws of thermocouple – Fabrication of industrial thermocouples – Signal conditioning of thermocouples output – Thermal block Reference Books functions – Commercial circuits for cold junction compensation–Response of thermocouple–Special techniques for measuring high temperature using thermocouples– Radiation methods of temperature measurement

UNIT V APPLICATION IN INDUSTRIES 9

Stepper Motors and Servo motors – Control and Application – Servo Amplifiers – Selection of Servo motor and Application–Fibre Optics– Barcode Equipment and Application of Barcode in Industry

Total No. of Periods:45

TEXT BOOKS

1. Doebelin, E.O. (2003) Measurement Systems–Application and Design. Tata McGraw Hill publishing company.
2. Jain, R.K. (1999) Mechanical and Industrial Measurements. NewDelhi: Khanna Publishers.
3. Michael Jacob, (1988) 'Industrial Control Electronics–Applications and Design', Prentice Hall
4. Thomas, E. Kissel, (2003) Industrial Electronics, PHI

REFERENCE BOOKS

1. Patranabis, D. (1996) Principles of Industrial Instrumentation. Tata McGraw Hill Publishing Company Ltd.
2. Sawhney, A. K. and Sawhney, P. (2004)A Course on Mechanical Measurements, Instrumentation and Control Dhanpath Rai and Co.
3. Nakra, B.C.& Chaudary, B.C. Instrumentation Measurement & Analysis. Tata McGraw Hill Publishing Ltd.
4. Singh, S.K. (2003) Industrial Instrumentation and Control.Tata McGrawHill.
5. Eckman, D.P. Industrial Instrumentation. Wiley Eastern Ltd.

Course Code: EBEE22E19	Course Name: ELECTRIC TRACTION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Electrical Machines, Power Electronics	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To know about traction drive
- To estimate motor rating with Reference Books to Indian Standards
- To apply concepts in electrical Machines

COURSEOUTCOMES(Cos)

Students completing this course were able to

CO1	Recognition of Electric traction and Electric Drive
CO2	Classify the operating modes of different types of Drives
CO3	Estimate the Power rating of the Motor, Drives, equivalent system of motor
CO4	Summarize the losses in the Drives system and compliment the usage of Special Drives to the present scenario
CO5	Utilize the Traction system and special Drives for a sustainable society

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	2	3	2	3	3	2	2
CO2	2	3	3	2	2	3	2	3	2	2	3	2
CO3	3	2	2	3	3	2	3	2	3	3	2	2
CO4	2	3	2	2	2	3	2	2	2	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	3	2	3
CO4	2	3	2
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					✓				

Course Code: EBEE22E19	Course Name: ELECTRIC TRACTION	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: Electrical Machines, Power Electronics	Ty	3	0/0	0/0	3

UNIT I INTRODUCTION 9

Basic drive components classification and operating modes of electric drive, nature and type of mechanical loads, review of speed torque characteristics of electric motors and load, joint speed torque characteristics. Electric Braking**:** Plugging, dynamic and regenerative braking of DC and AC motors.

UNIT II DYNAMICS OF ELECTRIC DRIVES SYSTEM 9

Equation of motion, equivalent system of motor load combination, stability considerations, electro mechanical transients during starting and braking, calculation of time and energy losses, optimum frequency of starting.

UNIT III TRACTION DRIVE 9

Electric traction services, duty cycle of traction drives calculations of drive rating and energy consumption, desirable characteristics of traction drive and suitability of electric motors, control of traction drives. Energy Conservation in Electric Drive: Losses in electric drive system and their minimization energy, efficient operation of drives, load equalization.

UNIT IV ESTIMATION OF MOTOR POWER RATING 9

Heating and cooling of electric motors, load diagrams, classes of duty, Reference Books to India standards, estimation of rating of electric motors for continuous, short time and intermittent ratings.

UNIT V SPECIAL ELECTRIC DRIVE 9

Servo motor drive, step motor drive, linear induction motor drive, permanent magnet motor drive. Selection of electric drive: Selection criteria of electric drive for industrial applications, case studies related to steel mills, paper mills, textile mills and machine tool etc.

Total No. of Periods:45

TEXT BOOKS

1. Dubey, G.K. (1995) Fundamentals of Electric Drive. Narosa Publishing House.
2. Chilkin, M. Electric Drive. Mir Publications.

REFERENCE BOOKS

1. Pillai, S.K.A first course on Electric Drive. New age international publishers.
2. Dev, N.K. Sen, P.K. (1999) Electric Drives. Prentice Hall of India.
3. Vedam Subhramanyam, (1994) Electric Drive: Concepts and Applications. Tata McGraw Hill.

Course Code: EBEE22E20	Course Name: ENVIRONMENTAL SCIENCE AND ENGINEERING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	**Ty**	**3**	**0/0**	**0/0**	**3**

L : Lecture T : Tutorial SLr : Supervised Learning P: Project R : Research C : Credits T/L/ETL: Theory/Lab/Embedded Theory and Lab

OBJECTIVES

- To acquire the knowledge about nature and environment
- To study the importance of environment by assessing its impact on the human world
- To study the integrated themes and biodiversity, natural resource, pollution control and waste management
- To learn about the public awareness of environmental science and engineering
- To understand the impact of human activities to the environment

COURSE OUTCOMES(Cos)

Students completing this course were able to

CO1	Implement the scientific and technologies for environmental problems
CO2	Understand the features of the earth's interior and surface
CO3	Understands public participation is an important aspect which serves the environmental Protection.
CO4	Public awareness of environmental science and engineering
CO5	Understands the impact of human activities to the environment

Mapping of Course Outcome with Program Outcome (POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	2	3	2	3	3	2	2
CO2	2	3	3	2	2	3	2	3	2	2	3	2
CO3	3	2	2	3	3	2	3	2	3	3	2	2
CO4	2	3	2	2	2	3	2	2	2	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

COs /PSOs	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	2
CO3	3	2	3
CO4	2	3	2
CO5	3	3	3

3/2/1 Indicates Strength of Correlation, 3–High, 2-Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Interdisciplinary	Skill Component	Practical / Project
					√				

Course Code: EBEE22E20	Course Name: ENVIRONMENTAL SCIENCE AND ENGINEERING	Ty/ Lb/ ETL/IE	L	T/SLr	P/R	C
	Prerequisite: None	**Ty**	**3**	**0/0**	**0/0**	**3**

UNIT I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY 9

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – 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, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

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 – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 9

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, 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, changes caused by agriculture and overgrazing, 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 – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From unsustainable to sustainable development — urban problems related to energy — water conservation, rain water harvesting, watershed management — resettlement and rehabilitation of people; its problems and concerns, case studies — role of non-governmental organization- environmental ethics: Issues and possible solutions — climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. — waste land reclamation — consumerism and waste products — environment production act — Air (Prevention and Control of Pollution) act — Water (Prevention and control of Pollution) act — Wildlife protection act — Forest conservation act — enforcement

machinery involved in environmental legislation-central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9

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.

Total No. of Periods:45

TEXT BOOKS

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

REFERENCE BOOKS

1. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hyderabad, 2015.
2. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT LTD, New Delhi, 2007.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005
4. G. Tyler Miller and Scott E. Spool man, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.