RAJALAKSHMI ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT VISION AND MISSION

VISION

To be an international centre in education, research and the application of knowledge, to benefit the society globally in the field of Electrical and Electronics Engineering

MISSION

- To impart high quality technical education and develop Electrical and Electronics Engineers with a sound theoretical combined with practical skills in all the areas concerning the discipline.
- To inculcate innovative research capabilities and exemplary professional conduct to lead and to use technology for the progress of our country.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

[1] To provide students with a strong foundation in mathematics, science and engineering, necessary to understand and solve engineering problems. Prepare the students for a successful career in industries and also for higher studies.

[2] To enable the students to acquire the ability to analyze, design and build electrical and electronic systems, needed in power electronic drives, variety of controllers, and power systems.

[3] To impart students with a sound knowledge of software tools and skills for taking up research in upcoming areas in the field of electrical and electronics engineering, and for embarking on entrepreneurial ventures with an aptitude for lifelong learning.

[4] To impart communication skills, to inculcate values and professional ethics, leadership qualities and team spirit for an overall personality development, to create environmental awareness and a passion for using the knowledge acquired, for addressing the societal concerns.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

(A) PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

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

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

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

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

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

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

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

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

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

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

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

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

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1. Analyse, model and design Electrical and Electronic circuits and machines**.**
PSO 2. Comprehend the structure of power apparatus and systems and analyze their operation, control, protection and utilization**.**
PSO 3. Use of programmable devices, embedded systems and software tools for the simulation, design and building newer electrical and electronic systems leading to research and invention.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION – 2019 (Batches - 2019-23 & 2020-24)

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	HS19151	Technical English	2	1	0	3	3	HS
2	MA19152	Linear Algebra and Applied Calculus	3	1	0	4	4	BS
3	CY19143	Applied Chemistry	3	0	2	5	4	BS
4	GE19141	Programming using C	2	0	4	6	4	ES
5	GE19122	Engineering Practices-Electrical and Electronics	0	0	2	2	1	ES
6	MC19102	Indian Constitution and Freedom Movement (Non Credit course)	3	0	0	3	0	MC
		TOTAL	**13**	**2**	**8**	**23**	**16**	

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	MA19252	Differential Equations and Complex Variables	3	1	0	4	4	BS
2	PH19242	Physics for Electronics Engineering	3	0	2	5	4	BS
3	GE19101	Engineering Graphics	2	2	0	4	4	ES
4	GE19202	Basic Civil and Mechanical Engineering	3	0	0	3	3	ES
5	EE19243	Electric Circuits	3	0	2	5	4	PC
6	GE19121	Engineering Practices - Civil and Mechanical	0	0	2	2	1	ES
7	MC19101	Environmental Science and Engineering (Non Credit course)	3	0	0	3	0	MC
		TOTAL	**17**	**3**	**6**	**26**	**20**	

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	MA19353	Transforms and Numerical Methods	3	1	0	4	4	BS
2	EE19301	Electromagnetic Theory	3	1	0	4	4	ES

3	EE19302	Electronic Devices and Circuits	3	1	0	4	4	PC
4	EE19303	Electrical Machines –I	3	1	0	4	4	PC
5	CS19241	Data Structures	3	0	4	7	5	ES
6	EE19311	Electrical Machines –I Laboratory	0	0	2	2	1	PC
7	EE19312	Electronic Devices and Circuits Laboratory	0	0	2	2	1	PC
8	MC19301	Essence of Indian Traditional Knowledge (Non Credit course)	3	0	0	3	0	MC
		TOTAL	**18**	**4**	**8**	**30**	**23**	

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	GE19301	Life Science for Engineers	3	0	0	3	3	BS
2	EE19401	Transmission and Distribution	3	0	0	3	3	PC
3	EE19402	Electrical Machines - II	3	1	0	4	4	PC
4	EE19441	Linear Integrated Circuits and Applications	3	0	2	5	4	PC
5	EE19442	Digital Logic Circuits	3	1	2	6	5	PC
6	GE19303	Economics for Engineers	3	0	0	3	3	HS
7	EE19411	Electrical Machines – II Laboratory	0	0	2	2	1	PC
8	GE19421	Soft Skills-I	0	0	2	2	1	EEC
		TOTAL	**18**	**2**	**8**	**28**	**24**	

SEMESTER V

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	EE19501	Power System Analysis	3	1	0	4	4	PC
2	EE19502	Power Electronics	3	0	0	3	3	PC
3	EE19503	Discrete Time Systems and Signal Processing	3	0	0	3	3	PC
4	EE19504	Measurements and Instrumentation	3	0	0	3	3	PC
5	EE19505	Control Systems	3	1	0	4	4	PC
6	EE19511	Measurements and Instrumentation Laboratory	0	0	2	2	1	PC
7	EE19512	Control Systems Laboratory	0	0	2	2	1	PC
8	*******	Open Elective - I	3	0	0	3	3	OE

9	GE19521	Soft Skills-II	0	0	2	2	1	EEC
		TOTAL	**18**	**2**	**6**	**26**	**23**	

SEMESTER VI

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	EE19601	Protection and Switchgear	3	0	0	3	3	PC
2	EE19602	Solid State Drives	3	0	0	3	3	PC
3	EE19603	Microprocessors, Microcontrollers and Applications	3	0	0	3	3	PC
4	EE19641	Design of Electrical Machines	3	0	2	5	4	PC
5	EE19P6X	Professional Elective I	3	0	0	3	3	PE
6	*******	Open Elective – II	3	0	0	3	3	OE
7	EE19611	Innovation and Design thinking for Electrical Engineers	0	0	4	4	2	EEC
8	EE19612	Power Electronics and Drives Laboratory	0	0	2	2	1	PC
9	EE19613	Microprocessors, Microcontrollers and Applications Laboratory	0	0	2	2	1	PC
10	GE19621	Problem Solving Techniques	0	0	2	2	1	EEC
		TOTAL	**18**	**0**	**12**	**30**	**24**	

SEMESTER VII

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	EE19701	Hybrid Electric Vehicles	3	0	0	3	3	PC
2	EE19741	Renewable Energy Systems	3	0	2	5	4	PC
3	EE19742	Power System Operation and Control	2	1	2	5	4	PC
4	EE19P7X	Professional Elective II	3	0	0	3	3	PE
5	EE19P7X	Professional Elective III	3	0	0	3	3	PE
6	EE19711	Project Work / Phase -I	0	0	8	8	4	EEC
		TOTAL	**14**	**1**	**12**	**27**	**21**	

SEMESTER VIII

S.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	EE19P8X	Professional Elective IV	3	0	0	3	3	PE

2	EE19P8X	Professional Elective V	3	0	0	3	3	PE
3	EE19811	Project Work/ Phase -II	0	0	12	12	6	EEC
		TOTAL	**6**	**0**	**12**	**18**	**12**	
TOTAL CREDITS : 163								

PROFESSIONAL ELECTIVES FOR SEMESTER VI

PROFESSIONAL ELECTIVE- I

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE19P61	Special Electrical Machines	PE	3	3	0	0	3
2	EE19P62	Advanced Control Systems	PE	3	3	0	0	3
3	EE19P63	Fundamentals of Communication Engineering	PE	3	3	0	0	3
4	EE19P64	PLC & SCADA	PE	3	3	0	0	3
5	ME19P79	Operation Research	PE	3	3	0	0	3

PROFESSIONAL ELECTIVES FOR SEMESTER VII

PROFESSIONAL ELECTIVE- II

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE19P70	Comprehension in Electrical and Electronics Engineering	PE	3	3	0	0	3
2	EE19P71	Restructured Power Systems	PE	3	3	0	0	3
3	EE19P72	Fundamentals of Embedded Systems	PE	3	3	0	0	3
4	EE19P73	High Voltage Engineering	PE	3	3	0	0	3
5	EE19P74	Digital Control Systems	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE19P75	Power Systems Transients	PE	3	3	0	0	3
2	EE19P76	Power Quality	PE	3	3	0	0	3
3	EE19P77	Applications of IoT in Electrical Engineering	PE	3	3	0	0	3
4	EE19P78	High Voltage Direct Current Transmission	PE	3	3	0	0	3
5	EE19P79	Flexible AC Transmission Systems	PE	3	3	0	0	3

PROFESSIONAL ELECTIVES FOR SEMESTER VIII

PROFESSIONAL ELECTIVE – IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE19P81	Fiber Optics and Laser Instrumentation	PE	3	3	0	0	3
2	EE19P82	Micro Electro Mechanical Systems	PE	3	3	0	0	3
3	EE19P83	Soft Computing Techniques	PE	3	3	0	0	3
4	EE19P84	Fundamentals of Biomedical Instrumentation	PE	3	3	0	0	3

5	EE19P85	SMPS and UPS	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – V

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	EE19P86	Electric Energy Utilization and Conservation	PE	3	3	0	0	3
2	EE19P87	Energy Management and Auditing	PE	3	3	0	0	3
3	EE19P88	Microcontroller Based System Design	PE	3	3	0	0	3
4	EE19P89	Smart Grid	PE	3	3	0	0	3
5	CS19301	Computer Architecture	PE	3	3	0	0	3

CREDIT DISTRIBUTION

CATEGORY	I	II	III	IV	V	VI	VII	VIII	Total
HS	3			3					6
BS	8	8	4	3					23
ES	5	8	9						22
EEC				1	1	3	4	6	15
PC		4	10	17	19	15	11		76
PE						3	6	6	15
OE					3	3			6
									163

SYLLABUS
SEMESTER I

Subject Code	Subject Name	Category	L	T	P	C
HS19151	TECHNICAL ENGLISH Common to all branches of I semester B.E./ B.Tech programmes	HS	2	1	0	3

Objectives:

- To enable learners to acquire basic proficiency in English reading and listening.
- To write in English precisely and effectively.
- To speak flawlessly in all kinds of communicative contexts.

UNIT-I VOCABULARY BUILDING **9**

The concept of word formation - Root words from foreign languages and their use in English - Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives - Synonyms, antonyms, and standard abbreviations. Compound words – abbreviation – single word substitution – **Listening:** Listening comprehension, listening to motivational speeches, podcasts and poetry. **Speaking:** Short talks on incidents - place of visit – admiring personalities, etc.

UNIT-II BASIC WRITING SKILLS **9**

Sentence structures - Use of phrases and clauses in sentences - punctuation - coherence - Organizing principles of paragraphs in documents - Techniques for writing precisely. **Reading & Writing** – Free writing – paragraphs - article reading and writing criticism - change of tense forms in short text or story – inferential reading – rewrite or interpret text - prepare questions based on the text. **Speaking:** Everyday situations – conversations and dialogues, speaking for and against.

UNIT-III GRAMMAR AND LANGUAGE DEVELOPMENT **9**

Subject-verb agreement- Noun-pronoun agreement - Articles – Prepositions – Redundancies. **Reading & Writing:** Read from innovation and ideas that changed the world, newspaper column writing – **Speaking:** Demonstrative speaking practice using visual aids (charts, graphs, maps, pictures, etc,.).

UNIT-IV WRITING FOR FORMAL PRESENTATION **9**

Nature and Style of sensible Writing - Describing – Defining – Classifying - Providing examples or evidence - Writing introduction and conclusion. **Reading & Writing –** Read from Literary pieces – identify different parts text – difference between print and digital writing. Writing: Recommendations - Foreword - Review of book. **Speaking-** Formal Presentations – Debate on social issues/taboos and solutions.

UNIT-V EXTENDED WRITING AND SPEAKING **9**

Writing: Précis writing – Essay writing – workplace communication: Resume – Business letters and emails – Proposals. **Speaking:** Panel discussion – reporting an event – mock interview – Master Ceremony.

Total Contact Hours : 45

Course Outcomes:
On completion of course students will be able to

- Discuss and respond to the listening content.
- Read and comprehend different texts and appreciate them
- Understand structures and techniques of precise writing
- Analyse different genres of communication and get familiarized with new words, phrases, and sentence structures.
- Write and speak appropriately in varied formal and informal contexts.

Text Books:

1. English for Technologists & Engineers, Orient BlackSwan Publications, Chennai 2012.

Reference Books / Web links:

1. Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3. Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4. Practical English Usage. Michael Swan. OUP. 1995.
5. Remedial English Grammar. F.T. Wood. Macmillan.2007
6. On Writing Well. William Zinsser. Harper Resource Book. 2001
7. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	-	-	-	-	1	-	2	3	1	3	-	1	-
CO 2	-	3	-	2	-	-	-	-	-	2	1	1	1	1	-
CO 3	-	-	-	1	-	-	-	-	-	3	-	-	-	1	-
CO 4	-	1	-	1	-	-	-	-	-	3	-	2	1	1	-
CO 5	1	1	1	1	1	1	1	1	2	3	1	1	-	-	-
Average	**1**	**1.6**	**1**	**1.25**	**1**	**1**	**1**	**1**	**2**	**2.8**	**1**	**1.75**	**1**	**1**	**-**

Subject Code	Subject Name	Category	L	T	P	C
MA19152	**LINEAR ALGEBRA AND APPLIED CALCULUS** **Common to I sem. B.E.- Computer Science and Engineering ,Biomedical Engineering, Electronics and Communication Engineering & Electrical and Electronics Engineering and B.Tech. – Information Technology**	**BS**	**3**	**1**	**0**	**4**

Objectives:

- To gain knowledge in using matrix algebra techniques and theconcepts of basis and dimension in vector spaces.
- To understand the techniques of calculus which are applied in the Engineering problems.

UNIT-I	**MATRICES**	**12**

Symmetric and skew – symmetric matrices , orthogonal matrices – Eigen values and Eigen vectors - Cayley – Hamilton theorem (without proof) and applications - orthogonal transformation and quadratic forms to canonical forms - Nature of quadratic forms.

UNIT-II	**VECTOR SPACES**	**12**

Vector space – Linear dependence and independence of vectors, bases, dimensions - range and kernel of a linear map, rank and nullity – matrix of Linear transformation - inverse of a linear transformation - rank nullity theorem – composition of Linear maps – Matrix Associated with Linear Map - inner products and norms – Gram – Schmidt orthogonalisation.

UNIT-III	**DIFFERENTIAL CALCULUS AND APPLICATIONS**	**12**

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes and Envelopes - Partial derivatives: Definitions and Simple problems - Jacobian and properties – Taylor's series for functions of two variables – Lagrange's method of undetermined multipliers.

UNIT-IV	**APPLICATION OF INTEGRATION AND IMPROPER INTEGRALS**	**12**

Evaluation of area, surface area and volume of revolution - Centre of Gravity – Moment of inertia – Improper integrals: Beta and Gamma integrals and their properties .

UNIT-V	**MULTIPLE INTEGRAL**	**12**

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

	Total Contact Hours : 60	

Course Outcomes:

On completion of the course students will be able to

- Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix for solving problems.
- Use concepts of basis and dimension in vector spaces in solving problems and to construct orthonormal basis using inner products.
- Analyze, sketch and study the properties of different curves and to handle functions of several variables and problems of maxima and minima.
- Apply the techniques of Integration in Engineering problems.
- Evaluate surface area and volume using multiple integrals.

Text Books:

1. Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan , Linear Algebra and Partial Differential Equations, Mc Graw Hill Education,2019

Reference Books / Web links:

1	Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	Friedberg, A.H., Insel, A.J. and Spence, L., ―Linear Algebra‖, Prentice - Hall of India, New Delhi, 2004.
3	Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
4	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5	T Veerarajan, Engineering Mathematics –I , Mc Graw Hill Education, 2018
6	T Veerarajan, Engineering Mathematics –II , Mc Graw Hill Education, 2018

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	1	-	-	-	-	2	2	2	1	1
CO 2	3	3	3	3	2	1	-	-	-	-	-	2	2	1	1
CO 3	3	3	3	3	3	1	1	-	-	-	2	3	2	2	1
CO 4	3	3	3	3	3	1	1	-	-	-	1	3	2	1	2
CO 5	3	3	3	3	2	1	-	-	-	-	1	3	2	2	1
Average	**3**	**3**	**3**	**3**	**2.6**	**1**	**1**	**-**	**-**	**-**	**1.5**	**2.6**	**2**	**1.4**	**1.2**

Subject Code	Subject Name	Category	L	T	P	C
CY19143	**APPLIED CHEMISTRY** **Common to I sem. B.E. – Electrical and Electronics Engineering & Computer Science Engineering and B.Tech. – Information Technology and II sem. B.E. – Civil Engineering**	**BS**	**3**	**0**	**2**	**4**

Objectives:

- To acquire theoretical and practical knowledge on water quality parameters
- To understand the principles of electrochemistry, corrosion and in turn construction of batteries
- To get familiarized with engineering materials including polymers

UNIT-I **WATER TECHNOLOGY** **9**

Water quality parameters - physical, chemical &biological significance- BOD, COD- definition significance - estimation of hardness by EDTA method - boiler feed water – boiler troubles - softening of water - zeolite process - demineralization process - internal treatment methods - specifications for drinking water BIS - WHO standards - treatment of water for domestic use - desalination - reverse osmosis -electrodialysis – UASB process.

UNIT-II **ELECTROCHEMISTRY AND CORROSION** **9**

Electrode potential - electrodes - standard and reference electrodes, glass electrode. Nernst equation - emf series– applications. Galvanic cells and concentration cells-applications-pH measurement, acid-base titration, potentiometric redox titration – conductometric titrations.Corrosion - causes- effects of corrosion - theories of chemical and electrochemical corrosion – types of corrosion – galvanic, water-line, intergranular and pitting corrosion - passivity - factors affecting rate of corrosion - corrosion control methods -cathodic protection-sacrificial anode and impressed current cathodic protection.

UNIT-III **BATTERIES AND FUEL CELLS** **9**

Batteries- types - characteristics-fabrication and working of lead-acid battery- NICAD battery - lithium ion batteries - supercapacitors- introduction - types - electrochemical double layer capacitor - activated carbon - carbon aerogels.
Fuel cells - classification – principle,working and applications of hydrogen-oxygen fuel cell - solid oxide fuel cell - direct methanol fuel cell and proton exchange membrane fuel cells-biofuel cells.

UNIT-IV **POLYMERS** **9**

Introduction to thermoplastics and thermosetting plastics- phenolic and epoxy resins - silicone polymers– polyelectrolytes - polymers with piezoelectric, pyroelectric and ferroelectric properties- photonic polymers -photo resists - conducting polymers - polyaniline, polypyrrole - preparation, structure,properties and applications - liquid crystals -classification,chemicalconstitution,liquid crystalline polymers-applicationsin displays- introduction to OLED.

UNIT-V **ENGINEERING MATERIALS** **9**

Composite materials - definition - classification - fibers - types - properties - matrix - properties - applications of

composites - advantages and limitations of composites.
Lubricants - definition -**characteristics** of lubricants-theories of lubrication –properties- viscosity, viscosity index, oiliness, pour point and cloud point, flash point and fire point - additives to lubricants - solid lubricants.

Contact Hours	**:**	**45**

List of Experiments

1	Estimation of mixture of acids by conductometry.
2	Estimation of extent of corrosion of iron pieces by potentiometry.
3	Estimation of the extent of dissolution of copper / ferrous ions by spectrophotometry.
4	Estimation of acid by pH metry.
5	Determination of total, temporary and permanent hardness by EDTA method.
6	Estimation of DO by winkler's method.
7	Estimation of alkalinity by indicator method.
8	Estimation of chloride by argentometric method
9	Estimation of sodium and potassium in water by flame photometry.
10	Determination of flash and fire point of lubricating oil
11	Determination of cloud and pour point of lubricating oil
12	Determination of corrosion rate on mild steel by weight loss method
13	Determination of molecular weight of a polymer by viscometry method.
14	Adsorption of acetic acid by charcoal
15	Determination of phase change temperature of a solid.

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**75**

Course Outcomes:
On completion of the course students will be able to

- Analyse the quality of water practically.
- Apply the knowledge of electrochemistry on corrosion and its control.
- Be assertive on types of batteries and fuel cells.
- Apply the knowledge of different types of polymers in various fields.
- Be conversant on the types of composites and lubricants used in engineering industry.

Text Books:

1	P. C. Jain and Monika Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd,New Delhi, 2015
2	O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) PVT, Ltd, New Delhi, 2017

Reference Books / Web links:

1	Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd, New Delhi, 2011
2	Shashi Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai & Co, New Delhi, 2005
3	F.W. Billmayer,"Textbook of Polymer Science", 3rd Edn, Wiley. N.Y. 2007.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	3	2	2	2	2	1	1	1	2	1	1	1	1
CO 2	3	2	3	2	1	2	2	1	1	1	1	1	2	1	1
CO 3	3	3	3	2	3	3	3	1	2	2	1	3	3	2	1
CO 4	3	3	3	1	1	2	2	1	1	2	1	2	2	2	1
CO 5	3	2	3	2	3	2	2	1	1	2	1	2	1	1	1
Average	**3**	**2.4**	**3**	**1.8**	**2**	**2.2**	**2.2**	**1**	**1.2**	**1.6**	**1.2**	**1.8**	**1.8**	**1.4**	**1**

Subject Code	Subject Name(Lab Oriented Theory Course)	Category	L	T	P	C
GE19141	PROGRAMMING USING C	ES	2	0	4	4

Objectives:

- To develop simple algorithms for arithmetic and logical problems.
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop applications in C using functions, pointers and structures
- To do input/output and file handling in C

UNIT-I GENERAL PROBLEM SOLVING CONCEPTS **6**

Computer – components of a computer system-Algorithm and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.

UNIT-II C LANGUAGE - TYPES OF OPERATOR AND EXPRESSIONS **6**

Introduction- C Structure- syntax and constructs of ANSI C - Variable Names, Data Type and Sizes, Constants, Declarations - Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.

UNIT-III I/O AND CONTROL FLOW **6**

Standard I/O, Formatted Output – Printf, Variable-length argument lists- Formatted Input – Scanf, Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, GoTo Labels.

UNIT-IV FUNCTIONS AND PROGRAM STRUCTURE **6**

Basics of functions, parameter passing and returning type, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, C Pre-processor, Standard Library Functions and return types.

UNIT-V POINTERS, ARRAYS AND STRUCTURES **6**

Pointers and addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional arrays, Strings, Initialisation of Pointer Arrays, Command line arguments, Pointers to functions, complicated declarations. Basic Structures, Structures and Functions,Array of structures, Pointer of Structures, Self-referential Structures, Table look up, Typedef, Unions, Bit-fields, File Access -Error Handling, Line I/O, Miscellaneous Functions.

Contact Hours	**:**	**30**

List of Experiments

1	Algorithm and flowcharts of small problems like GCD.
Structured code writing with::	
2	Small but tricky codes
3	Proper parameter passing
4	Command line Arguments
5	Variable parameter
6	Pointer to functions
7	User defined header
8	Make file utility
9	Multi file program and user defined libraries
10	Interesting substring matching / searching programs
11	Parsing related assignments

Contact Hours	**:**	**60**
Total Contact Hours	**:**	**90**

Course Outcomes:

On completion of the course students will be able to

- formulate simple algorithms for arithmetic and logical problems.
- implement conditional branching, iteration and recursion.
- decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- use arrays, pointers and structures to formulate algorithms and programs.
- apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

Text Books:

1	Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education India; 2nd Edition, 2015.
2	Byron Gottfried, "Programming with C", Second Edition, Schaum Outline Series, 1996.
Reference Books:	
1	Herbert Schildt, "C: The Complete Reference", Fourth Edition, McGraw Hill, 2017.
2	Yashavant Kanetkar, "Let Us C", BPB Publications, 15th Edition, 2016.
Web links for virtual lab:	
1	https://www.tutorialspoint.com/compile_c_online.php
2	https://www.codechef.com/ide
3	https://www.jdoodle.com/c-online-compiler
4	https://rextester.com/l/c_online_compiler_gcc

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	2	2	2	1	-	-	-	1	2	1	1	2	-	1
CO 2	1	1	1	1	1	-	-	-	-	-	1	1	-	-	2
CO 3	1	1	2	1	1	-	-	-	-	-	1	1	-	-	2
CO 4	2	2	3	2	1	-	-	-	1	-	2	1	-	-	2
CO 5	2	2	3	2	1	-	-	-	-	-	2	1	-	-	2
Average	**1.4**	**1.6**	**2.2**	**1.6**	**1.0**	**-**	**-**	**-**	**1.0**	**2.0**	**1.4**	**1.0**	**2**	**-**	**1.8**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
GE19122	**ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS**	**ES**	**0**	**0**	**2**	**1**

Objectives:

- To provide hands on experience on various basic engineering practices in Electrical Engineering.
- To impart hands on experience on various basic engineering practices in Electronics Engineering.

List of Experiments

A. ELECTRICAL ENGINEERING PRACTICE

1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5	Measurement of resistance to earth of an electrical equipment.

B. ELECTRONICS ENGINEERING PRACTICE

1	Study of Electronic components and equipment's – Resistor, colour coding, measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2	Study of logic gates AND, OR, EXOR and NOT.
3	Generation of Clock Signal.
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5	Measurement of ripple factor of HWR and FWR.

Total Contact Hours : 30

Course Outcomes:

On completion of the course, the students will be able to

- Fabricate the electrical circuits
- formulate the house wiring
- Fabricate the electronic circuits
- Design the logic gates and verify the truth table

●	design the AC-DC converter using diodes and passive components
REFERENCE	
1	Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
2	Jeyachandran K., Natarajan S. & Balasubramanian S., "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., "Engineering Practices Lab Manual",Vikas Publishing House Pvt.Ltd, 2006.
4	Rajendra Prasad A. &Sarma P.M.M.S., "Workshop Practice", SreeSai Publication, 2002.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	2	-	-	2	-	3	-	-	3	3	-	2
CO 2	3	3	2	2	-	-	2	-	3	-	-	3	3	-	2
CO 3	3	3	3	2	-	-	2	-	3	-	-	3	3	2	2
CO 4	3	3	3	2	-	-		-	3	-	-	3	3	2	2
CO 5	3	3	3	2	-	-		-	3	-	-	3	3	2	2
Average	**3**	**3**	**2.67**	**2**	**-**	**-**	**2**	**-**	**3**	**-**	**-**	**3**	**3**	**2**	**2**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
MC19102	**INDIAN CONSTITUTION AND FREEDOM MOVEMENT** **Common to I sem. B.E. – Computer Science and Engineering, Electronics and Communication Engineering & Electrical and Electronics Engineering** **and** **B.Tech. – Information Technology & Artificial Intelligence and Machine Learning** **and** **Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering, Mechatronics & Robotics and Automation** **and** **B.Tech. – Biotechnology, Chemical Engineering & Food Technology** **and** **III sem. – Computer Science and Business Systems**	**MC**	**3**	**0**	**0**	**0**

Objectives: To inculcate the values enshrined in the Indian constitution.

- To create a sense of responsible and active citizenship.
- To know about Constitutional and Non- Constitutional bodies.
- To understand sacrifices made by the freedom fighters.

UNIT-I **INTRODUCTION** **9**

Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II **STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT** **9**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT-III **STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY** **9**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, ,Village level: Role of Elected and Appointed officials.

UNIT-IV	CONSTITUTIONAL FUNCTIONS AND BODIES	9
Indian Federal System – Centre – State Relations – President's Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.		
UNIT-V	**INDIAN FREEDOM MOVEMENT**	**9**
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India-**Indian Freedom Struggle under Mahatma Gandhi**-Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.		
	Contact Hours : 45	

Course Outcomes:

On completion of the course students will be able to

- Understand the functions of the Indian government.
- Understand and abide the rules of the Indian constitution.
- Gain knowledge on functions of state Government and Local bodies.
- Gain Knowledge on constitution functions and role of constitutional bodies and non constitutional bodies.
- Understand the sacrifices made by freedom fighters during freedom movement.

Text Books:

1	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21st ed 2013.
2	Bipan Chandra, History of Modern India, Orient Black Swan, 2009.
3	Bipan Chandra, India's Struggle for Independence, Penguin Books, 2016.
4	Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.2nd ed, 2014.
5	P K Agarwal and K N Chaturvedi , Prabhat Prakashan, New Delhi, 1st ed , 2017.

Reference Books / Web links:

1	Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2	U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO 2	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO 3	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO 4	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO 5	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
Average	-	-	-	-	-	**3**	-	-	-	-	-	**3**	-	-	-

SEMESTER II

Subject Code	Subject Name	Category	L	T	P	C
MA19252	**DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES** **Common to II sem. B.E.- Computer Science and Engineering, Biomedical Engineering, Electronics and Communication Engineering &** **Electrical and Electronics Engineering** **and** **B.Tech. – Information Technology**	BS	3	1	0	4

Objectives:

- To handle practical problems arising in the field of engineering and technology using differential equations.
- To solve problems using the concept of Vectors calculus, Complex analysis, Laplace transforms.

UNIT-I **SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS** **12**

Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre's linear equations - Formation of partial differential equations - Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogenous partial differential equations of second and higher order with constant coefficients.

UNIT-II **VECTOR CALCULUS** **12**

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT-III **ANALYTIC FUNCTIONS** **12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c,\ cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT-IV **COMPLEX INTEGRATION** **12**

Cauchy's integral theorem – Cauchy's integral formula **(**excluding proof) – Taylor's and Laurent's series – Singularities – Residues – Residue theorem **(**excluding proof) – Application of residue theorem for evaluation of real integrals - Evaluation of real definite integrals as contour integrals around semi-circle (excluding poles on the real axis).

UNIT-V **LAPLACE TRANSFORM** **12**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions, periodic functions - Inverse Laplace transform – Problems using Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

Total Contact Hours : 60

Course Outcomes:

On completion of the course, students will be able to

- Apply various techniques in solving ordinary differential equations and partial differential equations
- Use the concept of Gradient, divergence and curl to evaluate line, surface and volume integrals.
- Use the concept of Analytic functions, conformal mapping and bilinear transformation.
- Use complex integration techniques to solve Engineering problems.
- Use Laplace transform and inverse transform techniques in solving differential equations.

Text Books:

1. Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. T Veerarajan, Engineering Mathematics –II , Mc Graw Hill Education, 2018.

Reference Books / Web links:

1. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
4	T Veerarajan Transforms and Partial Differential Equations Mc Graw Hill Education, 2018.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	2	-	-	-	-	2	2	3	2	2
CO 2	3	3	3	3	2	1	-	-	-	-	2	2	3	1	2
CO 3	3	3	2	2	2	1	-	-	-	-	1	1	3	1	1
CO 4	3	3	2	3	2	1	-	-	-	-	1	1	3	1	1
CO 5	3	3	2	2	2	1	-	-	-	-	1	1	3	2	2
Average	**3**	**3**	**2.4**	**2.6**	**2.2**	**1.2**	**-**	**-**	**-**	**-**	**1.4**	**1.4**	**3**	**1.4**	**1.6**

Subject Code	Subject Name	Category	L	T	P	C
PH19242	**PHYSICS FOR ELECTRONICS ENGINEERING** **Common to II sem. B.E. – Electronics and Communication Engineering & Electrical and Electronics Engineering**	**BS**	**3**	**0**	**2**	**4**

Objectives:

- To understand the essential principles of physics of semiconductor devices and electron transport properties.
- To become proficient in magnetic, dielectric and optical properties of materials and nano devices.

UNIT-I ELECTRICAL PROPERTIES OF MATERIALS **9**

Classical free electron theory - expression for electrical conductivity - electrons in metals – concept of quantum physics-wave function-Schrodinger equation- particle in a box-one dimension and three dimension - degenerate states - Fermi- Dirac statistics - density of energy states – electron in periodic potential: Bloch theorem– metals and insulators - Brillouin zone - energy bands in solids–- electron effective mass – concept of hole.

UNIT-II SEMICONDUCTOR PHYSICS **9**

Intrinsic semiconductors - energy band diagram - direct and indirect semiconductors - carrier concentration in intrinsic semiconductors -–extrinsic semiconductors - carrier concentration in N-type and P-type semiconductors. Carrier transport: Velocity-electric field relations - drift and diffusion transport – Einstein's relation. Hall effect and applications. P-N junctions - Zener and avalanche breakdown - Ohmic contacts - Schottky diode– MOS capacitor.

UNIT-III MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS **9**

Magnetism in materials - magnetic field and induction - magnetization - magnetic permeability and susceptibility - types of magnetic materials - microscopic classification of magnetic materials. Ferromagnetism: origin and exchange interaction - saturation magnetization and Curie temperature - domain theory. Dielectric materials: Polarization processes - dielectric loss - internal field - Clausius-Mosotti relation- dielectric breakdown - high-k dielectrics.

UNIT-IV OPTICAL PROPERTIES OF MATERIALS **9**

Classification of optical materials - carrier generation and recombination processes. Absorption, emission and scattering of light in metals, insulators and semiconductors (concepts only). Photo current in a P- N diode - solar cell - photo detectors - LED - Organic LED -–laser diodes - excitons - quantum confined Stark effect -–quantum dot laser.

UNIT-V NANOELECTRONIC DEVICES **9**

Introduction - electron density in bulk material - size dependence of Fermi energy–- quantum confinement –- quantum structures. Density of states in quantum well, quantum wire and quantum dot structures. Zener-Bloch oscillations - resonant tunneling -–quantum interference effects -–mesoscopic structures: conductance fluctuations and coherent transport. Coulomb blockade effects - single electron phenomena and single electron transistor - magnetic semiconductors -–spintronics. Carbon nanotubes: Properties and applications.

Contact Hours : 45

List of Experiments

1	Determination of Band gap of Semiconducting material.
2	Determination of Hall coefficient of Semiconductor
3	Experiments on electromagnetic induction – BH-Curve experiment to determine magnetic parameter.
4	Determination of free space permeability using Helmholtz coil.
5	Determination of magnetic susceptibility of water and ferrous liquid using quincke's Method.

6	Measurement of Magnetoresistance of Semiconductors			
7	Determination of Solar Cell parameters			
8	To determine the work function and threshold frequency using Einstein's Photoelectric effect.			
9	Diffraction- Determination of wavelength of diode laser;			
10	Measurement of speed of light using fiber cable;			
11	Determination of quantum efficiency of photo diode from I-V Characteristic curve.			
12	Determination of Resonance frequency of LC circuit and LCR circuits.			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**
Course Outcomes: On completion of the course, students will be able to				
●	Apply the concept of electron transport in devices.			
●	Analyze the physical properties of semiconductors.			
●	Analyze the properties of magnetic and dielectric materials.			
●	Analyze the properties of optical materials used for optoelectronics.			
●	Analyze the quantum behaiour in nanoelectronic devices.			
Text Books:				
1	Kasap, S.O. Principles of Electronic Materials and Devices, McGraw-Hill Education, 2007.			
2	Wahab, M.A. Solid State Physics: Structure and Properties of Materials. Narosa Publishing House, 2009.			
Reference Books / Web links:				
1	Garcia, N. & Damask, A. Physics for Computer Science Students. Springer-Verlag, 2012.			
2	Hanson, G.W. Fundamentals of Nanoelectronics. Pearson Education, 2009.			
3	Rogers, B., Adams, J. & Pennathur, S. Nanotechnology: Understanding Small Systems. CRC Press, 2014**.**			
4	S. O. Pillai, Solid state physics, New Age International, 2015.			
5	Umesh K Mishra &Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2008.			

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	1	2	1	1	1	1	1	-	1	1	1	-	-
CO 2	3	2	1	2	1	1	1	1	1	1	1	1	2	1	-
CO 3	3	2	1	2	1	1	1	1	1	1	1	1	1	1	-
CO 4	3	2	1	2	1	1	1	1	1	1	1	1	-	1	-
CO 5	3	2	1	2	1	1	1	1	1	1	1	1	1	-	2
Average	**3**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.25**	**1**	**2**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
GE19101	**ENGINEERING GRAPHICS**	**ES**	**2**	**2**	**0**	**4**

Objectives:

- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply these skill in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination) **1**

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications– Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I **PLANECURVES AND FREE HAND SKETCH** **11**

Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method– Construction of cycloids, Construction of involutes of square and circle drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional

objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects		
UNIT-II	**PROJECTION OFPOINTS, LINESAND PLANESURFACE**	**12**
Orthographic projection- principles-Principal planes- projection of points. First angle projection - Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method- Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT-III	**PROJECTIONOFSOLIDS**	**12**
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.		
UNIT-IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENTOF SURFACES**	**12**
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of the section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.		
UNIT-V	**ISOMETRIC AND PERSPECTIVEPROJECTIONS**	**12**
Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.		
	Total Contact Hours : 60	

Course Outcomes: After learning the course, the students should be able

- To construct different plane curves and free hand sketching of multiple views from pictorial objects.
- To comprehend the theory of projection and to draw the basic views related to projection of points, lines and planes
- To draw the projection of solids in different views
- To draw the projection of Sectioned solids and development of surfaces of solids
- To visualize and prepare Isometric and Perspective view of simple solids

Text Book (s):

1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2	Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2017.

Reference Books(s) / Web links:

1	Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt.Ltd., 2013.
2	Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P)Limited, 2008.
3	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
4	Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2018.
5	https://nptel.ac.in/courses/112103019/

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	-	-	-	-	-	-	-	-	1	-	2	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	1	-	2	-	1	-
CO 3	2	-	-	-	-	-	-	-	-	1	-	2	-	1	-
CO 4	2	-	-	-	-	-	-	-	-	1	-	2	-	1	-
CO 5	2	-	-	-	-	-	-	-	-	1	-	2	-	1	-
Average	2	-	-	-	-	-	-	-	-	1	-	2	-	**1**	-

Subject Code	Subject Name	Category	L	T	P	C
GE19202	BASIC CIVIL AND MECHANICAL ENGINEERING (Common to II Sem Biotech and EEE)	ES	3	0	0	3

Objectives:

- To impart basic knowledge on Civil and Mechanical Engineering
- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures.
- To enable the students to distinguish the components
- To understand the working principle of power plant units, IC engines, and Refrigeration & AC system.

UNIT-I	SCOPE OF CIVIL AND MECHANICAL ENGINEERING	9

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering Overview of Mechanical Engineering - Mechanical Engineering contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

UNIT-II	SURVEYING AND CIVIL ENGINEERING MATERIALS	9

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

UNIT-III	BUILDING COMPONENTS AND STRUCTURES	9

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

UNIT-IV	INTERNAL COMBUSTION ENGINES AND POWER PLANTS	9

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

UNIT-V	REFRIGERATION AND AIR CONDITIONING SYSTEM	9

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

Total Contact Hours	:	45

Course Outcomes: At the end of this course students can

- Appreciate the Civil and Mechanical Engineering components of Projects.
- Explain the usage of construction material and proper selection of construction materials.
- Measure distances and area by surveying
- Identify the components used in power plant cycle.
- Demonstrate working principles of petrol and diesel engine.

Text Book (s):

1. Shanmugam G and Palanichamy M S, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, 2018

Reference Books(s) / Web links:

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
2. RamamruthamS.,"Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd.2013.
3. Sadhu Singh.,"Basic Mechanical Engineering", S.Chand Publication 2009

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	-	2	-	-	-	-	-	-	-	-	1	-	-	-
CO 2	3	-	2	-	-	-	-	-	-	-	-	1	-	-	1
CO 3	3	-	2	-	-	-	-	-	-	-	-	1	-	-	1
CO 4	3	-	2	-	-	-	-	-	-	-	-	1	-	-	1

CO 5	3	-	2	-	-	-	-	-	-	-	-	1	-	-	1
Average	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**

Subject Code	**Subject Name(Lab Oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
EE19243	**ELECTRIC CIRCUITS**	**PC**	**3**	**0**	**2**	**4**

Objectives:

- To introduce DC circuits and provide knowledge on the analysis of circuits using network theorems.
- To teach AC circuits and their solutions using network theorems
- To familiarise the phenomenon of resonance in series and parallel circuits.
- To impart knowledge on obtaining the transient response of RC, RL and RLC circuits.
- To provide knowledge on analysis and applications of balanced and unbalanced three phase circuits.

UNIT-I **DC CIRCUITS ANALYSIS** **9**

Ohm's Law – Kirchoff's laws – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis, Source transformation, voltage and current division method - Network reduction using circuit theorems- Thevenin's and Norton's Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem.

UNIT-II **AC CIRCUIT ANALYSIS** **9**

Series and Parallel RL, RC and RLC circuits, Phasor Diagram – Power, Power Factor - star delta conversion – Network reduction using circuit theorems for AC circuits.

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

Series and parallel resonance –frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling –Tuned Circuits-Single Tuned Circuits.

UNIT-IV **TRANSIENT RESPONSE FOR DC AND AC CIRCUIT** **9**

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

UNIT-V **THREE PHASE CIRCUITS** **9**

Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

Contact Hours : 45

List of Experiments

1	Experimental verification of Kirchhoff's voltage and current laws
2	Experimental verification of network theorems(Thevenin, Norton, Superposition and Maximum power transfer Theorem).
3	Experimental determination of time constant of series R-C circuit.
4	Experimental determination of time constant of series R-L circuit.
5	Experimental determination of frequency response of RLC circuits.
6	Design and Simulation of series resonance circuit.
7	Design and Simulation of parallel resonant circuits.
8	Simulation of three phase balanced and unbalanced star, delta networks circuits.
9	Experimental determination of power in three phase circuits by two-watt meter method.
10	Realization of RL and RC series circuits using Matlab.
11	Realization of RL and RC parallel circuits using Matlab.

Contact Hours : 30

Total Contact Hours : 75

Course Outcomes: On completion of the course, the students will be able to

- analyse DC circuits and apply circuit theorems
- examine AC circuits using circuit theorems
- realize series and parallel resonant circuits
- obtain the transient response of DC and AC Circuits

●	evaluate power in balanced and unbalanced three phase circuits.
Text Book (s):	
1	William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 8th edition, New Delhi, 2013.
2	Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum Series and Systems", Schaum"s Outlines, Tata McGrawHill, Indian. 5th Edison , 2017
3	Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 2015
Reference Books(s) / Web links:	
1	Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, New Delhi, 2013.
2	Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Sixth Edition, McGraw Hill, 2019.
3	J. David Irwin, R. Mark Nelms with Amalendu Patnaik. "Engineering Circuit Analysis", 11th Edition, Wiley Publishers, April 2015

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	2	2	2	-	-	-	-	-	-	-	3	1	3
CO 2	3	3	2	-	2	-	-	-	-	-	-	-	3	1	1
CO 3	2	3		-	2	-	-	-	-	-	-	-	3	1	3
CO 4	3	3	2	-	2	-	-	-	-	-	-	-	3	3	3
CO 5	3	3	3	3	3	-	-	1	3	1	-	2	3	3	3
Average	**2.8**	3	**2.25**	**2.5**	**2.2**	-	-	**1**	**3**	**1**	-	**2**	**3**	**1.8**	**2.6**

Subject Code	**Subject Name (Laboratory Course)**	**Category**	**L**	**T**	**P**	**C**
GE19121	**ENGINEERING PRACTICES – CIVIL AND MECHANICAL**	**ES**	**0**	**0**	**2**	**1**

Objectives:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Exercises

CIVIL ENGINEERING PRACTICE	
1.	Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
2.	Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
3.	Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.
Carpentry Works:	
4.	Study of joints in roofs, doors, windows and furniture.
5.	Hands-on-exercise: Woodwork, joints by sawing, planning and chiseling.
MECHANICAL ENGINEERING PRACTICE	
6.	Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
7	welding practice.
Basic Machining:	
8	Simple Turning and Taper turning
9	Drilling Practice
Sheet Metal Work:	
10	Forming & Bending:
11	Model making – Trays and funnels
12	Different type of joints.
Machine Assembly Practice:	
13	Study of centrifugal pump

14	Study of air conditioner			
		Total Contact Hours	**:**	**30**

Course Outcomes:

●	Able to perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
●	Able to perform wood working carpentry activities like sawing, planning, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
●	Able to produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
●	Able to perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
●	Able to perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

Os/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	-	-	-	1	-	-	-	-	-	1	-	-	-
CO 2	1	-	-	-	-	1	-	-	-	-	-	1	-	-	1
CO 3	1	-	-	-	-	1	-	-	-	-	-	1	-	-	1
CO 4	1	-	-	-	-	1	-	-	-	-	-	1	-	-	1
CO 5	1	-	-	-	-	1	-	-	-	-	-	1	-	-	1
Average	1	-	-	-	-	1	-	-	-	-	-	1	-	-	**1**

Subject Code	Subject Name	Category	L	T	P	C
MC19101	**ENVIROMENTAL SCIENCE AND ENGINEERING** **Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering & Mechatronics** **&** **B.Tech. – Biotechnology, Chemical Engineering & Food Technology** **and** **Common to II sem. B.E. – Computer Science and Engineering, Electronics and Communication Engineering & Electrical and Electronics Engineering** **&** **B.Tech. – Information Technology and Artificial Intelligence and Machine Learning**	**MC**	**3**	**0**	**0**	**0**

Objectives:

●	To understand the importance of natural resources, pollution control and waste management.
●	To provide the students about the current social issues and environmental legislations.

UNIT-I	**NATURAL RESOURCES**	**9**

Environment -definition - scope and importance - forest resources -use and overexploitation -water resources -use and over utilization - dams - benefits and problems - water conservation -energy resources - growing energy needs - renewable and non renewableenergy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT-II	**ENVIRONMENTAL POLLUTION**	**9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.
Soil pollution : definition-causes-effects and control of soil pollution.

UNIT-III	**SOLID WASTE MANAGEMENT**	**9**

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes
Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

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

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT-V	**TOOLS FOR ENVIRONMENTAL MANAGEMENT**	**9**

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle- constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organisations- international conventions and protocols.

	Contact Hours	**:**	**45**

Course Outcomes:
On completion of the course students will be able to

- Be conversant to utilize resources in a sustainable manner.
- Find ways to protect the environment and play proactive roles.
- Apply the strategies to handle different wastes
- Develop and improve the standard of better living.
- Be conversant with tools of EIA and environmental legislation.

Text Books:

1	Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2	Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd ed, Pearson Education, 2004.

Reference Books / Web links:

1	Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi,2007.
2	ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015
3	G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, CengageLearning India PVT, LTD, Delhi, 2014.
4	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", 3rdedition,Oxford University Press,2015.
5	De. A.K., "Environmental Chemistry", New Age International, New Delhi,1996.
6	K. D. Wager, Environmental Management, W. B. Saunders Co., Philadelphia, USA, 1998.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	3	1	1	3	3	2	1	1	2	2	1	2	2
CO 2	3	2	3	2	1	3	3	2	1	1	2	2	2	2	2
CO 3	3	3	3	2	1	3	3	2	1	1	2	2	2	2	2
CO 4	3	2	3	2	2	3	3	2	1	1	1	2	1	2	2
CO 5	3	2	3	1	-	3	3	1	1	2	1	1	-	-	-
Average	**3**	**2.2**	**3**	**1.6**	**1.25**	**3**	**3**	**1.8**	**1**	**1.2**	**1.6**	**1.8**	**1.5**	**2**	**2**

SEMESTER III

Subject Code	Subject Name	Category	L	T	P	C
MA19353	TRANSFORMS AND NUMERICAL METHODS Common to III sem. B.E. Electrical and Electronics Engineering and B.Tech. Biotechnology & Food Technology	BS	3	1	0	4

Objectives:

- To introduce Fourier series and Z transforms to solve problems that arise in the field of Engineering.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.

UNIT-I	**FOURIER SERIES**	**12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT-II	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z- transform.

UNIT-III	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**12**

Newton Raphson method – secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value of a matrix by power method and by Jacobi method for symmetric matrix.

UNIT-IV	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**12**

Curve fitting ($y= a+ bx$, $y = a+bx+cx^2$)-Lagrange's interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's 1/3 rules.

UNIT-V	**NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS**	**12**

Taylor's series method – Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations – Finite difference methods for solving second order equations- Finite difference solution of one dimensional heat equation by explicit and implicit methods - Two dimensional Laplace equation.

Total Contact Hours	**:**	**60**

Course Outcomes:

On completion of course students will be able to

- develop skills to construct Fourier series for different periodic functions and to evaluate infinite series.
- solve difference equations using Z – transforms that arise in discrete time systems.
- Solve algebraic equations and eigen value problems that arise during the study of engineering problems.
- use interpolation methods to solve problems involving numerical differentiation and integration.
- solve differential equations numerically that arise in course of solving engineering problems.

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt.Ltd.,New Delhi, Second reprint, 2012.
3. Kandasamy P., Thilagavathi and K. Gunavathi., "Numerical Methods" , S. Chand & Company Ltd. (2010).

Reference Books / Web links:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
4. Chapra S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGrawHill, New Delhi, 2015.
5. Veerarajan T., Ramachandran T., 'Numerical Methods with Programs in C and C++' Tata McGraw Hill., 2007.
6. Jain M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', New Age Publishers. 6th edition, 2007.
7. Rajaraman V., Computer-Oriented Numerical Methods, Third Edition, Published by PHI Learning Private Limited (2013).

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	1	-	-	-	-	-	-	1	2	1	2
CO 2	3	3	3	2	1	-	-	-	-	-	-	1	2	1	2
CO 3	3	3	3	2	2	-	-	-	-	-	1	2	1	2	2
CO 4	3	3	3	2	2	-	-	-	-	-	1	2	1	2	2
CO 5	3	3	3	3	2	-	-	-	-	-	-	2	1	2	2
Average	**3.00**	**3.00**	**3.00**	**2.20**	**1.60**	**-**	**-**	**-**	**-**	**-**	**1.00**	**1.60**	**1.40**	**1.60**	**2.00**

Subject Code	Subject Name	Category	L	T	P	C
EE19301	**ELECTROMAGNETIC THEORY**	**ES**	**3**	**1**	**0**	**4**

Objectives:

- To learn the basic concepts and make them understand the laws of electrostatics.
- To impart knowledge on dielectrics and electrostatic boundary conditions.
- To impart knowledge on magnetic materials and understand the laws of magnetostatics
- To formulate Maxwell's equations for electromagnetic fields.
- To understand and compute the electromagnetic wave parameters.

UNIT-I **ELECTROSTATICS – I** **12**

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

UNIT-II **ELECTROSTATICS – II** **12**

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Electric field in free space, conductors, dielectrics – Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Capacitance, Energy density, Poisson's and Laplace's equations-solutions by direct integration method, Applications.

UNIT-III **MAGNETOSTATICS** **12**

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

UNIT-IV **ELECTRODYNAMIC FIELDS** **12**

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

UNIT-V **ELECTROMAGNETIC WAVES** **12**

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

Total Contact Hours : 60

Course Outcomes: On completion of the course, the students will be able to

- comprehend the basic concepts and learn the laws of electrostatics.
- determine the field quantities based on laws of electrostatics.
- analyze the field quantities based on the laws of magnetostatics.
- obtain Maxwell's equations for electromagnetic fields.
- evaluate the electromagnetic wave parameters.

Text Book(s):

1	Mathew N. O. Sadiku and S.V.Kulkarni, "Principles of Electromagnetics", 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2	Ashutosh Pramanik, "Electromagnetism – Theory and Applications", PHI Learning Private Limited, New Delhi, Second Edition-2009.
3	K.A. Gangadhar, P.M. Ramanathan, "Electromagnetic Field Theory (including Antennas and wave propagation', 16th Edition, Khanna Publications, 2007.
Reference Books(s) / Web links:	
1	Joseph. A.Edminister, "Schaum's Outline of Electromagnetics", Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010.
2	William H. Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill 8th Revised edition, 2011.
3	Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, Fifth Edition, 2010.
4	Bhag Singh Guru and Hüseyin R. Hiziroglu "Electromagnetic field theory Fundamentals", Cambridge University Press; Second Revised Edition, 2009.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	3	-	3
CO 2	3	3	-	3	2	-	-	-	-	-	-	-	3	-	3
CO 3	3	3	-	2	2	-	-	-	-	-	-	-	3	-	3
CO 4	3	3	-	2	2	-	-	-	-	-	-	-	3	-	3
CO 5	3	3	-	2	2	-	-	-	-	-	-	-	3	-	3
Average	**3**	**3**	-	**2.25**	**2.00**	**-**	-	-	-	-	-	-	**3**	-	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19302	**ELECTRONIC DEVICES AND CIRCUITS**	**PC**	**3**	**1**	**0**	**4**

Objectives:

- To teach the structure and operation of basic electronic devices.
- To provide knowledge on the operation and characteristics of various transistors
- To inculcate the concepts of small signal modeling of amplifiers.
- To impart knowledge on several multistage, feedback amplifiers.
- To familiarize the concepts of different types of oscillators and multivibrator circuits.

UNIT-I	**PN JUNCTION DIODES**	**12**

PN junction diode – structure, operation and V-I characteristics – Rectifiers – Half Wave and Full Wave Rectifier – Display devices – LED, photo transistor & photo diode – Zener diode characteristics – Zener Reverse characteristics – Zener as regulator

UNIT-II	**TRANSISTORS**	**12**

BJT, JFET, MOSFET – structure, operation, characteristics. UJT – Structure, characteristics and UJT as saw tooth oscillator.

UNIT-III	**AMPLIFIERS**	**12**

BJT amplifier circuit – Analysis of CE, CB, CC amplifiers using h-parameters – Gain and frequency response –JFET & MOSFET amplifier circuit – Small signal model analysis of CS and Source follower – Gain and frequency response.

UNIT-IV	**MULTISTAGE AMPLIFIERS AND FEEDBACK AMPLIFIERS**	**12**

Differential amplifier – Common mode and Difference mode analysis using BJT. Power amplifiers – Class A, Class B , Class C & Class AB . Advantages of negative feedback – voltage /current, series, shunt feedback.

UNIT-V	**OSCILLATORS AND MULTIVIBRATORS**	**12**

Positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley and Colpitts Crystal oscillators. Non-sinusoidal oscillators – Multivibrators – Bi-stable, Monostable, Astable Multivibrators.			
	Total Contact Hours	**:**	**60**

Course Outcomes: On completion of the course, the students will be able to

●	comprehend the structure of the basic electronic devices.
●	realize the characteristics and small signal modelling of amplifiers
●	analyze and obtain small signal model of all amplifiers.
●	design multistage and feedback amplifier circuits.
●	perform experimental verification of various oscillators and multivibrators.

Text Book (s):

1	David A. Bell, "Electronic Devices and Circuits", Prentice Hall of India, 5th edition, 2008.
2	Sedra and smith, "Microelectronic Circuits", Oxford University Press, 7th edition, 2015.
3	R.S.Sedha, "A Textbook of Electronic Circuits" S.Chand publications, 2008

Reference Books(s) / Web links:

1	Rashid, "Microelectronic Circuits" Analysis and design: Cengage learning,3rd edition 2017.
2	S.Salivahanan, "Electronic Devices and Circuits", Tata McGraw Hill Education, second 2011.
3	Floyd, "Electron Devices" Pearson Asia, 10th edition, 2017.
4	Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd edition, 2007.
5	Robert L.Boylestad, "Electronic Devices and Circuit theory", Pearson Prentice Hall, 11th edition, 2012.
6	Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, 2003.

Web links for virtual lab (if any)

1	https://www.youtube.com/watch?v=n0SiQIaitHk
2	https://www.youtube.com/watch?v=sRVvUkK0U80

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	-	-	-	-	1	-	-	1	-	-	3	1	-	-
CO 2	3	3	3	3	-	1	-	-	1	-	-	3	3	-	3
CO 3	3	3	3	1	-	1	-	-	1	-	-	3	3	-	3
CO 4	3	3	3	2	-	2	-	-	1	-	-	3	3	-	3
CO 5	3	3	3	3	-	2	2	-	3	1	-	3	3	-	3
Average	**3**	**3**	**3**	**2.25**	-	**1.4**	**2**	**-**	**1.4**	**1**	-	**3**	**2.6**	-	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19303	**ELECTRICAL MACHINES – I**	**PC**	**3**	**1**	**0**	**4**

Objectives:

●	To introduce the concept of rotating machines and the principle of electromechanical energy conversion in single and multiple excited systems.
●	To impart knowledge on the generation of D.C. voltages by using different type of generators and study their performance.
●	To study the working principles of D.C. motors and their load characteristics, starting and methods of speed control.
●	To familiarize with the constructional details of different type of transformers, working principle and their performance.
●	To teach the various losses in D.C. machines and transformers and to study the different testing methods to arrive

	at their performance.	
UNIT-I	**BASIC CONCEPTS OF ROTATING MACHINES**	**15**
Principles of electromechanical energy conversion – Single and multiple excited systems – m.m.f of distributed A.C. windings – Rotating magnetic field.		
UNIT-II	**DC GENERATORS**	**15**
Constructional details – emf equation – Methods of excitation – Self and separately excited generators – Characteristics of series, shunt and compound generators – Armature reaction and commutation – Parallel operation of DC shunt and compound generators.		
UNIT-III	**DC MOTORS**	**15**
Principle of operation – Back emf and torque equation – Series, Shunt and Compound motors – Characteristics - Starting – Types of starters – Speed control.		
UNIT-IV	**TRANSFORMERS**	**15**
Constructional details of core and shell type transformers – Types of windings – Principle of operation – emf equation – Transformer on no-load – Parameters referred to HV / LV windings – Equivalent circuit – Transformer on load – Regulation – Parallel operation of single phase transformers – Auto transformer – Three phase transformers – Vector group- tap changing.		
UNIT-V	**TESTING OF DC MACHINES AND TRANSFORMERS**	**15**
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, Sumpner's test, load test – All day efficiency.		
	Total Contact Hours :	**60**

Course Outcomes:	
	On completion of the course, the students will be able to
●	analyze the concept of rotating machines and the principle of electromechanical energy conversion in single and multiple excited systems.
●	evaluate the induced emf for different type of generators and study their performance.
●	analyze the working principles of DC motors and their load characteristics, starting and methods of speed control.
●	realize the construction, principle of operation and performance of transformers.
	estimate the various losses in D.C. machines and transformers and to study the different testing methods to arrive at their performance.
Text Book (s):	
1	D.P. Kothari and I.J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 4th edition, 2010
2	P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 7th edition, 2003.
3	B. L. Theraja and AK Theraja, "A Text book of Electrical Technology", Volume 2, S. Chand Publications, 2015.
Reference Books(s) / Web links:	
1	A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery", Tata McGraw Hill publishing Company Ltd, 6th edition, 2003.
2	J.B. Gupta, "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2009.
3	K. Murugesh Kumar, "Electric Machines", Vikas publishing house Pvt Ltd, 2002
Web links for virtual lab (if any)	
1	https://www.youtube.com/watch?v=97G6FGS2JC0

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	-	1	-	3	-	-	3	3	-	3
CO 2	3	3	3	3	3	-	2	-	3	-	-	3	3	-	3
CO 3	3	3	3	3	3	-	2	-	3	-	-	3	3	-	3
CO 4	3	3	3	3	3	-	2	-	3	-	-	3	3	-	3

CO 5	3	3	3	3	3	-	2	-	3	-	-	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	-	**1.8**	-	**3**	**0**	**0**	**3**	**3**	-	**3**

Subject Code	**Subject Name (Lab oriented Theory Courses)**	**Category**	**L**	**T**	**P**	**C**
CS19241	**DATA STRUCTURES**	**ES**	**3**	**0**	**4**	**5**

Objectives:

- To apply the concepts of List ADT in the applications of various linear and nonlinear data structures.
- To demonstrate the understanding of stacks, queues and their applications.
- To analyze the concepts of tree data structure.
- To understand the implementation of graphs and their applications.
- To be able to incorporate various searching and sorting techniques in real time scenarios.

UNIT-I	**LINEAR DATA STRUCTURES – LIST**	**9**

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

UNIT-II	**LINEAR DATA STRUCTURES – STACKS, QUEUES**	**9**

Stack ADT – Operations - Applications - Evaluating arithmetic expressions- Conversion of Infix topostfix expression - Queue ADT – Operations - Circular Queue –DEQUE –applications of queues.

UNIT-III	**NON LINEAR DATA STRUCTURES – TREES**	**9**

Tree Terminologies- Binary Tree–Representation-Tree traversals – Expression trees – Binary Search Tree–AVL Trees –Splay Trees - Binary Heap – Applications.

UNIT-IV	**NON LINEAR DATA STRUCTURES – GRAPHS**	**9**

Graph Terminologies – Representation of Graph – Types of graph - Breadth-first traversal - Depth-first traversal – Topological Sort - Shortest path - Dijikstra's Algorithm - Minimum Spanning Tree- Prim's Algorithm.

UNIT-V	**SEARCHING, SORTING AND HASHING TECHNIQUES**	**9**

Searching- Linear Search - Binary Search. Sorting - Bubble sort - Selection sort - Insertion sort – Shell sort – Quick sort - Merge Sort. Hashing- Hash Functions –Collision resolution strategies- Separate Chaining – Open Addressing – Rehashing.

Contact Hours	**:**	**45**

List of Experiments

1	Array implementation of Stack and Queue ADTs
2	Array implementation of List ADT
3	Linked list implementation of List, Stack and Queue ADTs
4	Applications of List, Stack and Queue ADTs
5	Implementation of Binary Trees and operations of Binary Trees
6	Implementation of Binary Search Trees
7	Implementation of AVL Trees
8	Implementation of Heaps using Priority Queues
9	Graph representation and Traversal algorithms
10	Applications of Graphs
11	Implementation of searching and sorting algorithms
12	Hashing –any two collision techniques

Contact Hours	**:**	**60**
Total Contact Hours	**:**	**105**

Course Outcomes:

On completion of the course, the students will be able to

- Analyze the various data structure concepts.
- Implement Stacks and Queue concepts for solving real-world problems.
- Analyze and structure the linear data structure using tree concepts.

●	Critically Analyse various non-linear data structures algorithms.
●	Apply different Sorting, Searching and Hashing algorithms.
Text Books:	
1	Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2002.
2	ReemaThareja, Data Structures Using C, Second Edition, Oxford University Press, 2014.
Reference Books:	
1	Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, McGraw Hill, 2002.
2	Aho, Hopcroft and Ullman,Data Structures and Algorithms, Pearson Education, 1983.
3	Stephen G. Kochan, Programming in C, 3rd edition, Pearson Education.
4	Ellis Horowitz, SartajSahni and Susan Anderson Freed,Fundamentals of Data Structures in C, 2nd Edition, University Press, 2008.
Web links for virtual lab (if any)	
1	http://vlabs.iitb.ac.in/vlab/labscse.html

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	2	1	2	1	-	-	-	-	-	-	1	1	-	1
CO 2	1	1	2	1	1	-	-	-	-	-	-	2	1	-	2
CO 3	1	1	2	1	1	-	-	-	-	-	-	2	1	-	2
CO 4	1	1	2	1	1	-	-	-	-	-	-	2	1	-	2
CO 5	1	1	2	1	1	-	-	-	-	-	-	1	1	-	1
Average	**1.0**	**1.2**	**1.8**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.6**	**1.0**	**-**	**1.6**

Subject Code	Subject Name	Category	L	T	P	C
EE19311	**ELECTRICAL MACHINES-I LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:	
●	To conduct and to obtain the load characteristics of DC motors by conducting load test.
●	To conduct load test on DC generators and to obtain the load characteristics.
●	To obtain the load characteristics of single phase transformer by conducting load test.
●	To predetermine the regulation of single phase transformers by conducting Polarity test , No load and Short circuit test.
●	To predetermine the efficiency of DC machine by conducting Swinburne's test and Hopkinson's Test.
List of Experiments	
1	Open circuit and load characteristics of DC shunt generator- critical resistance and critical speed.
2	Load test on DC shunt and compound motor.
3	Load test on DC series motor.
4	Swinburne's test and speed control of DC shunt motor.
5	Hopkinson's test on DC motor – generator set.
6	Load test on single-phase transformer and three phase transformers.
7	Open circuit and short circuit tests on single phase transformer.
8	Polarity Test and Sumpner's test on single phase transformers.
9	Study of characteristics of DC compound generator with differential and cumulative connections.
10	Study of DC motor starters.
Total Contact Hours	**: 30**
Course Outcomes: On completion of the course, students will be able to	
●	conduct and obtain the load characteristics of DC motors by conducting load test.

●	conduct load test on DC generators and will be able obtain the load characteristics.
●	obtain the load characteristics of single phase transformer by conducting load tests
●	predetermine the regulation of single phase transformers by conducting Polarity Test, No load and Short circuit tests.
●	predetermine the efficiency of DC machine by conducting Swinburne's test and Hopkinson Test.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3		1		3			3	3		3
CO 2	3	3	3	3	3		2		3			3	3		3
CO 3	3	3	3	3	3		2		3			3	3		3
CO 4	3	3	3	3	3		2		3			3	3		3
CO 5	3	3	3	3	3		2		3			3	3		3
Average	**3**	**3**	**3**	**3**	**3**		**1.8**	**0**	**3**	**0**	**0**	**3**	**3**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19312	**ELECTRONIC DEVICES AND CIRCUITS LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

●	To impart knowledge on the behavior of semiconductor devices.
●	To provide knowledge on the applications of semiconductor devices.
●	To teach the design of amplifier and oscillator circuits.
●	To study the frequency response of amplifier circuit.
●	To impart knowledge on characteristics of astable multivibrator.

List of Experiments

1	Study of CRO for frequency and phase measurements
2	Characteristics of Semiconductor diode and Zener diode.
3	Characteristics of a NPN Transistor under common emitter, common collector and common base configurations.
4	Characteristics of JFET
5	Characteristics of UJT and generation of saw tooth waveforms
6	Design and Frequency response characteristics of a Common Emitter amplifier
7	Characteristics of photodiode and phototransistor, Study of light activated relay circuit
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	Astable Multivibrator
11	Differential amplifier using BJT

Total Contact Hours	**:**	**30**

Course Outcomes:

On completion of the course, students will be able to

●	experimentally analyze the behavior of various semiconductor devices.
●	realize the applications of semiconductor devices.
●	design and evaluate the applicable parameters of amplifier and oscillator circuits.
●	obtain frequency response of BJT amplifier.
●	realize the characteristics of astable multivibrator.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	-	-	2	3	-	-	-	3	2	3	3	3	-	3
CO 2	3	-	-	2	3	-	-	-	3	2	3	3	3	-	3
CO 3	3	3	3	3	3	-	-	-	3	2	3	3	3	-	3
CO 4	3	3	3	3	3	-	-	-	3	2	3	3	3	-	3
CO 5	3	-	-	2	3	-	-	-	3	2	3	3	3	-	3
Average	**3**	**3**	**3**	**2.4**	**3**	**-**	**-**	**-**	**3**	**2**	**3**	**3**	**3**	**-**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MC19301	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**	**MC**	**3**	**0**	**0**	**0**

Objectives:

- This course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom are important in modern society with rapid technological advancements and societal disruptions. The course mainly focuses on introduction to Indian knowledge system, Indian perspective of modern science, basic principles of Yoga and holistic healthcare system, Indian philosophical, linguistic and artistic traditions.

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

UNIT-I	**Introduction to Indian Knowledge System:** Basic structure of the Indian Knowledge System –Veda – Upaveda - Ayurveda, Dhanurveda- Gandharvaveda, Sthapathyaveda and Arthasasthra. Vedanga (Six forms of Veda) – Shiksha, Kalpa, Nirukta, Vyakarana, Jyothisha and Chandas- Four Shasthras - Dharmashastra, Mimamsa, Purana and Tharkashastra.	6
UNIT-II	**Modern Science And Yoga:** Modern Science and the Indian Knowledge System – a comparison - Merits and demerits of Modern Science and the Indian Knowledge System - the science of Yoga-different styles of Yoga – types of Yogaasana, Pranayam, Mudras, Meditation techniques and their health benefits – Yoga and holistic healthcare – Case studies.	6
UNIT-III	**Indian Philosophical Tradition:** Sarvadharshan/Sadhdharshan – Six systems (dharshans) of Indian philosophy - Nyaya, Vaisheshika, Sankhya, Yoga, Vedanta-Other systems- Chavarka, Jain (Jainism), Boudh (Buddhism) – Case Studies.	**6**
UNIT-IV	**Indian Linguistic Tradition:** Introduction to Linguistics in ancient India – history – Phonetics and Phonology – Morphology – Syntax and Semantics-Case Studies.	6
UNIT-V	**Indian Artistic Tradition:** Introduction to traditional Indian art forms – Chitrakala (Painting), Murthikala / Shilpakala (Sculptures), Vaasthukala, Sthaapathya kala (Architecture), Sangeeth (Music), Nruthya (Dance) and Sahithya (Literature) – Case Studies.	6
	Total Contact Hours :	**30**

Course Outcomes: On completion of the course students will be able to

1	Understand basic structure of the Indian Knowledge System
2	Apply the basic knowledge of modern science and Indian knowledge system in practise
3	Understand the importance Indian Philosophical tradition
4	Appreciate the Indian Linguistic Tradition.
5	Understand the concepts of traditional Indian art forms

Text Book (s):

1	V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014.
2	Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan.
3	Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan.
4	Fritzof Capra, Tao of Physics.

5	Fritzof Capra, The Wave of life.
Reference Books(s) / Web links:	
1	VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Arnakulam.
2	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata.
3	GN Jha (Eng. Trans.), Ed. RN Jha, Yoga-darshanam with Vyasa Bhashya,VidyanidhiPrakashan, Delhi 2016.
4	RN Jha, Science of Consciousness Psychotherapy and Yoga Practices,VidyanidhiPrakashan, Delhi 2016.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	-	-	-	-	-	1	1	3	2	-	-	1	-	-	-
CO 2	-	-	-	-	-	1	1	3	2	-	-	1	-	-	1
CO 3	-	-	-	-	-	1	1	3	2	-	-	1	-	-	1
CO 4	-	-	-	-	-	1	1	3	2	-	-	1	-	-	1
CO 5	-	-	-	-	-	1	1	3	2	-	-	1	-	-	1
Average	-	-	-	-	-	1	1	3	2	-	-	1	-	-	**1**

SEMESTER IV

Subject Code	Subject Name	Category	L	T	P	C
GE19301	**LIFE SCIENCE FOR ENGINEERS** **Common to III sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Electronics and Communication Engineering, Mechanical Engineering, Mechatronics & Robotics and Automation** **and** **B.Tech. – Chemical Engineering & Artificial Intelligence and Machine Learning** **and** **Common to IV sem. B.E. – Computer Science and Engineering & Electrical and Electronics Engineering** **and** **B.Tech. – Information Technology**	**BS**	**3**	**0**	**0**	**3**

Objectives:

- To give an introduction of life science to engineering students.
- To help the students to familiarize with human physiology, life style diseases and their management and basic diagnostic aspects.

UNIT-I	**OVERVIEW OF CELLS AND TISSUES**	**9**

Introduction to Bacteria, virus, fungi and animal cells. Organisation of cells into tissues and organs. Functions of vital organs.

UNIT-II	**HEALTH AND NUTRITION**	**9**

Balanced diet, Importance of RDA, BMR, and diet related diseases. Role of antioxidants PUFA, DHA, Essential amino acids, Essential fatty acids in diet. Water and its significance for human health. Physical and Mental health – Significance of exercise and yoga.

UNIT-III	**UNHEALTHY PRACTICES AND THEIR IMPACT ON HEALTH**	**9**

Drug induced toxicity, Unhealthy practices - Drug abuse/Narcotics/Smoking/Alcohol/Self-medication/Undue usage of electronic gadgets.

UNIT-IV	**COMMON DISEASES AND LIFESTYLE DISORDERS**	**9**

Prevention and management of food, water and airborne illness (Common cold, dehydration, food poisoning etc). Lifestyle disorders – obesity, diabetes, stroke, heart attack, ulcer, renal calculi, cancer, AIDS, hepatitis- prevention and management.

UNIT-V	**DIAGNOSTIC TESTS AND THEIR RELEVENCE**	**9**

Normal range of biochemical parameters, significance of organ function tests, organ donation.

Contact Hours	**:**	**45**

Course Outcomes:

On completion of the course students will be able to

- Classify the living organisms and relate the functions of vital organs
- Demonstrate the importance of balanced diet and plan methods for healthy living
- Analyse the hazards of unhealthy practices and take preventive measures
- Categorise the various life style disorders and recommend ways to manage the common diseases
- Evaluate and interpret biochemical parameters and their significance

Text Books:

1	Diseases of human body , Carol D Tamparo, Marcia A Lewis , Marcia A, Lewis ,EdD, RN, CMA-AC, F.A Davis Company, 2011.
2	Textbook of Medical Biochemistry ,Chatterjea ; Rana Shinde.

Reference Books / Web links:

1	Biology for Engineers, Arthur.T.,Johnson, CRC Press, Taylor and Francis, 2011.
2	Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.
3	Web link: https://nptel.ac.in/courses/122103039/

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	-	-	-	-	3	2	-	-	-	1	3	-	-	-
CO 2	3	-	-	-	-	3	2	-	-	-	1	3	-	-	1
CO 3	3	-	-	-	-	3	2	-	-	-	1	3	-	-	1
CO 4	3	-	-	-	-	3	2	-	-	-	1	3	-	-	1
CO 5	3	-	-	-	-	3	2	-	-	-	1	3	-	-	1
Average	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**-**	**1**	**3**	**-**	**-**	**1**

Subject Code	Subject Name	Category	L	T	P	C
EE19401	**TRANSMISSION AND DISTRIBUTION**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on the structure of electric power system and different distribution schemes.
- To provide knowledge on the computation of transmission line parameters.
- To impart knowledge on the modelling of transmission lines and determining voltage regulation and efficiency.
- To familiarize the voltage distribution in insulator strings and cables.
- To inculcate knowledge on the mechanical design of transmission line, sag calculations and substation layout.

UNIT-I **STRUCTURE OF POWER SYSTEM** **9**

Structure of electric power system: generation, transmission and distribution; Types of AC and DC distributors – distributed and concentrated loads – interconnection – EHVAC and HVDC transmission. Introduction to FACTS and smart grid.

UNIT-II **TRANSMISSION LINE PARAMETERS** **9**

Parameters of single and three phase transmission lines with single and double circuits – Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects – interference with neighbouring communication circuits – corona discharges.

UNIT-III **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, surge impedance loading, Ferranti effect. Series and shunt compensation.

UNIT-IV **INSULATORS AND CABLES** **9**

Insulators – Types, voltage distribution in insulator string, improvement of string efficiency. Underground cables – Types of cables, Capacitance of single core cable, Grading of cables, Power factor and heating of cables, Capacitance of three core belted cable, Comparison of cables with overhead lines.

UNIT-V **MECHANICAL DESIGN OF LINES** **9**

Mechanical design of transmission line – sag and tension calculations for different weather conditions, Tower spotting, Types of towers, Substation Layout (AIS, GIS) – Busbar arrangements.

Total Contact Hours : 45

Course Outcomes:

At the end of the course students will be able to

- comprehend the structure of electric power system, distribution schemes, HVDC system and FACTS devices.
- evaluate the transmission line parameters.
- determine the voltage regulation and efficiency of the transmission lines.
- analyze the voltage distribution in insulator strings and cables
- realize the mechanical design of transmission line, sag calculations and substation layout.

Text Book (s):

1 D.P.Kothari, I.J. Nagrath, "Power System Engineering", Tata McGraw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.

2 C.L.Wadhwa, "Electrical Power Systems", New Academic Science Ltd, Third Edition, 2017.

3 S.N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.

Reference Books(s) / Web links:	
1	B.R.Gupta, S.Chand, "Power System Analysis and Design" New Delhi, Fifth Edition, 2008
2	Luces M.Faulkenberry ,Walter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 2007.
3	Hadi Saadat, "Power System Analysis", PSA Publishing; Third Edition, 2010.
4	J.Brian, Hardy and Colin R.Bayliss, "Transmission and Distribution in Electrical Engineering", Newnes; Fourth Edition, 2012.
5	Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
6	Stuart Borlase, "Smart Grid :Infrastructure, Technology and Solutions", CRC Press 2017.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	-	2	1	-	-	-	1	3	3	3	3
CO 2	3	3	3	2	-	2	1	-	-	-	1	3	3	3	3
CO 3	3	3	3	2	-	2	1	-	-	-	1	3	3	3	3
CO 4	3	3	3	2	-	2	1	-	-	-	1	3	3	3	3
CO 5	3	3	3	2	-	2	1	-	-	-	1	3	3	3	3
Average	**3**	**3**	**3**	**2**	-	**2**	**1**	-	-	-	**1**	**3**	**3**	**3**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE 19402	**ELECTRICAL MACHINES – II**	**PC**	**3**	**1**	**0**	**4**

Objectives:

- To impart knowledge on construction, theory of operation and performance of non – salient types of synchronous generators.
- To illustrate the process of synchronisation and parallel operation of alternators and to teach the two reaction theory of salient pole alternators.
- To teach the principle of operation and performance of synchronous motors under varying excitation and load condition.
- To impart knowledge on construction, principle of operation and performance of three phase induction machines.
- To explain the starting and speed control methods and applications of three-phase and single phase induction motors

UNIT-I	SYNCHRONOUS GENERATORS	9

Constructional details – Types of rotors – EMF equation – Synchronous reactance – Armature reaction – Voltage regulation – EMF, MMF, ZPF and ASA methods.

UNIT-II	SYNCHRONIZING AND PARALLEL OPERATION OF SYNCHRONOUS GENERATORS	9

Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics - Capability curves

UNIT-III	SYNCHRONOUS MOTORS	8

Principle of operation – Torque equation – Operation on infinite bus bars - V-curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed

UNIT-IV	INDUCTION MOTORS	12

Constructional details – Types of rotors – Principle of operation – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque -No load and blocked rotor tests- Load test – Losses and efficiency – Circle diagram – Separation of no load losses — Induction generators – Self-excited and Grid connected. Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis

UNIT-V	STARTING AND SPEED CONTROL OF INDUCTION MOTORS	7
Need for starting – Types of starters in three phase induction motors – autotransformer , star-delta and rotor resistance starters – Methods of speed control – Change of voltage, frequency - number of poles and slip – Slip power recovery scheme. Starting methods of single-phase induction motors – Universal motor		
	Total Contact Hours : 45+15=60	

Course Outcomes: On completion of the course, the students would have

●	Understood the theory of synchronous machines and will be able to calculate the regulation of non- salient pole alternators by different methods.
●	Learnt the parallel operation of alternators and will be able to calculate the regulation of salient pole alternators by two reaction theory.
●	Comprehended the principle of operation and performance of synchronous motors under varying excitation and load condition.
●	Understood the construction and complete working of three phase induction machines, including its performance as induction generators.
	Learnt the need for the methods of starting and would have understood the technique of speed control and applications of three-phase and single phase induction motors.

Text Book (s):

1	D.P. Kothari and I.J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 2010.
2	P.S. Bhimbhra, "Electrical Machinery", Khanna Publishers, 2003
3	B. L. Theraja and AK Theraja, "A Text book of Electrical Technology", Volume 2, S. Chand Publications, 2015.

Reference Books(s) / Web links:

1	A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery", Tata McGraw Hill publishing Company Ltd, 2003
2	J.B. Gupta, "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2002
3	K. Murugesh Kumar, "Electric Machines", Vikas publishing house Pvt Ltd, 2002.
4	Sheila.C.Haran, "Synchronous, Induction and Special Machines", Scitech Publications, 2001

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 2	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 3	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 4	3	3	3	-	-	2	-	-	-	-	-	1	3	3	3
CO 5	3	3	3	-	-		-	-	-	-	-	-	3	3	3
Average	**3**	**3**	**3**	-	-	**2**	-	-	-	-	-	**1**	**3**	**3**	**3**

Subject Code	Subject Name (Lab Oriented Theory Course)	Category	L	T	P	C
EE19441	**LINEAR INTEGRATED CIRCUITS AND APPLICATIONS**	**PC**	**3**	**0**	**2**	**4**

Objectives:

●	To learn the IC fabrication procedure and the internal structure of an op-amp.
●	To study the characteristics, design and implementation of basic op-amp applications.
●	To explore on active filters, signal generators, ADC and DAC.
●	To impart knowledge on design and implementation of IC 555 timer, VCO and PLL.
●	To inculcate knowledge on design of power supply using regulator ICs.

UNIT-I	OP-AMP FUNDAMENTALS AND CHARACTERISTICS	9
Fundamentals of monolithic IC technology and fabrication – Internal structure of op-amp – Ideal op-amp characteristics – DC characteristics, AC characteristics – closed loop operation of op-amp.		

UNIT-II	**BASIC APPLICATIONS OF OP-AMP**	**9**
Inverting and Non-inverting Amplifiers – Voltage follower – Summing amplifier – Difference amplifier –V/I and I/V converter – Differentiator – Integrator – Instrumentation amplifier–log and antilog amplifier–S/H circuit.		
UNIT-III	**APPLICATIONS OF OP-AMP**	**9**
First order active filters – Comparators – Multivibrators – Triangular wave generators — Digital to Analog converter (R - 2R ladder and weighted resistor types) – Analog to Digital converters (Successive approximation and Flash type).		
UNIT-IV	**SPECIAL ICs**	**9**
Functional block, characteristics and application circuits with 555 Timer IC – IC566 Voltage Controlled Oscillator (VCO) – IC 565 Phase Locked Loop (PLL) – Applications of PLL (frequency multiplier and frequency divider) – Analog multiplier ICs.		
UNIT-V	**REGULATOR ICs**	**9**
IC voltage regulators – LM78XX, 79XX – Fixed voltage regulators – LM317, 723 Variable voltage regulators, switching regulator – SMPS – ICL 8038 function generator IC.		
	Contact Hours : 45	

List of Experiments

1	Application of Op-Amp I : inverting amplifier and non-inverting amplifier
2	Application of Op-Amp II : Adder and subtractor
3	Application of Op-Amp III : comparator and Zero crossing detector
4	Application of Op-Amp IV : Triangular wave generators
5	Application of Op-Amp V : Integrator
6	Application of Op-Amp VI : Differentiator
7	Timer IC applications: Monostable operation and Astable operation.
8	Fixed and variable voltage regulators
9	Switched Mode Power Supply design using analog ICs
10	Study of VCO and PLL.

	Contact Hours	**: 30**
	Total Contact Hours	**: 75**

Course Outcomes: On completion of course, students will be able to

- obtain the characteristics of op-amp.
- realize the various mathematical applications of op-amp.
- design the active filters using op-amp.
- generate a PWM pulses.
- develop power supply circuits.

Text Book (s):

1	D. Roy Choudhary, Sheilb.Jani, "Linear Integrated Circuits", fifth edition, New Age, 2018.
2	Ramakant A.Gayakwad, "Op-amps and Linear Integrated Circuits", fourth edition, Pearson Education, 2015.
3	David. A. Bell, "Op-amp & Linear ICs", Oxford, 3rd edition, 2011.

Reference Books(s) / Web links:

1	Fiore, "Op Amps & Linear Integrated Circuits Concepts & Applications", Cengage publications, 2010.
2	Floyd, Buchla, "Fundamentals of Analog Circuits", Pearson, 2001.
3	Jacob Millman, Christos C.Halkias, "Integrated Electronics – Analog and Digital circuits system", Tata McGraw Hill, 2003.
4	Robert F.Coughlin, Fredrick F. Driscoll, "Op-amp and Linear ICs", PHI Learning, 6th edition, 2012.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	3	-	1	1	2	-	3	3	3	2	3
CO 2	3	3	3	3	3	-	1	1	2	-	3	3	3	2	3
CO 3	3	3	3	3	3	-	1	1	2	-	3	3	3	2	3

CO 4	3	3	3	3	3	-	1	1	2	-	3	3	3	2	3
CO 5	3	3	3	3	3	-	1	1	2	-	3	3	3	2	3
Average	**3**	**3**	**3**	**2.8**	**3**	-	**1**	**1**	**2**	-	**3**	**3**	**3**	**2**	**3**

Subject Code	**Subject Name (Lab oriented Theory Course)**	**Category**	**L**	**T**	**P**	**C**
EE19442	**DIGITAL LOGIC CIRCUITS**	**PC**	**3**	**1**	**2**	**5**

Objectives:

- To impart knowledge on various number systems and to simplify logical expressions using Boolean laws
- To inculcate concepts of design and implementation of combinational circuits.
- To teach design methodology of various synchronous circuits, FSMs and introduce ASMs
- To introduce asynchronous sequential circuits and PLDs.
- To familiarize Hardware descriptive language(HDL) for implementation of combinational circuits and simple FSMs

UNIT-I	**NUMBER SYSTEMS AND LOGIC FUNCTIONS**	12

Review of number systems, Boolean laws - Combinational logic – representation of logic functions-SOP and POS forms, K-map representations minimization using K maps – simplification and implementation of combinational logic

UNIT-II	**COMBINATIONAL CIRCUITS**	12

Binary codes - code converters, adders, subtractors , multiplexers and de-multiplexer, encoders and decoders - error detection and correction codes (Parity and Hamming code)

UNIT-III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	12

Sequential logic- SR, JK, D and T flip flops – level triggering and edge triggering – counters – asynchronous and synchronous type – Modulo counters – Shift registers – design of synchronous sequential circuits – Moore and Mealy models- Counters, state diagram; state reduction; state assignment- FSM, ASM, Designing Vending Machine Controller.

UNIT-IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	12

Analysis of asynchronous sequential logic circuits -Transition table, flow table-race conditions, hazards & errors in digital circuits -- introduction to Programmable Logic Devices: PROM – PLA –PAL, FPGA – Digital Logic Families, comparison of RTL, DTL, TTL, ECL and MOS families – operation, characteristics of digital logic family.

UNIT-V	**HDL**	12

RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages – Subprograms – Test bench. (Simulation /Tutorial Examples: adders, counters, flip-flops, Multiplexers /Demultiplexers using simulators)

Contact Hours	**:**	**60**

List of Experiments

1	Implementation of combinational circuit using logic gates.
2	Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa
3	Study of Encoders and Decoders, multiplexers and demultiplexers using dedicated ICs
4	Counters: Design and implementation of 4-bit modulo counters as Synchronous and Asynchronous types using FF ICs and specific counter IC.
5	Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitable IC's.

Contact Hours	**:**	**30**
Total Contact Hours	**:**	**90**

Course Outcomes:

On completion of the course, the students will be able to

- simplify the logical expressions using reduction techniques
- implement combinational circuits using basic gates.

●	design various synchronous circuits.
●	analyse asynchronous sequential circuits and design combinational functions using PLDs.
●	simulate HDL programs for digital logic circuits.
Text Book (s):	
1	M. Morris R. Mano Michael D. Ciletti, "Digital Design with an introduction to VHDL", Pearson Education, 2013.
2	Comer "Digital Logic & State Machine Design", Oxford, 2012.
3	William Keitz, "Digital Electronics-A Practical Approach with VHDL", Pearson, 2013.
Reference Books(s) / Web links:	
1	Charles H.Roth, Jr. LizyLizy Kurian John, "Digital System Design using VHDL", Cengage, 3 rd edition, 2017
2	John M.Yarbrough, "Digital Logic, Application & Design", Thomson, 2002
3	Botros, "HDL Programming Fundamentals, VHDL & Verilog", Cengage, 2013.
4	Floyd and Jain, "Digital Fundamentals", 8th edition, Pearson Education, 2003
5	Anand Kumar, "Fundamentals of Digital Circuits", PHI, 2013
6	Gaganpreet Kaur, "VHDL Basics to Programming", Pearson, 2013.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	-	2	-	-	-	-	3	1	-	3	1	-	2
CO 2	3	3	3	2	2	1	-	-	3	1	-	3	3	-	3
CO 3	3	3	3	2	2	1	-	-	3	1	2	3	3	-	3
CO 4	3	3	3	2	-	1	-	-	3	1	-	3	3	-	3
CO 5	3	3	2	2	2	1	-	-	3	1	2	3	3	-	3
Average	**3**	**3**	**2.75**	**2**	**2**	**1**	**-**	**-**	**3**	**1**	**2**	**3**	**2.6**	**0**	**2.8**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
GE19303	**ECONOMICS FOR ENGINEERS**	**HS**	**3**	**0**	**0**	**3**

Objectives:

●	The course will cover the determination of income, employment, the price level, interest rates and exchange rates in the economy. The economy will be analysed in the short run (e.g. business cycle and stabilization policy) and in the long run (e.g. economic growth). The insights of Keynesian and classical theories will be integrated. As macroeconomics is an empirical discipline the course will cover case studies and statistical data interpretation.

UNIT-I	**MICROECONOMICS:** Principles of Demand and Supply — Supply Curves of Firms — Elasticity of Supply; Demand Curves of Households — Elasticity of Demand; Equilibrium and Comparative Statics (Shift of a Curve and Movement along the Curve); Welfare Analysis — Consumers' and Producers' Surplus.	9
UNIT-II	**PRICE AND CONSUMER BEHAVIOUR:** Price Ceilings and Price Floors; Consumer Behaviour — Axioms of Choice — Budget Constraints and Indifference Curves; Consumer's Equilibrium — Effects of a Price Change, Income and Substitution Effects —Derivation of a Demand Curve; Applications — Tax and Subsidies — Intertemporal Consumption — Suppliers' Income Effect.	9
UNIT-III	**PRODUCTION FUNCTION AND COMPETITION:** Theory of Production — Production Function and Iso-quants — Cost Minimization; Cost Curves — Total, Average and Marginal Costs — Long Run and Short Run Costs; Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition .	9
UNIT-IV	**NATIONAL INCOME AND KEYNESIAN MULTIPLIER:** National Income and its Components — GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector — Taxes and Subsidies; External Sector — Exports and Imports; Money — Definitions; Demand for Money — Transactionary and Speculative Demand; Supply of Money — Bank's Credit Creation Multiplier;	9

	Integrating Money and Commodity Markets.	
UNIT-V	**IS, LM MODEL, MONETARY, FISCAL POLICY AND TAXES:** IS, LM Model; Business Cycles and Stabilization — Monetary and Fiscal Policy — Central Bank and the Government; The Classical Paradigm — Price and Wage Rigidities — Voluntary and Involuntary Unemployment- Introduction to individual Income Tax-and Corporate Income Tax- GST, GST Council.	9
	Total Contact Hours : 45	

Course Outcomes:

- Students are expected to become familiar with both principles of micro and macro economics. They would also become familiar with application of these principles to appreciate the functioning of both product and input markets as well as the economy.
- Students will be able to improve their economic vocabulary- the knowledge of the terms and concepts commonly used in discussions of economic issues.
- Students will be able to demonstrate the ability to employ 'the economic way of thinking'.
- Students will learn to apply economic theories and concepts to contemporary social issues, as well as analysis of policies.
- Students will be able to formulate informed opinions on policy issues and recognize the validity of opposing view points.

Text Book (s):

1. Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, Tata McGraw Hill, New Delhi, 2010.
2. D N Dwivedi, Managerial Economics, 8th Edition, Vikas Publishing House,2018.
3. N. Gregory Mankiw, Principles of Economics, 3rd edition, Thomson learning, New Delhi, 2007.
4. Richard Lipsey and Alec Charystal, Economics, 12th edition, Oxford, University Press, New Delhi, 2011.

Reference Books(s) / Web links:

1. Karl E. Case and Ray C. fair, Principles of Economics, 6th edition, Pearson, Education Asia, New Delhi, 2002.
2. William Boyes and Michael Melvin, Textbook of economics, Biztantra, 2005.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	1	-	-	-	2	1	-	-	-	2	2	-	1	-
CO 2	2	1	-	-	-	2	1	-	-	-	2-	2	-	1	-
CO 3	2	1	-	-	-	2	1	-	-	-	2	2	-	1	-
CO 4	2	1	-	-	-	2	1	-	-	-	2	2	-	1	-
CO 5	2	1	-	-	-	2	1	-	-	-	2	2	-	1	-
Average	**2**	**1**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**2**	**2**	**-**	**1**	**-**

Subject Code	Subject Name	Category	L	T	P	C
EE19411	**ELECTRICAL MACHINES - II LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

- To impart knowledge on operation and performance of non – salient types of synchronous generators.
- To calculate the regulation of salient pole alternators by two reaction theory
- To teach the performance of synchronous motors under varying excitation on no load condition.
- To impart knowledge on performance of three phase induction machines.
- To explain the starting and speed control methods three-phase and single phase induction motors

List of Experiments

1. Regulation of three phase alternator by EMF and MMF methods
2. Regulation of three phase alternator by ZPF and ASA methods
3. Regulation of three phase salient pole alternator by slip test.
4. V and Inverted V curves of Three Phase Synchronous Motor

5	Load test on three-phase induction motors. (Both Squirrel cage and Slip-ring induction motors)			
6	No load and blocked rotor test on three-phase induction motor (Determination of equivalent circuit parameters)			
7	Operation of grid connected induction generator			
8	Load test on single-phase induction motor			
9	No load and blocked rotor test on single-phase induction motor			
10	Study of three-phase Induction motor Starters			
		Total Contact Hours	**:**	**30**

Course Outcomes: On completion of the course, the students would have

- Understood the theory of synchronous machines and will be able to calculate the regulation of non- salient pole alternators by different methods.
- Learnt to calculate the regulation of salient pole alternators by two reaction theory.
- Comprehended the principle of operation and performance of synchronous motors under varying excitation on no load condition
- Understood the performance of three phase induction machines.
- Learnt the need for the methods of starting and would have understood the technique of speed control of three-phase and single phase induction motors.

Text Book (s):

D.P. Kothari and I.J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 2010.

P.S. Bhimbhra, "Electrical Machinery", Khanna Publishers, 2003

B. L. Theraja and AK Theraja, "A Text book of Electrical Technology", Volume 2, S. Chand Publications, 2015.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 2	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 3	3	3	3	-	-	2	-	-	-	-	-	-	3	3	3
CO 4	3	3	3	-	-	2	-	-	-	-	-	1	3	3	3
CO 5	3	3	3	-	-	-	-	-	-	-	-		3	3	3
Average	**3**	**3**	**3**	-	-	**2**	-	-	-	-	-	**1**	**3**	**2**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
GE19421	**Soft Skills-I**	**EEC**	**0**	**0**	**2**	**1**

Objectives:

- To help the students break out of shyness.
- To build confidence
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions.

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	**Activity Name**	**Description**	**Objective**
1	Introduction	The trainer and the college facilitator talk to the students about the course and in turn the students introduce themselves.	To set expectations about the course and the students are made aware of the rules and regulations involved in this program
2	If I ruled the world	This is a quick and useful game by getting students to form a circle and provide their point of view. Each student then repeats what	The aim of this activity is to for students to get to know each other and also develop their

		the other has said and comes up with their own opinion.	listening skills as well as learning how to agree and disagree politely.
3	Picture Narrating	This activity is based on several sequential pictures. Students are asked to tell the story taking place in the sequential pictures by paying attention to the criteria provided by the teacher as a rubric. Rubrics can include the vocabulary or structures they need to use while narrating.	The aim of this activity is to make the students develop creative way of thinking.
4	Brainstorming	On a given topic, students can produce ideas in a limited time. Depending on the context, either individual or group brainstorming is effective and learners generate ideas quickly and freely. The good characteristics of brainstorming are that the students are not criticized for their ideas so students will be open to sharing new ideas.	The activity aims at making the students speak freely without the fear of being criticized. It also encourages students to come up with their own opinions.
5	Debate	Is competition necessary in regards to the learning process?	The aim of this activity is to develop the students ability to debate and think out of the box
6	Short Talks	Here the students are given topics for which they take one minute to prepare and two minutes to speak. They can write down points but can't read them out they can only use it as a reference.	The activity aims at breaking the students' shyness and encouraging them to standup in front of the class and speak. It also aims at creating awareness that they are restricted for time so they only speak points that are relevant and important.
7	Debate	Will posting students' grades on bulletin boards publicly motivate them to perform better or is it humiliating?	This activity aims at enhancing the students unbiased thought process when it comes to exams and grades as well as develop their skills to debate
8	The Art of diplomacy	The facilitator proceeds to share multiple concepts of conversation and helps the participants to identify the various methods of being diplomatic and how do deal with misinformation.	The aim of the lesson is to provide an opportunity for the participants to learn about body language and choosing the appropriate words for conversation.
9	Debate	Are humans too dependent on computers?	The aim of this activity is to test the students debating skills and thought process with a topic that affects everybody in daily life.
10	Story Completion	The teacher starts to tell a story but after 2 sentences he/she asks students to work in groups to create the rest of the story which includes the plot and the ending.	This activity aims at building their narrating skills as well as their creativity and ability to work in a team.
11	Role play debate	Students scrutinize different points of view or perspectives related to an issue. For example, a debate about the question "Should students be required to wear uniforms at school?" might yield a range of opinions. Those might include views expressed by a student (or perhaps two students – one representing each	The aim of this activity is to get students to speak based on other people's perspective instead of their own. The students take the role of various characters and debate accordingly.

		side of the issue), a parent, a school principal, a police officer, a teacher, the owner of a clothing store, and others.	
12	I Couldn't Disagree More	This is a game where students practice rebuttal techniques where one student provides a thought or an idea and the other students starts with the phrase I couldn't disagree more and continues with his opinion	The aim of this activity is to improve general communication skills and confidence.
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits	The aim is to do both give feedback to students as well as obtain feedback on the course from them.
	Total Contact Hours		**30**
Course Outcomes: At the end of the course the student will be able to			
●	Be more confident		
●	Speak in front of a large audience		
●	Be better creative thinkers		
●	Be spontaneous		
●	Communicate in English		

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
CO 2	1	-	-	-	-	-	1	-	1	3	1	1	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Average	1	-	-	-	-	-	1	-	1	3	1	1	-	-	-

SEMESTER V

Subject Code	Subject Name	Category	L	T	P	C
EE19501	POWER SYSTEM ANALYSIS	PC	3	1	0	4

Objectives:

- To impart knowledge on the modeling of various power system elements under steady state operating condition.
- To provide knowledge on solution of power flow problems using numerical methods.
- To inculcate the impact of balanced and unbalanced faults in power system.
- To familiarize modeling of generators, transformers, lines and cables in the positive, negative and zero sequence systems.
- To get knowledge on modeling and analysis of transient behaviour of power system when it is subjected to a fault.

UNIT-I	INTRODUCTION	12

Basic Components of Power system-Need for system planning and operational studies- Power system Single line diagram - per phase and per unit analysis - Network modeling, Representation of Generator, transformer, transmission line, balanced load and Unbalanced load for different power system Studies-Reactance and Impedance diagram - Primitive network -construction of Y-bus using inspection and singular transformation methods – Z bus.

UNIT-II	POWER FLOW ANALYSIS	12

Importance of power flow analysis - Load flow studies: problem formulation, classification of buses, Development of load flow model – Iterative solution using Gauss-Seidel method, Newton -Raphson method and Fast Decoupled load flow method – Comparison between Gauss-Seidel, Newton –Raphson and Fast Decoupled load flow methods. Case Study: Load flow analysis with FACTS devices.

UNIT-III	FAULT ANALYSIS – BALANCED FAULTS	12

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin's theorem - Z-bus building algorithm - fault analysis using Z-bus – computations of short circuit capacity, post fault voltage and currents with no load and full loads.

UNIT-IV	FAULT ANALYSIS – UNBALANCED FAULTS	12

Introduction to symmetrical components – sequence impedances – sequence circuits of synchronous machine, transformer and transmission lines - sequence networks analysis of single line to ground, line to line, double line to ground faults and open circuit faults using Thevenin's theorem and Z-bus matrix.-Case study for fault analysis: Transformer, Transmission lines.

UNIT-V	STABILITY ANALYSIS	12

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

Total Contact Hours	:	60

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

- realize the nature of the modern power system, including the behaviour of the constituent Components and sub-systems and evaluate the individual parts of an electrical power system.
- analyze load flow of an electrical power network and interpret the results of the analysis.
- analyze a network under both balanced and unbalanced fault conditions and interpret the results
- comprehend modeling of generators, transformers, lines and cables in the positive, negative and zero sequence systems.
- evaluate the transient stability of a single machine infinite bus system using both analytical and time simulation methods.

Text Book(s):

1. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.
2. John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2010.

Reference Books(s) / Web links:

1. HadiSaadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
2. Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.
3. J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, ' Power System Analysis & Design',Cengage Learning, Fifth Edition, 2012.

4	P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, 'Electrical Power Systems- Analysis, Security and Deregulation', PHI Learning Private Limited, New Delhi, 2012.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	2		1					2	3	3	2
CO 2	3	3	3	2	2		1					2	3	3	2
CO 3	3	3	3	2	2		1					2	3	3	2
CO 4	3	3	3	2	2		1					2	3	3	2
CO 5	3	3	3	2	2		1					2	3	3	2
Average	**3**	**3**	**3**	**2**	**2**		**1**					**2**	**3**	**3**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19502	**POWER ELECTRONICS**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on the different types of power semiconductor devices and their switching characteristics.
- To inculcate the operation, characteristics and performance parameters of controlled rectifiers.
- To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
- To learn the different modulation techniques and harmonics suppression for pulse width modulated inverters.
- To get knowledge on the operation of AC voltage controller and various configurations

UNIT-I	**POWER SEMI-CONDUCTOR SWITCHES AND CIRCUITS**	9

Study of switching devices, Power Transistors, SCR, TRIAC, MOSFET, IGBT- Temperature dependent Static and Dynamic characteristics - Triggering and commutation circuit for SCR- Design of Driver and snubber circuit- Introduction to Intelligent Power module (IPM).Introduction SiC Devices.

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

2-pulse, 3-pulse and 6-pulseconverters using R and RL loads– Performance parameters –Effect of source inductance– Dual converters, Light dimmer application.

UNIT-III	**DC TO DC CONVERTERS**	9

Non isolated converters-Buck, Boost and Buck Boost- Isolated Converters- Push pull, Fly back converter-Introduction to Resonant converters- Battery operated vehicle.

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

Voltage Source Inverter-Current Source Inverter-PWM Techniques – Diode Clamped Multi level Inverter- Induction Heating

UNIT-V	**AC TO AC CONVERTERS**	9

AC Voltage Controllers - Integral cycle control – Multistage sequence control-single phase and three phase Cyclo converter- Welding application

Total Contact Hours	**:**	**45**

Course Outcomes:

On completion of course, students will be able to

- Realize a power electronic converters with proper choice of semiconductor devices
- Evaluate the performance parameters of a controlled rectifier system.
- Obtain an efficient SMPS.
- Analyse and Design the inverters based on harmonic suppression.
- Evaluate the AC to AC converter system.

Text Book (s):

1	M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, PHI 4th Edition, New Delhi, 2017.
2	P.S.Bimbra "Power Electronics", Khanna Publishers, 6th Edition, 2018.

3	L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2009.
Reference Books(s) / Web links:	
1	Joseph Vithayathil,"Power Electronics, Principles and Applications", McGraw Hill Series, 6th Reprint, 2013.
2	Ashfaq Ahmed, "Power Electronics for Technology", Pearson Education, Indian reprint, 2003.
3	Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2012 Edition.
4	Ned Mohan, Tore. M. Undel and, William. P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and sons, 3rd edition, 2007.
5	Daniel.W.Hart, "Power Electronics", Indian Edition, McGraw Hill Education, 2nd edition, 2013.
6	M.D. Singh and K.B. Khanchandani, "Power Electronics," McGraw Hill India, 2017.
7	https://www.elprocus.com/power-electronics-in-automotive-applications/
8	Course material on "Switched Mode Power Conversion" by V.Ramanarayanan

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1		3	3	2	2								3	3	3
CO 2		3	2	3	2								3	2	3
CO 3		2	2	2	3						2		3	2	2
CO 4		3	2	2	1	2		2				2	3	2	2
CO 5	3		3				2	3	3		2	3	2	3	2
Average	**3**	**2.75**	**2.4**	**2.25**	**2**	**2**	**2**	**2.5**	**3**	**-**	**2**	**2.5**	**2.8**	**2.4**	**2.4**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19503	**DISCRETE TIME SYSTEMS AND SIGNAL PROCESSING**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on signals and systems and their basic representation.
- To inculcate the discrete time systems and its computation process.
- To learn various transformation technique and their representation designed for Infinite impulse response.
- To familiarize the difference in filters and their design for implementing Finite impulse response system
- To understand a programmable digital signal processor.

UNIT-I	**DISCRETE TIME SIGNAL AND SYSTEM**	9

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect, Antialiasing filter, Solution of difference equation by z-transform, application to discrete systems.

UNIT-II	**DISCRETE FOURIER TRANSFORM & COMPUTATION**	9

Discrete Time Fourier transforms, Discrete Fourier Transform- properties- Circular convolution, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure-inverse FFT.

UNIT-III	**DESIGN OF IIR FILTERS**	9

Analog filter design – Butterworth and Chebyshev approximations; digital filter design using impulse invariant and bilinear transformation – Warping and pre warping, realization of IIR filter using direct form, cascade form and parallel form -

UNIT-IV	**DESIGN OF FIR FILTERS**	9

Amplitude and phase response of FIR filters–Linear phase characteristics, FIR design using Fourier series method - Gibbs phenomenon- Window - Need and choice of windows – Windowing technique for the design of linear phase FIR filters, FIR design using frequency sampling method, Realization of IIR filters using direct form, cascade form and linear phase form.

UNIT-V	**DIGITAL SIGNAL PROCESSORS**	9

Introduction – Architecture – Features – Addressing Formats – Functional modes - Introduction to Commercial Digital Signal Processors – TMS320C5X - TMS320C54X - C2000 Piccolo MCU F28027-Matlab coding for the

design of IIR filter using bilinear transformation.				
		Total Contact Hours	**:**	**45**
Course Outcomes: At the end of the course the student will be able to				
●	Analyze on Signals and systems & their mathematical representation using z transform.			
●	Analyze the harmonics present in the signals using FFT			
●	Analyze the transformation techniques & their computation.			
●	Determine the types of filters and their design for digital implementation			
●	Realize on programmability skills towards digital signal processor			
Text Book (s):				
1	J.G. Proakis and D.G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, New Delhi, PHI. 2003.			
2	S.K. Mitra, "Digital Signal Processing – A Computer Based Approach", McGraw Hill Edu, 2013.			
3	Lonnie C.Ludeman, "Fundamentals of Digital Signal Processing",Wiley,2013			
Reference Books(s) / Web links:				
1	Poorna Chandra S, Sasikala. B , "Digital Signal Processing", Vijay Nicole/TMH,2013.			
2	Robert Schilling & Sandra L.Harris, "Introduction to Digital Signal Processing using Matlab", Cengage Learning,2014.			
3	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2010			
4	SenM.kuo, woonseng s.gan, "Digital Signal Processors, Architecture, Implementations & Applications", Pearson,2013			
5	Dimitris G.Manolakis, Vinay K. Ingle, "Applied Digital Signal Processing" ,Cambridge,2012			
6	https://www.ti.com/lit/ds/symlink/tms320f28027.pdf?ts=1610094285617&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FTMS320F28027			

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	3	1	2	1	1	1	2	3	3	3	3
CO 2	3	3	3	3	3	2	2	1	1	1	1	3	3	3	3
CO 3	3	3	3	3	3	2	1	1	1	1	1	2	3	3	3
CO 4	3	3	3	3	3	2	1	1	1	1	1	2	3	3	3
CO 5	3	3	3	3	3	2	1	1	1	1	1	3	3	3	3
Average	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19504	**MEASUREMENTS AND INSTRUMENTATION**	**PC**	**3**	**0**	**0**	**3**

Objectives:	
●	To learn the functional elements, characteristics and types of errors in instrumentation system.
●	To impart knowledge on various electrical and electronic instruments and display devices.
●	To learn the different methods of measurement of resistance, inductance and capacitance.
●	To provide knowledge on various transducers and data acquisition systems.
●	To teach methods for experimentally measuring various parameters using electrical and electronic instruments and transducers.

UNIT-I	**INTRODUCTION**	**6**
Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration.		
UNIT-II	**ELECTRICAL INSTRUMENTS**	**12**
Measurement of voltage and current – Permanent Magnet Moving Coil and Moving Iron Meters Measurement of power and energy – Dynamometer type Wattmeter and Induction type Energy Meter (Single phase and three phase) Power Factor Meter – Magnetic measurement –Flux Meter – BH curve – Introduction to Current and Potential		

Transformers(Construction and working) – Power measurement using Instrument Transformers- Introduction to Spectrum Analyser and Power Quality Analyser.		
UNIT-III	**ELECTRONICS INSTRUMENTS AND DISPLAY DEVICES**	**9**
Introduction to electronic voltmeter – Digital voltmeter – Multimeter – Counter – Frequency meter – Phase meter – CRO – Time, Frequency and Phase angle measurements using CRO – CRT display –Digital Storage Oscilloscope - LED, LCD and Dot Matrix Display – Data Loggers.		
UNIT-IV	**COMPARISON METHODS OF MEASUREMENTS AND GROUNDING TECHNIQUES**	**9**
DC and AC Potentiometers – Measurement of low and medium resistance using DC bridges – Measurement of inductance and capacitance using AC bridges – Transformer ratio bridges – Electrostatic and Electromagnetic interference – Shielding - Grounding techniques.		
UNIT-V	**TRANSDUCERS AND DATA ACQUISITION SYSTEMS**	**9**
Classification of Transducers – Selection of transducers – Resistive, Capacitive and Inductive transducers – Piezoelectric, Hall effect, Optical Encoder type Digital transducers – Elements of Data Acquisition System – Introduction to MEMS- Introduction to Smart Sensor.		
	Total Contact Hours : 45	

Course Outcomes:

On completion of the course, the students will be able to

- comprehend the basic concepts of measurements and instrumentation.
- analyze the working of various electrical and electronic instruments.
- realize the different methods of measurement of resistance, inductance and capacitance.
- analyze and use display devices, data acquisition systems and transducers appropriately.
- experimentally analyze the electrical and electronic instruments and transducers.

Text Book (s):

1	A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2012.
2	J. B. Gupta, "A Course in Electronic and Electrical Measurements", S. K. Kataria & Sons, Delhi, 2013.
3	Doebelin E.O. and Manik D.N., "Measurement Systems – Application and Design", Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007

Reference Books(s) / Web links:

1	H.S. Kalsi, "Electronic Instrumentation and Measurements", Tata McGraw Hill, 4th Edition 2019.
2	D.V.S. Murthy, 'Transducers and Instrumentation", Prentice Hall of India Pvt Ltd, 2008.
3	A.J. Bouwens, "Digital Instrumentation", Tata McGraw Hill, XVI reprint 2008.
4	Martin Reissland, "Electrical Measurements", New Age International (P) Ltd., Delhi, 2001.
5	Alan. S.Morris, "Principles of Measurements and Instrumentation", 2nd Edition, Prentice Hall of India, 2006.
6	Helfrick and Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice-Hall of India, Reprint 1988
7	Golding, E.W., "Electrical Measurement and Measuring Instruments", 3rd Edition, Sir Isaac Pitman and Sons, 1960

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2						1		2	3	3	1	3
CO 2	3	3	2						1		2	3	3	1	3
CO 3	3	3	2						1		2	3	3	1	3
CO 4	3	3	2						1		2	3	3	1	3
CO 5	3	3	3	3	2	2	1		3	2	3	3	3	1	3

Average	**3**	**3**	**2.2**	**3**	**2**	**2**	**1**		**1.4**	**2**	**2.2**	**3**	**3**	**1**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19505	**CONTROL SYSTEMS**	**PC**	**3**	**1**	**0**	**4**

Objectives:

- To familiarize various representations of systems
- To provide knowledge on time response of systems and steady state error analysis
- To get knowledge on obtaining the open loop and closed–loop frequency responses of systems.
- To analyze the stability of linear systems in time domain and frequency domain.
- To learn importance of compensator and design of different kinds of compensators.

UNIT-I	**SYSTEMS AND THEIR REPRESENTATION**	12

Basic elements in control systems – Open and closed loop systems – Transfer function –mathematical model of mechanical and electrical system – AC and DC servomotors, Synchros- Electrical analogy of mechanical system– Block diagram reduction techniques – Signal flow graphs.

UNIT-II	**TIME RESPONSE**	12

Types of test signal –Time response of I and II order system – Time domain specifications-Steady state error – Error coefficients – Generalized error series – Effects of P, PI,PD,PID modes of feedback control – Modeling and Design of Electronic P,PI and PID controller.

UNIT-III	**FREQUENCY RESPONSE**	12

Frequency response – frequency domain specifications Correlation between frequency domain and time domain specifications – Bode plot - Polar plot– Gain margin and phase margin.

UNIT-IV	**STABILITY ANALYSIS**	12

Stability analysis, characteristic equation, location of roots in s plane for stability, effect of addition of pole and zero, Routh-Hurwitz stability criterion – Nyquist stability criterion – root locus

UNIT-V	**COMPENSATOR DESIGN**	12

Need of compensator, types of compensator – Lag, lead and lag-lead networks – compensator design using bode plots

Total Contact Hours	**:**	**60**

Course Outcomes: At the end of the course the student will be able to

- determine the transfer function of various systems and control system representation.
- analyze the transient and steady state response of the system ,effects of P, PI,PID controllers and MATLAB simulation for first and second order system
- analyze the frequency response of the system by using bode plots and polar plots.
- determine the stability analysis by using Routh Hurwitz criterion, Nyquist stability criterion, root locus and also verified with MATLAB simulation
- realize a Lag/Lead compensator using bode plots.

Text Book (s):

1. M. Gopal, “Control Systems, Principles and Design”, 4th Edition, Tata McGraw Hill, New Delhi, 2015
2. K. Ogata, “Modern Control Engineering”, 5th edition, PHI, 2012.
3. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers, 2017.

Reference Books(s) / Web links:

1. Arthur, G.O.Mutambara, “Design and Analysis of Control; Systems”, CRC Press, 2009.
2. S.K.Bhattacharya, “Control System Engineering”, 3rd Edition, Pearson, 2013.
3. Dhanesh. N. Manik, “Control System”, Cengage Learning, 2012.
4. Richard C. Dorf and Robert H. Bishop, “Modern Control Systems”, Pearson Prentice Hall, 2012.
5. S.Palani, Anoop. K.Jairath, “Automatic Control Systems including MATLAB”, Vijay Nicol McGraw Hill
6. K R Varmah,”Control systems”, Tata McGraw Hill, New Delhi, 2010.
7. William Bolton,”Control systems”,Newnes,USA,2006.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	1	3	1	-	-	-	-	1	2	2	2	3
CO 2	3	3	3	1	3	2	1	-	-	-	3	2	3	2	3
CO 3	3	3	3	2	3	2	1	-	-	-	3	2	3	2	3
CO 4	3	3	3	3	3	2	1	-	-	-	3	2	3	2	3
CO 5	3	3	3	3	3	2	1	-	-	-	3	2	1	2	3
Average	**3**	**3**	**3**	**2**	**3**	**1.8**	**1**	**-**	**-**	**-**	**2.6**	**2**	**2.4**	**2**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19511	**MEASUREMENTS AND INSTRUMENTATION LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

- To conduct an experiment on measurement of resistance by Wheatstone's and Kelvin's double Bridges.
- To conduct an experiment on measurement of inductance and capacitance by Maxwell's and Schering's Bridges.
- To teach the concepts of measurement of physical parameters using various transducers like RTD, Thermistor, LVDT, LDR and Strain gauge.
- To familiarize the working of Instrumentation Amplifier.
- To impart knowledge on signal converters such as ADC and DAC.

List of Experiments

1	Measurement of Medium and Low Resistances using Kelvin's Double bridge and Wheatstone bridge.
2	Measurement of Inductance using Maxwell's bridge.
3	Measurement of Capacitance using Schering's bridge.
4	Measurement of temperature using RTD and Thermistor
5	Measurement of displacement using LVDT
6	Measurement of strain using strain Gauge
7	Characteristics of LDR
8	Instrumentation Amplifier.
9	Analog to Digital Converter
10	Digital to Analog Converter

Total Contact Hours : 30

Course Outcomes:

On completion of the course, students will be able to

- determine the medium and low resistance using DC bridges.
- determine the inductance and capacitance using AC bridges.
- experimentally analyze the behavior of various transducers.
- realise the Instrumentation amplifier as differential amplifier.
- realize the characteristics of ADC and DAC.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2						1		2	3	3	1	3
CO 2	3	3	2						1		2	3	3	1	3
CO 3	3	3	2						1		2	3	3	1	3

CO 4	3	3	2						1		2	3	3	1	3
CO 5	3	3	3	3	2	2	1		3	2	3	3	3	1	3
Average	**3**	**3**	**2.2**	**3**	**2**	**2**	**1**		**1.4**	**2**	**2.2**	**3**	**3**	**1**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19512	**CONTROL SYSTEMS LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:	
●	To familiarize various representations of systems.
●	To provide knowledge on first and second order systems
●	To learn different types of P, PI, PD, PID controllers using MATLAB
●	To teach stability analysis of linear systems
●	To get knowledge on design of Lag ,Lead and Lag-Lead compensator
LIST OF EXPERIMENTS	
1	Study of basic blocks used in control system design using Simulink/Matlab.
2	Determination of transfer function of armature controlled DC servomotor
3	Determination of transfer function of AC servomotor
4	Digital Simulation of First-Order Systems for obtaining the time response of a system to various inputs.
5	Digital Simulation of Second-order Systems for obtaining the time response of a system under various damping conditions
6	Digital simulation of P, PI, PD, PID controllers using MATLAB
7	Stability Analysis of Linear Systems using Bode plots method using simulation software.
8	Stability Analysis of Linear Systems using Polar plots method using simulation software.
9	Stability Analysis of Linear Systems using Root locus & Nyquist plots method using simulation software.
10	Design of Lag and Lead compensator
11	Design of Lag-Lead compensator
Total Contact Hours : **30**	
Course Outcomes: At the end of the course the student will be able to	
●	determine the transfer function of various control systems.
●	analyze the steady state and transient state response of first and second order systems using MATLAB simulation
●	realize the different types of P, PI, PD, PID controllers using MATLAB
●	analyze the stability of linear systems and also verified with MATLAB simulation
●	realize the Lag, Lead and Lag- Lead compensator using bode plots.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	-	1	-	-	-	1	-	1	1	2	-	3
CO 2	3	3	3	-	1	-	-	-	1	-	1	1	2	-	3
CO 3	3	3	3	-	1	-	-	-	1	-	1	1	2	-	3
CO 4	3	3	3	-	1	-	-	-	1	-	1	1	2	-	3
CO 5	3	3	3	-	1	-	-	-	1	-	1	1	2	-	3
Average	**3**	**3**	**3**	-	**1**	-	-	-	**1**	-	**1**	**1**	**2**	-	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
********	**OPEN ELECTIVE-I**	**OE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
GE19521	SOFT SKILLS-II	EEC	0	0	2	1

Objectives:

- To help the students break out of shyness.
- To build confidence
- To enhance English communication skills.
- To encourage students' creative thinking to help them frame their own opinions.

Learning and Teaching Strategy:

The program is completely student centric where the focus is on activities led by students which include role plays, discussions, debates other games as well. These activities would be supplemented by interactive use of technology and brief trainer input.

Week	Activity Name	Description	Objective
1	The News hour	Students are made to read news articles from the English newspapers. The students also have to find words and their meaning from the article they have not come across before and share it with the group. They then use these words in sentences of their own	The aim of this activity is not only to get the students to read the newspaper but also aims at enhancing the students' vocabulary.
2	Court Case	The facilitator provides the participants the premise of a story and proceeds to convert the story into a court case. The students are required, department-wise to debate and provide their points to win the case for their clients.	The aim of the lesson is to encourage creative and out-of-the -box thinking to ensure a good debate and defense skills.
3	The ultimate weekend	The students design activities they are going to do over the weekend and they have to invite their classmates to join in the activity. The students move around the class and talk to other students and invite them.	The aim of this activity is to develop the art of conversation among students. It also aims at practicing the grammatical structures of "going to" "have to" and asking questions.
4	The Four Corners	This is a debate game that uses four corners of the classroom to get students moving. The following is written on the 4 corners of the room "Strongly Agree, Somewhat Agree, Somewhat Disagree and Strongly Disagree". The topics are then given to the class and students move to the corner that they feel best explains their opinions	This activity aims at getting students to come up with their own opinions and stand by it instead of being overshadowed by others and forcing themselves to change based on others opinions.
5	Debate	Boarding school or day school? Which is more beneficial for a student?	The aim of this activity is to encourage students to draw up feasible points on the advantages and benefits of both. And enhance their debating ability
6	Grand Master	The facilitator starts the session by keeping an individual in mind, upon which the students guess it only through "Yes or No" questions. Post few trials the students are given same opportunity to do the same with the crowd.	The aim of the lesson is designed to teach the art of questioning. It also helps to enhance the students' speaking and listening skills.
7	Debate	Does violence on the TV and Video games influence children negatively?	This activity aims at encouraging the students to debate on real life scenarios that most students spend a lot of time on.
8	Turn Tables	This is a speaking activity where the students need to speak for and against the given topics	The aim of this activity is to make the participants become

		when the facilitator shouts out 'Turn Table'.	spontaneous and have good presence of mind.
9	Debate	Do marks define the capabilities of a student?	This debate activity aims at allowing the students to argue on this worrisome adage of marks.
10	FictionAD	The Participants are asked to create an Ad for a challenging topic only using fictional characters.	The activity aims at developing their creativity and presentation skills.
11	Debate	Are social networking sites effective, or are they just a sophisticated means for stalking people?	This activity aims at refining the students debating skills on a very real life situation
12	Talent Hunt	Talent Hunt is a fun activity where the students are selected at random and supported to present any of their own skills.	The aim of this activity is designed to evoke their inner talents and break the shyness and the fear of participating in front of a crowd
	Feedback	At the end of the session in the final week (12) the trainer would provide feedback to the students on best practices for future benefits.	The aim is to do both give feedback to students as well as obtain feedback on the course from them.
		Total Contact Hours	**30**

Course Outcomes: At the end of the course the student will be able to

- Be more confident
- Speak in front of a large audience without hesitation.
- Be better creative thinkers
- Be spontaneous
- Communicate in English

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	-	-	-	-	-	-	-	-	2	3	1	1	-	1	1
CO 2	-	-	-	-	-	-	-	-	2	3	2	-	-	-	-
CO 3	-	1	-	-	-	-	-	-	2	3	1	1	-	-	-
CO 4	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO 5	-	1	-	-	-	-	-	-	2	3	1	1	-	-	-
Average	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**1.2**	**1**	**-**	**-**	**-**

SEMESTER VI

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19601	PROTECTION AND SWITCHGEAR	PC	3	0	0	3

Objectives:

- To know the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- To learn the operation, characteristics and applications of relays and protection schemes.
- To impart knowledge on electrical apparatus protection.
- To study static and numerical relays.
- To expose on operation and function of circuit breakers.

UNIT-I	PROTECTION SCHEMES	9

Principles and need for protective schemes – nature and causes of faults – types of faults – fault current calculation using symmetrical components – Methods of Neutral grounding – Zones of protection and essential qualities of protection – Protection schemes

UNIT-II	ELECTROMAGNETIC RELAYS	9

Operating principles of relays - the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays.

UNIT-III	APPARATUS PROTECTION	9

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line.

UNIT-IV	NUMERICAL PROTECTION AND DIGITAL RELAYS	9

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

UNIT-V	CIRCUIT BREAKERS	9

Types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of circuit breakers.

Total Contact Hours	:	45

Course Outcomes: On completion of the course, the students will be able to

- Evaluate the nature of the fault and various protection schemes.
- Know the operation of different types of electromagnetic relays.
- Apply the protection schemes for protecting the apparatus
- Realize the function of static relays.
- Know the operation of circuit breakers.

Text Book(s):

1. Sunil S.Rao, “Switchgear and Protection”, Khanna Publishers, New Delhi, Ninth reprint, 2012.
2. B.Rabindranath and N.Chander, “Power System Protection and Switchgear”, New Age International (P) Ltd. First Edition 2011.
3. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, “A Text Book on Power System Engineering”, DhanpatRai & Co.,2014.
4. Arun Ingole , “Switchgear and Protection”,Pearson Education; First edition , May 2018)

Reference Books(s) / Web links:

1. BadriRam ,B.H. Vishwakarma, “Power System Protection and Switchgear”, New Age International Pvt Ltd Publishers, Second Edition 2011.
2. Y.G.Paithankar and S.R.Bhide, “Fundamentals of power system protection”, Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. Ravindra P.Singh, “Switchgear and Power System Protection”, PHI Learning Private Ltd., NewDelhi, 2009.

4	Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani, "Protection and Switchgear" Oxford University Press, 2011.
6	P.M.Anderson " Power System Protection" Wiley-Interscience, 1999.
7	A.T.Johns and S.K.Salman " Digital protection for power system" peter peregrinus Ltd 1995.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	2	3	2	2	2	2	2	2	3	3	2
CO 2	3	3	3	2	2	3	2	2	2	2	2	2	3	3	2
CO 3	3	3	3	2	2	3	2	2	2	2	2	2	3	3	2
CO 4	3	3	3	2	2	3	2	2	2	2	2	2	3	3	2
CO 5	3	3	3	2	2	3	2	2	2	2	2	2	3	3	2
Average	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**

Subject Code	Subject Name	Category	L	T	P	C
EE19602	**SOLID STATE DRIVES**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To provide knowledge on steady state operation and transient dynamics of a motor load system.
- To teach and analyse the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.
- To expose and understand the operation and performance of AC motor drives.
- To familiarize the knowledge on using special electrical machines for drives.
- To learn the applications of an electric drive.

UNIT-I	**DRIVE CHARACTERISTICS**	9

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

UNIT-II	**DC MOTOR DRIVE**	9

Transient analysis of separately excited DC motor-controlled rectifier fed DC drives-single phase and three phase-multi quadrant operation of dc separately excited motor-chopper control of separately excited and series motor-closed loop control.

UNIT-III	**INDUCTION MOTOR DRIVES**	9

Stator voltage control of induction motor–variable frequency control of IM from voltage sources and current sources-slip power recovery-Introduction to vector control. Linear Induction Motors.

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 - SRM Drives. BLDC drives.

UNIT-V	**APPLICATIONS OF ELECTRICAL DRIVES**	9

Traction drives-conventional DC and AC traction drives-poly phase AC motor for traction drives-solar powered pump drives- Electric vehicles-Design of electrical vehicle

	Contact Hours :	**45**

- Determine the motor for an electric drive by analysing the dynamic and steady state characteristics.
- Analyse and implement the drive system using DC motors.
- Evaluate and implement the drive system using AC motors.
- Realize a drive system using special electrical machines.
- Synthesize and develop an efficient drive system for EV.

Text Book(s):

1	Vedam Subramanyam, " Electric Drives Concepts and Applications ", 2e, McGraw Hill, 2016
2	Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2013.

3	John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System," Elsevier 2012.
4	N.K. De., P.K. SEN" Electric drives" PHI, 2012
5	Theodore Wildi, " Electrical Machines ,Drives and power systems ,6th edition, Pearson Education ,2015
6	G.K. Dubey ,"Fundamentals of Electrical Drives" Narosa; Second Edition,January 2010
7	R.Krishnan , "Electric Motor Drives – Modelling, Analysis and Control" , Pearson Education India; 1st edition,January 2015
Reference Books(s) / Web links:	
1	John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System," Elsevier2012.
2	Shaahin Felizadeh, "Electric Machines and Drives", CRC Press(Taylor and Francis Group), 2013
3	S.K.Pillai, "A First course on Electrical Drives", Wiley Eastern Limited, 1993.
4	S. Sivanagaraju, M. Balasubba Reddy, A. Mallikarjuna Prasad, "Power semiconductor drives", PHI, 5th printing, 2013.
5	N.K.De., P.K.SEN, "Electric drives" , PHI, 2012.
6	Vedam Subramanyam, "Thyristor Control of Electric Drives", Tata McGraw Hill, 2007.
7	https://www.youtube.com/watch?v=vwJYIorz_Aw
8	https://www.youtube.com/watch?v=2Gjs7IPOCXs
9	https://www.scribd.com/doc/29764542/Power-Electronics-Converters-Applications-And-Design

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	3	2										3	2	1
CO 2		3	3	1									3	2	1
CO 3		3	3	1									2	3	1
CO 4			1	3	2								1	2	3
CO 5			1	3	2								1	2	3
Average	**2**	**3**	**2**	**2**	**2**								**2**	**2.2**	**1.8**

Subject Code	Subject Name	Category	L	T	P	C
EE19603	**MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To apply knowledge in architecture and programming of 8085 microprocessor.
- To develop skills in interfacing of peripheral devices with 8085 microprocessor.
- To apply knowledge in architecture and programming of 8051 microcontroller.
- To impart the knowledge about the instruction set
- To understand the basic idea about the data transfer schemes and its applications

UNIT-I	**8085 MICROPROCESSOR**	8

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory Interfacing Techniques - I/O Interfacing Techniques – Interrupt Structure.

UNIT-II	**8085 INSTRUCTION SET AND PROGRAMMING**	10

Instruction -format and addressing modes – Data transfer, data Manipulation & control instructions – Timing Diagram – Timing diagram of STA, LDA, IN, OUT and INR M - Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – Delay routine - stack.

UNIT-III	**PERIPHERAL INTERFACING**	9

Study on need, Architecture, configuration and interfacing, with ICs: 8255, 8254, 8257, 8251, 8279, A/D and D/A converters &Interfacing with 8085.

UNIT-IV	**8051 MICROCONTROLLER**	9

Hardware Architecture, pin outs – Functional Building Blocks of Processor – Memory organization - SFR– I/O ports,

Timers/Counters – Interrupts			
UNIT-V	**8051 INSTRUCTION SET AND PROGRAMMING**		9
Data Transfer, Manipulation, Control Algorithms& I/O instructions – Programming for Measurement of frequency, phase angle and power factor – Waveform generators - Generation of Gate signals – stepper motor control – Washing Machine Control.			
	Contact Hours	**:**	**45**

Course Outcomes:	
●	Design 8085 microprocessor based system.
●	Apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
●	Analyse the data transfer information through serial & parallel ports.
●	Illustrate how the different peripherals (8255, 8253 etc.) are interfaced with Microprocessor.
●	Design circuits for various applications using microcontrollers
Text Book (s):	
1	Krishna Kant, "Microprocessor and Microcontrollers", PH1 Learning private limited, New Delhi, 2nd Edition 2010.
2	R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
3	Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
Reference Books(s) / Web links:	
1	Muhammad Ali Mazidi& Janice GilliMazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.
2	N.Senthil Kumar, M.Saravanan, S.Jeevananthan, "Microprocessors and Microcontrollers", Oxford, 2013.
3	Kenneth J Ayala , The 8051 Microcontroller Architecture, Programming And Applications, West Publishing Company, 2004
4	K.M.Bhurchandi, "Advanced Microprocessors and Pheripherals" Tata McGraw Hill Publishing Company Ltd, 3rd Edition 2013.
5	A.Nagoorkani, "Microprocessors and Microcontrollers", Tata McGraw Hill Publishing Company Ltd, 2nd Edition 2015.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 2	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 4	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 5	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
Average	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**

Subject Code	**Subject Name (Lab oriented Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19641	**DESIGN OF ELECTRICAL MACHINES**	**PC**	**3**	**0**	**2**	**4**

Objectives:	
●	To introduce thermal ratings and calculations of various types of electrical machines.
●	To provide knowledge on the design of armature and field systems for d.c machines.
●	To impart knowledge on the design of core, yoke, windings and cooling systems of transformers.
●	To familiarize knowledge on the design of stator and rotor of induction machines.
●	To inculcate knowledge on the design of stator and rotor of synchronous machines.

UNIT-I	**MAGNETIC CIRCUITS AND COOLING OF ELECTICAL MACHINES**	9
Concept of magnetic circuit – MMF calculation for various types of electrical machines – real and apparent flux density of rotating machines – leakage reactance calculation for transformers- thermal rating: continuous, short time and intermittent short time rating of electrical machines- Heat flow-Temperature rise and insulating materials-direct and indirect cooling methods – cooling of turbo alternators.		
UNIT-II	**D.C. MACHINES**	9
Constructional details – output equation – main dimensions - choice of specific loadings – choice of number of poles – armature design – net length of iron- winding design – design of field poles and field coil – design of commutator and brushes – losses and efficiency calculations.		
UNIT-III	**TRANSFORMERS**	9
Constructional details of core and shell type transformers – output rating of single phase and three phase transformers – design of core, yoke and windings for core and shell type transformers – operating characteristics–losses and efficiency calculations – design of tank and cooling of transformers.		
UNIT-IV	**THREE PHASE INDUCTION MOTORS**	9
Constructional details of squirrel cage and slip ring motors – output equation – main dimensions – choice of specific loadings –rules for selecting rotor slots of squirrel cage machine- design of stator – winding design for given poles - design of squirrel cage and slip ring rotor – losses and efficiency calculations – Application of Induction generator in both self-excited and grid connected mode.		
UNIT-V	**SYNCHRONOUS MACHINES**	9
Constructional details of cylindrical pole and salient pole alternators – output equation – choice of specific loadings – main dimensions – short circuit ratio – design of stator and rotor of cylindrical pole and salient pole machines – estimation of air gap length- design of field coil - Introduction to computer aided design.		
	Contact Hours :	**45**

List of Experiments

1. Calculation of airgap MMF for rotating machines using carter's coefficient.
2. Shunt field winding design for DC motor;
3. a) Design of core and winding of three phase transformers
   b) Design of cooling system for three phase transformers
4. Design of three phase squirrel cage induction motor
5. Complete torque-speed characteristics (S = 0 to 1) of wound rotor induction motor for various added rotor resistances
6. Curve fitting algorithm for magnetisation and iron loss characteristics of three phase induction motor
7. Performance predetermination of single-phase induction motors using double field revolving theory
8. Design of three phase synchronous generator including winding design
9. Analysis of grid connected induction generator with power factor correction
10. Analysis of self-excited induction generator using binary search algorithm

	Contact Hours :	**30**
	Total Contact Hours :	**75**

Course Outcomes:

On completion of the course, the students will be able to

- understand the calculations and thermal ratings of various types of electrical machines.
- analyse the design of armature and field systems for D.C. machines.
- apply the design of core, yoke, windings and cooling systems of transformers
- realize the design of stator and rotor of induction machines
- evaluate the design of stator and rotor of synchronous machines

Text Book (s):

1	A.K. Sawhney, "A Course in Electrical Machine Design", DhanpatRai and Sons, New Delhi, 1984.
2	S.K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing

	Co.Pvt Ltd., New Delhi, 1987.
3	M.V.Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010
Reference Books(s) / Web links:	
1	R.K. Agarwal, "Principles of Electrical Machine Design", S.K.Kataria and Sons, Delhi, 2002.
2	V.N. Mittle and A. Mittle, "Design of Electrical Machines", Standard Publications and Distributors, Delhi, 2002.
3	A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.
4	https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6584752
5	https://www.scottautomation.com/assets/Uploads/Opera-Electrical-Machine-Design.pdf

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 2	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 3	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 4	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19P6X	**PROFESSIONAL ELECTIVE-I**	**PE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
********	**OPEN ELECTIVE-II**	**OE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19611	**INNOVATION AND DESIGN THINKING FOR ELECTRICAL ENGINEERS**	**EEC**	**0**	**0**	**4**	**2**

Objectives:	
●	To impart the skills to innovatively design and fabricate and to test a prototype model chosen in the main field or one of the allied field of Electrical and Electronics Engineering
●	To impart knowledge on the design of transmission network, distribution network, relays, circuit breakers, DC excitation and starters for power system applications.
●	To provide knowledge on the design of power converters and controllers for various Power Electronic Applications.
●	To impart knowledge on the design of high frequency transformer, ferrite core inductor, series and parallel RL, RLC circuits and passive filters for various applications.
●	To inculcate knowledge on the design of analog and digital circuits for various applications.
List of Identified Problems	
POWER SYSTEM DESIGN	
1	To design a layout of transmission and distribution network which feeds power to 5 streets with 5 houses in each street. Find and indicate the distribution transformer rating, feeder rating, voltage, current, power ratings in each street and each house.
2	To perform load flow analysis of Tamilnadu power system network or any other state power system network in India.
3	To design the ratings of circuit breaker and relay to be connected in the electricity board which is located nearby your home based upon symmetrical and unsymmetrical fault analysis in the distribution network connected to electricity board.
4	To design and analyze the displacement power factor compensation capacitor KVR requirement for

	11KV/400V 250KVA transformer
5	To fabricate the variable DC excitation unit for Lab alternator
6	To design and fabricate digital star/delta control starter with single preventer and overload trip settings
7	To design and develope graphical user interface for calculating power system parameter of the short, medium and long transmission line
8	Annual reactive power saving in wind driven grid connected induction generator by star delta switching
9	Excitation capacitor calculation for SEIG for given performance specification
POWER ELECTRONICS AND CONTROLLER DESIGN	
1	Design of Switched Mode Power Supply using Non-Isolated DC-DC Converter.
2	Design of DC-DC Buck Converter for Battery Charging Applications
3	Analysis and Design of DC Drive system
4	Harmonics suppression in power converters
5	Create a innovative simple and cost effective Inverter circuit for PMSM fed Electric Vehicles
6	Design and develop a 12W solar powered controller for LED display application
7	Create a innovative simple and cost effective Inverter circuit for induction motor fed Electric Vehicles
8	Desing and develope 250 watts buck converter
9	Design of micro inverter for low power applications
10	Design of charge controller for solar PV system
11	chopper control of self excited induction generator
12	Design of PI,PD,PID controller
13	Design of buck and boost converter
14	Design of series inverter
15	Design of 3-phase inverter
ELECTRIC CIRCUITS AND MAGNETICS DESIGN	
1	Design of high frequency transformer and ferrite core inductor
2	Design of a single circuit to solve R, RL and RLC series and parallel operations.
3	Design a single circuit to analyse all the theorems of AC and DC Circuits.
4	Design and develop a simple passive filtering circuit using thevenin's theorem for lighting applications
ANALOG CIRCUIT DESIGN	
1	Design transistor circuit for simple water level indicator.
2	Design and develope analog circuit to measure the temperature
3	Design simple water level indicator using 555 timers.
4	Design and develop clock signal using oscillators (Multivibrators)
DIGITAL CIRCUIT DESIGN	
1	Design digital circuit for a gate closing system(or a traffic regulating system) at the 4 road junction(assuming one road for emergency vehicle and others for general public)with four sensors(camera) and four gates on each road. If there is a vehicle on the emergency road, the other roads should be blocked,and when the sensor shows that the emergency vehicle passed any one of the public roads, the gates should be opened for public use. 2)
2	Design and develope digital circuit to measure the wind speed
3	Filter Design using Digital circuits
4	Analysis of window technique problems for digital applications
	Total Contact Hours : 60
Course Outcomes: On completion of the course, students will be able to	
●	innovatively design and fabricate and test a prototype model chosen in the main field or one of the allied field of Electrical and Electronics Engineering
●	understand the design aspects of transmission network, distribution network, relays, circuit breakers, DC excitation and starters for power system applications
●	analyse the design of power converters and controllers for various Power Electronic Applications.

●	apply the design of high frequency transformer, ferrite core inductor, series and parallel RL, RLC circuits and passive filters for various applications
●	realize the design of the analog and digital circuits for various applications

COs/POs &PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	2	2	2	3	3	3	3	3		3
CO 3	3	3	3	3	3	2	2	2	3	3	3	3	3		3
CO 4	3	3	3	3	3	2	2	2	3	3	3	3	3		3
CO 5	3	3	3	3	3	2	2	2	3	3	3	3	3		3
Average	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19612	**POWER ELECTRONICS AND DRIVES LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

●	To know the triggering of SCR
●	To draw and extract the parameters from the static characterization of the semiconductor devices
●	To study the conversion of AC to DC supply and speed control of DC motor
●	To study the conversion of DC to AC supply and speed control of 1ϕ and 3ϕ IM
●	To acquire knowledge on generating high frequency AC supply

List of Experiments

1	Gate Pulse Generation using R,RL and RC circuits
2	Characteristics of SCR and TRIAC
3	Characteristics of MOSFET and IGBT
4	AC to DC half controlled converter fed DC motor
5	AC to DC fully controlled Converter fed DC motor
6	Step down and step up MOSFET based choppers fed DC motor
7	IGBT based single phase PWM inverter fed AC motor
8	IGBT based three phase PWM inverter fed AC motor
9	AC Voltage controller fed AC motor
10	Four Quadrant operation of DC Motor.

Total Contact Hours	**:**	**30**

Course Outcomes:

On completion of the course, students will be able to

●	Develop a firing circuit to trigger the SCR
●	Characterize the semiconductor devices
●	Control the speed of the DC and AC motor.
●	Convert the power supply from DC to AC and AC to DC.
●	Generate a variable voltage and frequency AC supply.

COs/POs &PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3		2	2	2								2	2	3
CO 2	3	3	2	2	2			2					2	2	3

CO 3	3	3	2	2	2							2	2	2	3
CO 4	3	3	2	2	2							2	2	2	3
CO 5	3	3	2	2	2							2	2	2	3
Average	**3**	**3**	**2**	**2**	**2**			**2**				**2**	**2**	**2**	**3**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19613	**MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS LABORATORY**	**PC**	**0**	**0**	**2**	**1**

Objectives:

- To study the programming of 8085 microprocessor and 8051 microcontroller.
- To study the 8085 microprocessor ALP using arithmetic, logical and shift Operations
- To study the interfacing of 8085 with I/O and other devices.
- To study the 8051 microcontroller ALP using arithmetic, logical and shift Operations
- To study the interfacing of 8051 with I/O and other devices.

List of Experiments

1	Arithmetic and logical program in 8085 microprocessor
2	Branching and control program in 8085 microprocessor
3	Code conversion program in 8085 microprocessor
4	Look-up table program in 8085 microprocessor
5	8085 microprocessor program on Fibonacci series, palindrome number, Sum of series of even numbers and odd numbers, and factorial of a number
6	Arithmetic and logical program in 8051 microcontroller
7	Branching and control program in 8051 microcontroller
8	Digital IO interfacing with 8085 and 8051
9	A/D and D/A interfacing with 8085 and 8051
10	8279 interfacing with 8085 and 8051
11	Stepper motor interfacing with 8085 and 8051
12	Traffic light controller interfacing model (Mini Project –DIY)

Total Contact Hours : 30

Course Outcomes:

On completion of the course, students will be able to

- Develop the arithmetic,logical,branching and control progrms and excute them using 8085 Microprocessor.
- Develop a program to interface A/D and D/A converters with 8085 Microprocessor and 8051 Microcontroller.
- Develop the arithmetic,logical,branching and control progrms and excute them using 8051 Microcontroller.
- Develop a program to interface 8279 with 8085 Microprocessor and 8051 Microcontroller.
- Develop a program to interface a stepper motor with 8085 Microprocessor and 8051 Microcontroller.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 2	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 4	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 5	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
Average	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
GE19621	PROBLEM-SOLVING TECHNIQUES	EEC	0	0	2	1

Objectives:

- To improve the numerical ability.
- To improve problem-solving skills.

COURSE TOPICS

S.NO	TOPIC NAME
1	Numbers system
2	Reading comprehension
3	Data arrangements and Blood relations
4	Time and Work
5	Sentence correction
6	Coding & Decoding, Series, Analogy, Odd man out and Visual reasoning
7	Percentages, Simple interest and Compound interest
8	Sentence completion and Para-jumbles
9	Profit and Loss, Partnerships and Averages
10	Permutation, Combination and Probability
11	Data interpretation and Data sufficiency
12	Logarithms, Progressions, Geometry and Quadratic equations.
13	Time, Speed and Distance
	Total Contact Hours : 30

Course Outcomes: On completion of the course, the students will be able to

- Have mental alertness
- Have numerical ability
- Solve quantitative aptitude problems with more confident

SEMESTER VII

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19701	HYBRID ELECTRIC VEHICLES	PC	3	0	0	3

Objectives:

- To introduce basic hybrid vehicle structure, characteristics and performance
- To teach various hybrid drive-train topologies
- To get knowledge on the operation and performance of electric components used in electric vehicles
- To inculcate the knowledge on energy storage systems.
- To get knowledge on the on ratings of drive motor and battery

UNIT-I INTRODUCTION TO HYBRID ELECTRIC VEHICLES **9**

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Commercial PHEV

UNIT-II HYBRID ELECTRIC DRIVE-TRAINS **9**

Electric Drive-trains: Requirements of Charging system - Charging system principles-Alternators and charging circuits, Requirements of starting system, Starter motor and circuits
Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT-III ELECTRIC PROPULSION UNIT **9**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of BLDC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of PMSM drives

UNIT-IV ENERGY STORAGE **9**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Smart Charger - Need of Charging station Selection - Developments in electrical storage

UNIT-V SIZING THE DRIVE SYSTEM **9**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology

Total Contact Hours : 45

Course Outcomes:

At the end of the course the student will be able to:

- Understand the concepts of suitable drive scheme for developing an electric hybrid vehicle depending on resources
- Realize the basic schemes of electric vehicles and hybrid electric vehicles.
- Analyse and Design a proper control circuit for DC and AC Drives
- Determine a better battery and BMS
- Determine proper energy storage systems for vehicle applications

Text Book (s):

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. Bosch Hand Book, SAE Publication, 2000

Reference Books(s) / Web links:

1. James Larminie, John Lowry "Electric Vehicle Technology Explained", Wiley, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi "Modern Electric, Hybrid Electric Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
3. Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	3	1										3	2	1
CO 2		3	3	2									2	3	1

CO 3		3	3	2									2	3	1
CO 4		3		2	3		1						1	3	2
CO 5		3		1	3	2							1	2	3
Average	**2**	**3**	**2.33**	**1.75**	**3**	**2**	**1**						**1.8**	**2.6**	**1.6**

Subject Code	**Subject Name (Lab oriented Theory Courses)**	**Category**	**L**	**T**	**P**	**C**
EE19741	**RENEWABLE ENERGY SYSTEMS**	**PC**	**3**	**0**	**2**	**4**

Objectives:

- To impart knowledge on general physical mechanism of energy conversion.
- To provide knowledge on renewable energy generation systems, such as wind and solar energy generations.
- To familiarize the biomass energy systems
- To teach the concept of tidal energy and fuel cell and other sources
- To expose the concept of micro generation systems

UNIT-I **ENERGY SCENARIO** 9

Classification of energy sources – Energy resources: Conventional and non-conventional –Energy needs of India – Energy consumption patterns – Worldwide Potentials of these sources – Energy efficiency – Energy security – Energy and its environmental impacts-Sox and NOx estimation for power generation – Global environmental concern – Kyoto Protocol – Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF) – Factors favouring and against renewable energy sources

UNIT-II **SOLAR ENERGY** 9

Solar thermal Systems – Types of collectors – Collection systems – Efficiency calculations – Applications – Photo Voltaic (PV) technology – Present status – Solar cells – Cell technologies – Characteristics of PV systems – Equivalent circuit- mathematical modeling – Array design – Building integrated PV system and its components – Sizing and economics – Peak power operation- Maximum power point tracking – Standalone and grid interactive systems. PV penetrated difficulties in distribution systems

UNIT-III **WIND ENERGY**

Wind Energy – Wind speed and power relation – Power extracted from wind – Wind distribution and wind speed predictions – Wind power systems – System components – Types of Turbine – Turbine rating – Choice of generators- Introduction to Induction generator- Double fed Induction generator – Turbine rating – Electrical load matching – Variable speed operation- overview of permanent magnet synchronous generator – Maximum power operation – Control strategy – System design features – Stand alone and grid connected operation.

UNIT-IV **OTHER ENERGY SOURCES** 9

Biomass – Various resources – Energy contents – Technological advancements – Conversion of biomass in other form of energy – solid, liquid and gases – Gasifiers – Biomass fired boilers – Cofiring – Generation from municipal solid waste – Issues in harnessing these sources – Hydro energy – Feasibility of small, mini and micro hydel plants: scheme, layout and economics – Tidal and wave energy – Geothermal and Ocean-Thermal Energy Conversion (OTEC) systems – Schemes, feasibility and viability.

UNIT-V **ENERGY STORAGE AND HYBRID SYSTEM CONFIGURATIONS** 9

Energy storage – Battery – Types – Equivalent circuit- Battery storage modeling – Performance characteristics – design –charge regulators – Battery management – Fly wheel - Fuel cell - Ultra capacitors – Benefits over battery. Introduction to vehicle to grid systems overview of standalone and grid connected Photovoltaic with Wind hybrid systems

Contact Hours : 45

List of Experiments

1	Modelling and simulation of Photovoltaic models.
2	Simulation of Perturb and Observe MPPT Algorithm for PV array
3	Modelling and simulation of self-excited Induction generator.
4	Modelling and simulation of DFIG.
5	Modelling and simulation of permanent magnet synchronous generator.

6	Simulation of isolated hybrid systems			
7	Modelling and simulation of Fuel Cell.			
8	Modelling and simulation of energy storage system.			
9	Power control for wind power generations.			
10	Power quality performance analysis for nonlinear loads.			
11	Experimental validation of self-excited Induction generator.			
12	Grid synchronization of PV sourced inverter. (demo)			
		Contact Hours	**:**	**30**
		Total Contact Hours	**:**	**75**
Course Outcomes: At the end of the course the student will be able to				
●	determine the general physical mechanism of energy conversion			
●	evaluate the function of micro generation systems			
●	analyze the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment			
●	realize the basic electrical concepts and system components			
●	know the information on renewable energy technologies as a basis for further investigation and evaluation.			
Text Book (s):				
1	Rai, G. D., "Non Conventional Energy Sources", Khanna Publishers,18th edition 2017.			
2	Rao S. Paruklekar, "Energy Technology – Non-Conventional, Renewable and Conventional", Khanna Publishers, 3rd edition (2009).			
Reference Books(s) / Web links:				
1	Openshaw Taylor, E., "Utilisation of Electric Energy in SI Units.", Orient Longman Ltd,2007			
2	Uppal, S.L., "Electric Power", 13th Edition, Khanna Publishers, 2009.			
3	Mukund R. Patel, "Wind and Solar Power Systems", CRC Press LLC, second edition (15 July 2005)			

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3			2	2							3	3
CO 2	3	3	3	2		1	1						3	3	3
CO 3	3	3	3	2							1		2	3	3
CO 4	3	3	3	3					2		1			3	3
CO 5	3	3	3	1										3	3
Average	**3**	**3**	**3**	**2**		**1.5**	**1.5**		**2**		**1**		**2.5**	**3**	**3**

Subject Code	**Subject Name (Lab oriented Theory Courses)**	**Category**	**L**	**T**	**P**	**C**
EE19742	**POWER SYSTEM OPERATION AND CONTROL**	**PC**	**2**	**1**	**2**	**4**

Objectives:		
●	To get knowledge on the overview of power system operation and control.	
●	To impart knowledge on modeling of real power-frequency dynamics and design of real power-frequency controller.	
●	To provide knowledge on reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.	
●	To learn the economic operation of power system.	
●	To familiarize SCADA and its application for real time operation and control of power systems.	
UNIT-I	**INTRODUCTION**	**9**
Power scenario in Indian grid – National and Regional load dispatching centers - An overview of power system operation and control - system load variation - load characteristics -load curves and load-duration curve - load factor - diversity factor - Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves - load		

forecasting– plant level and system level controls.		
UNIT-II	**REAL POWER - FREQUENCY CONTROL**	**9**
Basics of speed governing mechanism and modelling - speed-load characteristics – load sharing between two synchronous machines in parallel - control area concept - LFC control of a single-area system - static and dynamic analysis of uncontrolled and controlled cases - two-area system –modelling - static analysis of uncontrolled case - tie line with frequency bias control - state variable model - integration of economic dispatch control with LFC.		
UNIT-III	**REACTIVE POWER–VOLTAGE CONTROL**	**9**
Basics of reactive power control – Relation between voltage, power and reactive power at a node - Generation and absorption of reactive power - excitation systems –modelling - static and dynamic analysis - stability compensation - methods of voltage control: tap changing transformer, SVC (TCR + TSC) and STATCOM.		
UNIT-IV	**UNIT COMMITMENT AND ECONOMIC DISPATCH**	**9**
Formulation of economic dispatch problem – I/O cost characterization – incremental cost curve –coordination equations without and with loss (No derivation of loss coefficients) - solution by direct method and λ-iteration method - statement of unit commitment problem – priority-list method – forward dynamic programming.		
UNIT-V	**COMPUTER CONTROL OF POWER SYSTEMS**	**9**
Need for computer control of power systems - concept of energy control centre - functions – system monitoring - data acquisition and control - system hardware configuration – SCADA and EMS functions - network topology - state estimation – WLSE - Contingency Analysis - state transition diagram showing various state transitions and control strategies.		
	Contact Hours : 45	

	List of Experiments
1	Simulation of load curve, load duration curve and calculation of power plant parameters.
2	Load – Frequency Dynamics of Single- Area Power System.
3	Load – Frequency Dynamics of Two-Area Power System.
4	State space modelling of Load Frequency controller.
5	Analysis of Automatic Voltage Regulator.
6	Voltage control by FACTS device.
7	Economic Dispatch without Transmission Loss.
8	Economic Dispatch with Transmission Loss.
9	Unit commitment using priority list method.
10	Simulation study of SCADA.

	Contact Hours	**:**	**30**
	Total Contact Hours	**:**	**75**

Course Outcomes: At the end of the course, the student will be able to

- realize the overview of power system operation and control.
- analyze load frequency control of single area system and two area power systems.
- analyze the automatic voltage regulator and other reactive power - voltage control methods.
- evaluate the optimal unit commitment schedule and optimal economic dispatch.
- comprehend the various computer controls of power systems using simulation

Text Book (s):

1	Olle.I.Elgerd, "Electric Energy Systems theory - An introduction", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2	Allen. J. Wood and Bruce F. Wollenberg, "Power Generation, Operation and Control", John Wiley& Sons, Inc., Third Edition, 2013.
3	Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3

CO 2	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3
CO 3	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3
CO 4	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3
CO 5	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3
Average	3	3	3	3	2	2	2	-	-	-	1	3	3	3	3

Subject Code	Subject Name	Category	L	T	P	C
EE19P7X	**PROFESSIONAL ELECTIVE-II**	**PE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19P7X	**PROFESSIONAL ELECTIVE-III**	**PE**	**3**	**0**	**0**	**3**

Subject Code	Subject Name	Category	L	T	P	C
EE19711	**PROJECT/PHASE-I**	**EEC**	**0**	**0**	**8**	**4**

Course Objectives:

- To develop their own innovative prototype.
- To train the students in preparing comprehensive project report

The students in a group of 3 to 4 works on a topic approved by the head of the department and prepares a comprehensive project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report has to be submitted at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Total Contact Hours	**:**	**120**

Course Outcomes:

●	On Completion of the Phase-I project work, the students will be in a position to take up their final year Phase-II project work and find the solution by formulating the proper methodology.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

SEMESTER-VIII

Subject Code	Subject Name	Category	L	T	P	C
EE19P8X	PROFESSIONAL ELECTIVE-IV	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
EE19P8X	PROFESSIONAL ELECTIVE-V	PE	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
EE19811	PROJECT WORK / PHASE-II	EEC	0	0	12	6

Objectives:

- To develop the ability to solve a specific problem right from the identification from the extensive literature review till the successful solution of the same.
- To train the students in preparing the project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report has to be submitted at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Total Contact Hours	**:**	**180**

Course Outcomes:

- On Completion of the project work students will be in a position to take up any challenging practical problems and find the solution by formulating the proper methodology.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

PROFESSIONAL ELECTIVES FOR SEMESTER VI

PROFESSIONAL ELECTIVE-I

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P61	SPECIAL ELECTRICAL MACHINES	PE	3	0	0	3

Objectives:

- To impart knowledge on the construction, principle of operation, control and performance of stepping motors.
- To learn the construction, principle of operation, control and characteristics of switched reluctance motor.
- To provide knowledge on the construction, principle of operation, controller and performance of permanent magnet brushless dc motor

●	To introduce the construction, principle of operation, control and performance of permanent magnet synchronous motor.
●	To impart knowledge on the construction, principle of operation and performance of synchronous reluctance motors.

UNIT-I	**STEPPER MOTORS**	9
Constructional features – Principle of operation – Variable reluctance motor – Permanent magnet stepper motor- Hybrid motor – Single and multi-stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Applications-Traffic control and Robots		
UNIT-II	**SWITCHED RELUCTANCE MOTORS (SRM)**	9
Constructional features – Principle of operation – Torque production - Characteristics -Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation –Applications- Bullet train, Ropeless lift, Race car, S R Generators for wind power		
UNIT-III	**PERMANENT MAGNET BRUSHLESS D.C. MOTORS**	9
Permanent Magnet materials -Principle of operation – Types —Electronic Commutation- Magnetic circuit analysis – EMF and torque equations -Characteristics - Power controller- Applications.- PMBLDC fans, E-Bikes, PMBLDC air-conditioners		
UNIT-IV	**PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)**	9
Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements– Applications.- Lifts, Compressors, Blowers, Ship propulsion, E-vehicles		
UNIT-V	**SYNCHRONOUS RELUCTANCE MOTORS**	9
Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics – Applications-textile mills , coal conveyor and Motor Pump sets		
	Total Contact Hours : 45	

Course Outcomes:

●	analyse the modes of excitation and control of stepping motor.
●	Understand the construction, control and performance of Switched Reluctance Motor
●	Know the construction, control, analyse the performance and the magnetic circuit of PMBLDC motor.
●	Understand the construction, control and performance of Permanent magnet Synchronous Motor
●	Comprehend the construction, control and characteristics of Synchronous Reluctance Motor.

Text Book(s):

1	K.Venkataratnam, "Special Electrical Machines", Universities Press (India) Private Limited, 2008.
2	T.J.E. Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
3	T. Kenjo, "Stepping Motors and Their Microprocessor Controls", Clarendon Press London, 1984.

Reference Books(s) / Web links:

1	E G Janardanan, "Special Electrical Machines", Prentice Hall India Limited, 2013.
2	R.Krishnan, "Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application", RC Press, New York, 2001
3	P.Perengrinus London, 1982. . Aearnley, "Stepping Motors – A Guide to Motor Theory and Practice", Peter.
4	https://www.mouser.in/applications/motor-control-stepper
5	http://www.ohioelectricmotors.com/2015/07/brushless-dc-motors-used-in-industrial-applications

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	2	1	-	-	-	2	2	2	2	-
CO 2	3	3	3	-	-	2	1	-	-	-	3	2	2	2	-
CO 3	3	3	3	-	-	2	1	-	-	-	3	2	2	2	-
CO 4	3	3	3	-	-	2	1	-	-	-	3	2	2	2	-
CO 5	3	3	3	-	-	2	1	-	-	-	3	2	2	2	-

Average	**3**	**3**	**2.8**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**2.8**	**2**	**2**	**2**	**-**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P62	**ADVANCED CONTROL SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To provide adequate knowledge on modelling and representing systems in state variable form.
- To teach the basic knowledge in obtaining the solution of state equations.
- To inculcate the role of controllability and observability
- To familiarise the modal concepts and design of state and output feedback controllers and estimators.
- To impart knowledge on the phase plane analysis.

UNIT-I	**STATE VARIABLE REPRESENTATION**	9

Introduction-Concept of State variable –state assignment-State equation for Dynamic Systems – electrical , mechanical and electromechanical system-state diagram- Time invariance and linearity- Non uniqueness of state model.

UNIT-II	**SOLUTION OF STATE EQUATIONS**	9

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes- Role of Eigen values and Eigenvectors.

UNIT-III	**CONTROLLABILITY AND OBSERVABILITY**	9

Controllability and Observability- Stabilizability and Detectability-Gilbert's and Kalman's Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT-IV	**MODAL CONTROL**	9

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

UNIT-V	**PHASE PLANE ANALYSIS**	9

Features of linear and non-linear systems -Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method

Total Contact Hours	**:**	**45**

Course Outcomes: At the end of the course the student will be able to

- determine the state space representation of various control system.
- analyse the nonlinear and linear time varying system using state equations
- estimate the controllability and observability of the system.
- determine the state feedback for both SISO and MIMO systems
- analyse the linear and non-linear systems using phase plane analysis

Text Book(s):

1 K. Ogatta, "Modern Control Engineering", PHI, 5th edition 2015.

2 M. Gopal, "Modern Control System Theory", New Age International, 3rd edition , 2014

3 Bernard Friedland, "Advanced Control Systems Design", Pearson Education India; First edition, 2015

4 Richard C Dorf, Robert H bishop ,"Modern Control System" ,Pearson Education India; 12th edition, 2013

Reference Book(s):

1 I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2003.

2 Gene F. Franklin, J. David Powell and Abbasemami-Naeini, "Feedback Control of Dynamic Systems", Fourth edition, Pearson Education, 2002.

3 Ashish Tewari, 'Modern control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.

4 B.N Sarkar,"Advanced Control Systems", PHI Learning Private Limited; 1st edition, 2013

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO 2	3	3	3	3	3	3	2	1	1	1	2	3	3	3	3

CO 3	3	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO 4	3	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO 5	3	3	3	3	3	3	2	1	1	1	2	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**3**	**3**	**3**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P63	**FUNDAMENTALS OF COMMUNICATION ENGINEERING**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To expose the students the fundamentals of analog communication and their significance.
- To provide knowledge about Digital Communication methods for high bit rate transmission.
- To enlighten importance of source and line coding techniques for enhancing transmission.
- To introduce MAC used in communication systems for enhancing the number of users.
- To interpolate knowledge on various media for digital communication.

UNIT-I **ANALOG COMMUNICATION** **9**

amplitude modulation and demodulation, angle modulation and demodulation, AM – Frequency spectrum, vector representation – power relations, generation of AM – DSB, DSB/SC, generation of AM – SSB, VSB, AM Transmitter & Receiver, superheterodyne receivers.

UNIT-II **DIGITAL COMMUNICATION** **9**

Pulse modulations, concepts of sampling and sampling theorems, slope overloaded error, PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, applications of Data communication.

UNIT-III **SOURCE CODES, LINE CODES & ERROR CONTROL (Qualitative only)** **9**

Error free communication over a noisy channel, Hamming sphere, hamming distance and hamming bound, relation between minimum distance and error detecting and correcting capability, linear block codes, encoding & syndrome decoding ; cyclic codes, encoders and decoders for systematic cycle codes ; convolution codes, code tree & Trellis diagram, Viterbi and sequential decoding, burst error correction, comparison of performance.

UNIT-IV **MULTIPLE ACCESS TECHNIQUES** **9**

SS techniques. FDMA, TDMA, DAMA and CDMA, Random Access. DBS: Introduction to analog DBS & Digital DBS. Application of MA techniques in wired and wireless communication.

UNIT-V **SATELLITE COMMUNICATION AND RADAR** **9**

Location of Satellite in Orbit, Orbital Elements, Look Angle Determination, Elevation and Azimuthal Calculation, Orbital Perturbations, Geostationary Orbit. Satellite System: Review of the System, Broadcast System-Review. Wireless LAN Protocol, System Architecture. Bluetooth Technology- Introduction to wireless networks, 2G, 3G wireless systems, wireless standards. Basic Principles, Radar equation, Radar Performance Factors, Basic Pulsed Radar System, Radar Antenna and Scanning, Moving Target Indication, Overview o INSAT system & Intelsat system.

Total Contact Hours : 45

Course Outcomes:

- Students will be able to understand the Significance of analog communication.
- Students will be able to gain knowledge on Digital Communication methods.
- Students will be able to highlight the importance of line coding techniques.
- Students will be able to elucidate the concept of MAC.
- Students will be able to compare the various media for digital communication.

Text Book (s):

1. Proakis, John, and MasoudSalehi. *Communication Systems Engineering*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2001. ISBN: 9780130617934.
2. Haykin, Simon. *Communication Systems*. 5th ed. New York, NY: Wiley, 2009. ISBN: 9780470169964.
3. Tanenbaum, Andrew. *Computer Networks*. 4th ed. Upper Saddle River, NJ: Prentice Hall, 2002. ISBN: 9780130661029.

Reference Books(s) / Web links:	
1	Taub & Schiling "Principles of Communication Systems" Tata McGraw Hill 2007.
2	J.Das "Principles of Digital Communication" New Age International, 1986.
3	Satellite Communications / Pratt, Bostian, Allnutt / John Wiley & Sons
4	https://nptel.ac.in/courses/117102059/

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	2	2	2	2	2	2	2	3	3	1	3
CO 2	3	3	2	3	3	3	2	2	2	2	2	3	3	1	3
CO 3	3	3	2	3	3	2	2	2	2	2	2	3	3	1	3
CO 4	3	2	2	2	3	3	3	2	2	2	2	3	2	1	3
CO 5	2	2	2	2	3	3	3	2	2	2	2	3	2	1	3
Average	2.8	2.6	2.2	2.6	2.8	2.6	2.4	2	2	2	2	3	2.6	1	3

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P64	PLC & SCADA	PE	3	0	0	3

Objectives:

- To impart knowledge on the operation of PLC interfaced sensors and signal communication.
- To familiarize on the architecture, operation and programming of Programmable Logic Controllers.
- To provide knowledge on the basic features, different blocks used and its applications.
- To teach the functioning of SCADA also to make the students to interface PLC with SCADA.
- To introduce the students with various applications of PLC SCADA interfaced systems.

UNIT-I **INTRODUCTION TO INDUSTRIAL AUTOMATION** 9

Pulse measurement – Measurements and sensors – Interfacing Hardware Circuit –Interfacing DAC/ADC– Serial Data Communication.

UNIT-II **PROGRAMMABLE LOGIC CONTROLLERS** 9

Introduction — Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. PLC programming Simple instructions – Manually operated switches – Mechanically operated a Proximity switches - Latching relays.

UNIT-III **APPLICATIONS OF PROGRAMMABLE LOGIC CONTROLLERS.** 9

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine.

UNIT-IV **SCADA & SCADA PLC INTERFACING** 9

Introduction of SCADA- Buttons, sliders, pipe connections, civil & mechanical parts - Animation configuration - Text and text control - Graphs, bar charts - SCADA Softwares- PLC SCADA interfacing.

UNIT-V **CASE STUDIES** 9

Sensor interfacing with PLC SCADA - Relay Control – DC motor start stop with timer - Control panel – Basics of Voltage Frequency control – Artificial Intelligence in PLC.

Total Contact Hours : 45

Course Outcomes:

At the end of the course the student will be able to:

- Realise the function of different sensors and its output
- Realize the architecture of different PLCs and the type of modules
- Apply different blocks while programming

●	Comprehend different features available with SCADA for monitoring and controlling purpose
●	Analyse the applications of PLC & SCADA interface systems
Text Book (s):	
1	Gary Dunning, "Introduction to Programmable Logic Controllers" Thomson Learning, 2001.
2	John Webb, Programmable Logic Controllers: Principles and Applications,5th edition Prentice Hall of India, 2012
3	Katariya Sanjay B , "Industrial Automation Solutions For Plc, Scada, Drive And Field Instruments: Easy To Learn Industrial Automation" Notion Press; 1st Edition, 2020
Reference Books(s) / Web links:	
1	Bolton, "Programmable Logic Controllers" 5 th Edition Newnes,2009
2	Parr, "Programmable Controllers: An Engineers Guide", 3rd Edition, Elsevier, Indian Reprint, 2013
3	Petruzella , "Programmable Logic Circuits" 4th Edition, TATA Mcgraw hill, 2016
4	https://literature.rockwellautomation.com/idc/groups/literature/documents/um/ag-um008_-en-p.pdf
5	Programmable Logic Controller (Plc) Tutorial, Siemens Simatic S7-1200 by Stephen Philip Tubbs

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	3	1		2	1			1	3	2	3
CO 2	2	2	3	2	1	2		1	1			1	3	1	3
CO 3	3	3	3	2	3	1		2	1			1	2	2	3
CO 4	3	2	3	3	3	1		1	1			1	2	1	3
CO 5	3	3	3	3	2	1		1	1			2	3	2	2
Average	**2.8**	**2.6**	**2.8**	**2.6**	**2.4**	**1.2**		**1.4**	**1**			**1.2**	**2.6**	**1.6**	**2.8**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ME19P79	**OPERATIONS RESEARCH**	**PE**	**3**	**0**	**0**	**3**

Objectives:

●	To create awareness about optimization techniques in utilization of resources and to formulate the linear programming model for industrial applications based on the constraints and availability of the resources.
●	To provide knowledge and training in Transportation and other production models and to obtain the optimal solution to maximize the profit.
●	To provide knowledge about the Network models and to furnish the solution for the failure of item.
●	To understand the deterministic and stochastic inventory models and to plan, manage the stocks to meet the customer demands.
●	To understand the Queuing models, queue discipline and to explore the ways to give better customer service.

UNIT-I	**LINEAR PROGRAMMING MODELS**	**9**

Introduction to Operations Research - Scope, objectives, phases, models and limitations. Linear programming – formulation of LPP - Graphical method – Simplex algorithm – Artificial variables – Big M method – Two phase method – Duality formulation.

UNIT-II	**TRANSPORTATION MODELS**	**9**

Transportation Models - Finding basic feasible solution – LCM , NWC and VAM methods – Optimal solution using MODI method – Unbalanced model and Degeneracy. Assignment Models – Hungarian method for optimal solution - Unbalanced problem - Traveling Salesman problem.Sequencing Models - Processing n Jobs through 2 Machines, n Jobs through 3 Machines, n Jobs through m Machines using Johnson algorithm.

UNIT-III	**NETWORK AND REPLACEMENT MODELS**	**9**

Networks models: Network logic – Ford - Fulkerson's rule – Shortest route – Project network – CPM and PERT networks – Critical path scheduling – Types of Floats and calculations.Replacement models: Types of failures - Present value factor - Replacement of items that deteriorate with time, Items that fail suddenly - Individual and Group replacement policies.

UNIT-IV	**INVENTORY MODELS**	**9**

Need for Inventory – Types of Inventory – Inventory costs - Economic order quantity – Deterministic Inventory

models – with and without shortages - Quantity discount models – Stochastic inventory models – Multi product models – Inventory control – P and Q systems - Determination of Buffer stock and Reorder level .				
UNIT-V	**QUEUEING MODELS**			**9**
Queueing models - Queueing systems and structures – Notation parameter – Poisson input – Exponential service - Single server and multi-server models — Constant rate service – Infinite population – Simulation – Monte Carlo technique – Inventory and Queuing problems.				
		Total Contact Hours	**:**	**45**

Course Outcomes : At the end of this course, the students will be able to	
●	Formulate a real-world mathematical linear programming model, select the constraints based on the availability of the resources and determine the optimal solution.
●	Build and solve specialized Transportation, Assignment and Sequencing problems with optimum results.
●	Investigate the nature of the project / failure and give suggestions towards decision making.
●	Know about the maintenance of inventory level, Plan the manufacturing policies and manage the stocks according to the customer demands.
●	Model a dynamic system as a queuing model and compute important performance measures for better customer service.
Text Books:	
1	Hamdy A Taha, "Operations Research: An Introduction", 10th edition, PHI/Pearson education, 2017.
2	Wayne L. Winston, Jeffrey B. Goldberg, "Operations Research Applications and Algorithms", Thomson Brooks/Cole, 2004.
Reference Books(s) / Web links:	
1	Premkumar Gupta and D.S.Hira, "Problems in Operations Research", S.Chand, 2009.
2	Sharma J K, "Operations Research: Theory and Applications", 5th edition, Macmillan India, 2013.
3	Pannerselvam R, "Operations Research", 2nd edition, PHI, 2009.
4	Srinivasan G, "Operations Research: Principles and Applications", 3rd edition EEE PHI, 2017.
5.	Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO 2	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO 3	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO 4	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
CO 5	3	2	2	2	2	-	-	-	-	-	-	2	-	-	2
Average	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

PROFESSIONAL ELECTIVES FOR SEMESTER VII

PROFESSIONAL ELECTIVE- II

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19P70	**COMPREHENSION IN ELECTRICAL AND ELECTRONICS ENGINEERING**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To comprehend the knowledge acquired in the courses on Electric Circuits and Electromagnetic Fields, through periodic exercises.
●	To consolidate the various circuit configurations in Analog and Digital Electronics .
●	Tocomprehend the various types of Electrical Machinescommonly usedin drives.
●	To understand the working of the various components in power systems

●	To perceive the applications of Power Electronic circuits andvarious Control Systemconcepts.	
UNIT-I	**ELECTRICAL CIRCUITS AND FIELDS**	**9**
KCL, KVL, Nodal & Mesh analysis - Sinusoidal steady state analysis - Resonance in electrical circuits - Network theorems: Thevenin's, Norton's, Superposition and Maximum power transfer theorems - Balanced three phase circuits - Gauss theorem- Electric field intensity and potential due to point, line, plane and spherical charge distribution - dielectric, capacitance calculations for simple configurations - Ampere's and Biot-Savart's law- Inductance calculations for simple configurations.		
UNIT-II	**ANALOG AND DIGITAL ELECTRONICS**	**9**
Oscillators and Feedback Amplifiers, Operational Amplifiers characteristics and Applications – Inverting - Non Inverting – Summer - Differential amplifier and Instrumentation Amplifier -Schmitt trigger - Multivibrators - Number systems - Combinational logic circuits - Minimization of Boolean functions - Arithmetic circuits, Multiplexer & Decoders - Sequential circuits - Flip flops, Counters, Shift Registers, Architecture of 8051 Microcontroller – Architecture of TMS320C5X Digital Signal Processor.		
UNIT-III	**ELECTRICAL MACHINES**	
Single phase transformer - Equivalent circuit, phasor diagram, tests, regulation and efficiency - Three phase transformer connections- Auto transformer - Synchronous generators- Non-Salient and Salient pole types- expressions for power developed - Synchronous motors - Starting methods and applications - Starting and speed control of three phase and single-phase induction motors - Fractional horse power motors - Stepper motors, Reluctance motors and BLDC motors.		
UNIT-IV	**POWER SYSTEMS**	**9**
Power system network; Transmission line parameters and its performance - Distribution system; insulators; cables; corona; sag; neutral grounding types - FACTS devices; HVDC types; per-unit quantities; bus admittance and impedance matrices - Load flow studies; symmetrical components, analysis of symmetrical and unsymmetrical faults - Principle of power system stability - swing curves and equal area criterion.		
UNIT-V	**POWER ELECTRONICS AND CONTROL SYSTEMS**	**9**
Fully controlled Phase controlled rectifiers - Principles of Choppers and Voltage source Inverters – AC voltage controllers - Matrix converters - Basic concepts of adjustable speed DC and AC drives - Transfer function; Block diagram, Signal flow graphs – Steady state error; Static and Generalized error coefficients - Step response of underdamped Second order system - Root locus - Stability - Routh and Nyquist criteria - Bode plots –Effect of PI and PID Controllers.		
	Total Contact Hours : 45	

Course Outcomes:

On completion of course students will be able to

●	applythe knowledge acquired in analyzing Electric Circuits and Electromagnetic Fields.
●	designsuitable Analog and Digital Electronic circuits as needed for specific applications.
●	select appropriate Electrical Machines for any particular industrial requirement.
●	plan and evaluate the performance of cite specific configuration of Power Systems and components.
●	identify the best converter and controller configuration for any given application.

Text Books:

1	William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 8th edition, New Delhi, 2013.
2	M. Morris R. Mano Michael D. Ciletti, "Digital Design with an introduction to VHDL", Pearson Education, 2013.
3	D.P. Kothari and I.J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 4th edition, 2010.
4	Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.
5	Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.

Reference Books / Web links:

1	Joseph. A.Edminister, "Schaum's Outline of Electromagnetics", Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010.
2	D. Roy Choudhary, Sheilb.Jani, "Linear Integrated Circuits", fifth edition, New Age, 2018.
3	B. L. Theraja and AK Theraja, "A Text book of Electrical Technology", Volume 2, S. Chand Publications, 2015.

4	John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2010.
5	M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, PHI 4th Edition, New Delhi, 2017.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	2	2	2	3	3	3	3	3	-	3
CO 2	3	3	3	3	3	2	2	2	3	3	3	3	3	-	3
CO 3	3	3	3	3	3	2	2	2	3	3	3	3	3	-	3
CO 4	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	2	2	2	3	3	3	3	3	-	3
Average	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P71	**RESTRUCTURED POWER SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To introduce the restructuring of power industry and market models.
- To impart knowledge on fundamental concepts of congestion management.
- To analyse the concepts of T and financial transmission rights.
- To Illustrate about various power sectors in India.
- To analyse the recent trends in Indian power sector.

UNIT-I **INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY** 9

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis – a – vis other commodities, Market architecture, Case study.

UNIT-II **TRANSMISSION CONGESTION MANAGEMENT** 9

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

UNIT-III **LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS** 9

Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality - Simultaneous feasibility test and revenue adequency – FTR issuance process: FTR auction, FTR allocation – Treatment of revenue shortfall – Secondary trading of FTRs – Flow gate rights – FTR and market power - FTR and merchant transmission investment.

UNIT-IV **ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK** 9

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - How to obtain ancillary service –Co-optimization of energy and reserve services - International comparison - Transmission pricing – Principles – Classification – Rolled in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.

UNIT-V **REFORMS IN INDIAN POWER SECTOR** 9

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

Total Contact Hours : 45

Course Outcomes:

On completion of the course, the students will be able to

●	know restructuring of power industry and market models.
●	Understand fundamental concepts of congestion management.
●	evaluate locational marginal pricing.
●	realize various power sectors in India
●	learn the recent trends in Indian power sector.
Text Book(s):	
1	Sally Hunt, "Making competition work in electricity", John Willey and Sons Inc. 2002
2	Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.
Reference Books(s) / Web links:	
1	Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001
2	Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
3	https://nptel.ac.in/courses/108/101/108101005/
4	http://www.inderscience.com/info/ingeneral/cfp.php?id=948
5	file:///C:/Users/Guest/Downloads/9781852336707-c1.pdf

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	1	3	3		3	3	3	3	3	2	3	2	3	
CO 2	3	3	2	2	2	2	3	3	3	3	3	3	3	3	1
CO 3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2
CO 4	3	1	1	3	1	3	3	3	3	3	3	3	2	3	1
CO 5	3			3		3	3	3	3	3		3	1	3	
Average	**3**	**2**	**2.25**	**2.8**	**1.67**	**2.6**	**3**	**3**	**3**	**3**	**2.75**	**3**	**2.2**	**3**	**1.33**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P72	**FUNDAMENTALS OF EMBEDDED SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To introduce the building blocks of embedded system.
- To educate in various embedded development Strategies.
- To Introduce Bus Communication in processors, Input/output interfacing.
- To impart knowledge in various processor scheduling algorithms.
- To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool

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

Introduction to Embedded Systems – CyberPhysical Systems– The build process for embedded systems- Structural units in Embedded processor , selection of processor & memory devices- DMA –,Memory architectures- Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, Simulator, Emulator, Debugger, In circuit emulator, Target Hardware Debug

UNIT-II EMBEDDED NETWORKING **9**

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols - RS232 standard – RS422 – RS485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers

UNIT-III EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT **9**

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Embedded Firmware Design approaches, Data Flow Graph, State machine model, Extended state machines, Sequential Program Model, Concurrent Model, Object oriented Model, Unified Modelling language.

UNIT-IV RTOS BASED EMBEDDED SYSTEM DESIGN **9**

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Task models, Preemptive and non-preemptive scheduling, Task communication shared memory,

message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: VxWorks, ЧC/OS-II, RT Linux				
UNIT-V	**EMBEDDED SYSTEM APPLICATION DEVELOPMENT**			**9**
IDE, Case Study of Washing Machine- Automotive Application- Smart card System Application				
		Total Contact Hours	**:**	**45**

Course Outcomes:	
●	describe the building blocks of embedded system.
●	explain various embedded development strategies. Describe
●	Illustrate bus communication in processors, input/output interfacing.
●	discuss various processor scheduling algorithms
●	elucidate basics of real time operating system and example tutorials to discuss on one real time operating system.
Text Book (s):	
1	Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill,2009
2	Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006.
3	Lee and Seshia, "Introduction to Embedded Systems— A Cyber-Physical Systems Approach MIT Press , Second Edition, 2017
3	Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson, 2013
4	Peckol, "Embedded System Design", John Wiley & Sons, 2010
Reference Books(s) / Web links:	
1	.Jean Labrosse, "Embedded Systems Building Blocks: Complete and Ready-to-Use Modules in C", CRC Press, CRC Press; 2nd edition, 1999
2	Rajkamal, "Embedded System-Architecture, Programming, Design", McGraw Hill, 2013
3	Elicia White, "Making Embedded Systems", O' Reilly Series,SPD,2011.
4	Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning, 2009.
5	Rajib Mall, "Real-Time systems Theory and Practice" Pearson Education, 2007
6	https://www.youtube.com/watch?v=GfPcz1y0JoE

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	1													
CO 2	1														
CO 3			2												
CO 4			2												
CO 5			3				2					1	1		1
AVERAGE	**1**	**1**	**2.33**				**2**					**1**	**1**		**1**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P73	**HIGH VOLTAGE ENGINEERING**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To learn the various types of over voltages in power system and protection methods.
●	To provide knowledge on the nature of breakdown mechanism in solid, liquid and gaseous dielectrics.
●	To provide knowledge on generation of high voltages in laboratories.
●	To get knowledge on the measurement of high voltages.
●	To impart knowledge on testing of power apparatus and insulation coordination.

UNIT-I	**OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS**	9
Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – Reflection and Refraction of Travelling waves - Characteristics of Switching Surges - Protection against over voltages.		
UNIT-II	**DIELECTRIC BREAKDOWN**	9
Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and		

breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics statistical approach of breakdown.		
UNIT-III	**GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS**	9
Generation of High DC, AC, impulse voltages and currents- voltage multipliers, electrostatic machines – Van de Graff generator. Generation of High Impulse Voltages: Single stage and multistage Marx circuits - Generation of High AC Voltages: - cascade transformers, resonant transformers and tesla coil – generation of impulse currents - Triggering and control of impulse generators-generation of switching surge voltage.		
UNIT-IV	**MEASUREMENTS 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 - Hall effect generators - Digital techniques in high voltage measurement.		
UNIT-V	**HIGH VOLTAGE TESTING AND INSULATION COORDINATION**	9
High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers - Radio interference measurement-design, planning and layout of high voltage laboratory		
	Total Contact Hours : 45	

Course Outcomes:

At the end of the course the student will be able to:

- Analyse the types of transients in power systems
- Comprehend the occurrence of breakdown mechanism in different types of dielectrics
- Understand the method of generating high voltages in laboratories
- Know the methods of measuring high voltages
- Understand the methods of testing electrical apparatus and learn the layout of high voltage laboratory

Text Book (s):

1	S.Naidu and V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, Fifth Edition, 2013.
2	E. Kuffel and W.S. Zaengl, J.Kuffel, "High voltage Engineering fundamentals", Newnes Second Edition Elsevier, New Delhi, 2005.
3	Subir Ray, "An Introduction to High Voltage Engineering", PHI Learning Private Limited, New Delhi, Second Edition, 2013.
4	David A, Lloyd "Electrostatic Precipitator Handbook", Institute of Physics Publishing.

Reference Books(s) / Web links:

1	L.L. Alston, "High Voltage Technology", Oxford University Press, First Indian Edition, 2011.
2	C.L. Wadhwa, "High voltage engineering", New Age International Publishers, Third Edition, 2010.
3	Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, "High Voltage Engineering – Theory & Practice", Second Edition Marcel Dekker, Inc., 2010.
4	H.M. Ryan, "High Voltage Engineering and Testing", second edition, 2001, IEEE Power and Energy Series 32.
5	Rakosh Das Begamudre, "High Voltage Engineering, Problems and Solutions", New Age International Publishers, New Delhi, 2010.
6	Dieter Kind, Kurt Feser, "High Voltage Test Techniques", Reed educational and professional publishing ltd. (Indian edition), New Delhi-2001
7	Open source Tools- Virtual high voltage lab - http://vlabs.iitkgp.ernet.in/vhv/

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	1		2	1	2	2					1	3	3	1
CO 2	3	3		3	2	3	2					1	3	3	1
CO 3	3	3		3	2	3	2					1	3	3	1
CO 4	3	3		3	2	3	2					1	3	3	1
CO 5	3	3		3	2	3	2					1	3	3	1
Average	**3**	**2.6**		**2.8**	**1.8**	**2.8**	**2**					**1**	**3**	**3**	**1**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P74	DIGITAL CONTROL SYSTEMS	PE	3	0	0	3

Objectives:

- To study the importance of sample data control system.
- To impart adequate knowledge about signal processing in digital control.
- To study the importance of modeling of discrete systems and stability analysis of discrete data system.
- To study the importance of state space representation for discrete data system.
- To provide knowledge on the design concept for digital controllers.

UNIT-I	**COMPUTER CONTROLLED SYSTEM**	9

Configuration of the basic digital control system – general sampled data system variables – signal classifications – Significance of digital control system –Advantages – disadvantages – examples of discrete data and digital control systems..

UNIT-II	**SIGNAL PROCESSING IN DIGITAL CONTROL**	9

Sampling process – Frequency domain analysis –ideal samples– Shanon's sampling theorem –generation and solution of process –linear difference equations –Data reconstruction process –Frequency domain characteristics.

UNIT-III	**DISCRETE SYSTEM MODELLING**	9

Determination of the Z transform – Mapping between s and Z domains-Z transform of system equations –Open loop Hybrid sampled Data Control Systems –Open loop discrete Input Data Control System –Closed loop sampled data control system –modified Z transform method – Response between sampling instants –Stability on the Z-plane and Jury's stability test –Steady state error analysis for stable systems

UNIT-IV	**STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS**	9

State descriptions of digital process –Conversion of state variable models to transfer function – Conversion of transfer functions to canonical state variable models – Companion forms –Jordon Canonical form – State description of sampled continuous time plants –Solution of state difference equations –State transition matrix –Caley Hamilton Technique –Concepts of controllability and observability - Loss of controllability and observability due to sampling.

UNIT-V	**DESIGN OF DIGITAL CONTROL**	9

Digital PI, PD and PID Controller – Position and velocity forms –State regulator design – Design of state observers – Dead beat controller design by state feedback and Design of Dead beat observers.

Total Contact Hours	**:**	**45**

Course Outcomes:

At the end of the course the student will be able to:

- Acquire the concept of digital control system
- Acquire the concept of sampling and data reconstruction processes.
- Acquire detail knowledge on Z-Transforms.
- Obtain the different types of companion forms and to analyze controllability and observability of a discrete system.
- Acquire detail knowledge on design of PID controllers, state regulator, state observer Dead beat controller and Dead beat observers.

Text Book (s):

1. M.Gopal, 'Digital Control and State Variables Methods', Tata McGraw HILL, 2ndEdition, 2003.
2. B.C. Kuo, "Digital control systems", Second Edition, Oxford University press, 1992.
3. Katsuhiko Ogata, "Discrete-Time Control Systems", PHI, 1995.
4. Franklin, Powell, and Workman,"Digital Control of Dynamic Systems", Addison –Wesley,1998.

Reference Books(s) / Web links:

1. P.B. Deshpande and R.H. Ash, 'Computer Process Control', ISA Publication, USA, 1995.
2. Ioan D. Landau and Gianluca Zito Digital Control Systems: Design, Identification and Implementation Springer-Verlag , 2006.
3. C.M. Houpis, G.B. Lamount, 'Digital Control Systems-Theory, Hardware, Software', International Student Edition, McGraw Hill Book Co., 1985.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	2	2	3	1	1	1	3	2	3	3	3	1	3
CO 2	3	2	2	2	2	1	1	1	3	2	3	3	3	1	3
CO 3	3	3	3	3	3	1	1	1	3	2	3	3	3	2	3
CO 4	3	3	3	3	3	1	1	1	3	2	3	3	3	2	3
CO 5	3	3	3	3	3	1	1	1	3	2	3	3	3	2	3
Average	**3**	**2.6**	**2.6**	**2.6**	**2.8**	**1**	**1**	**1**	**3**	2	**3**	**3**	**3**	1.6	**3**

PROFESSIONAL ELECTIVE – III

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P75	**POWER SYSTEM TRANSIENTS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To learn the importance of study of transients, different types of power system transients and its effect on power system.
- To familiarize the over voltages due to switching transients by resistance, load and capacitive switching.
- To get knowledge on the over voltages due to lightning transients, protection of power system from lightning.
- To expose the transients using travelling wave equations on transmission line and repeated reflection by bewely's lattice diagram.
- To introduce the transient in integrated power system and transients computation using Electro Magnetic Transients Program (EMTP).

UNIT-I INTRODUCTION 9

Introduction of transients. Source and Causes of transients. Different types of transients. Basic transforms of the RLC circuits, Series and parallel circuit transients. Effect of transients on power systems. Importance of study of transients in system planning.

UNIT-II SWITCHING OVERVOLTAGES 9

Circuit closing transients (RL circuit transient with sine wave excitation), Types of Switching: Resistance switching, Load switching, Capacitance switching**.** Normal and abnormal switching transients. Ferro resonance. Generation of switching surge voltage.

UNIT-III LIGHTNING OVERVOLTAGES 9

Lightning: Physical phenomena of lightning. Interaction between lightning and power system. Factors contributing to good line design, Conventional lightning protection schemes for transmission lines and terminal equipments, Overvoltage protective devices. Insulation co-ordination, High voltage testing of electrical power apparatus as per international and Indian standards.

UNIT-IV COMPUTATION OF TRANSIENTS 9

Travelling wave concept: Bewely's lattice diagram. Reflection, Refraction and behavior of travelling waves at the line terminations. Computation of transients: Transient response of systems with series and shunt lumped parameters and distributed lines (Wave Equation). Introduction to EMTP for transient computation. Principle of digital computation of transients.

UNIT-V TRANSIENTS IN INTEGRATED POWER SYSTEM 9

Causes of power frequency over voltage. Switching surges on integrated power system. Voltage transients on closing and reclosing of lines. Line dropping and load rejection. Short line or kilometric fault. Case Studies: line with short and open end, line terminated with R, L and C.

Total Contact Hours : 45

Course Outcomes:

At the end of the course the student will be able to

- understand the importance of transients, and its effects on power system.
- analyze the over voltages due to switching transients
- know about the over voltages due to lightning transients and protection against it
- evaluate the transients using travelling wave equations and bewely's lattice diagram.

●	realize the transient in integrated power system and their computation using Electro Magnetic Transients Program.
Text Book(s):	
1	Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 2012.
2	Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
3	R. Ramanujam, "Computational Electromagnetic Transients: Modelling, Solution Methods and Simulation", I.K. International Publishing House Pvt. Ltd, New Delhi -110 016, ISBN 978-93-82332-74-9, 2014.
Reference Books(s) / Web links:	
1	Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) Newage International (P) Ltd., New Delhi, 2006.
2	Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
3	IEEE Guide for safety in AC substation grounding IEEE Standard 80-2000.
4	Working Group 33/13-09 (1988), "Very fast transient phenomena associated with Gas Insulated System", CIGRE, 33-13, pp. 1-20.
5	https://ieeexplore.ieee.org/document/7452713

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	2	1	2	0	1	0	1	2	0	3	2	3	2
CO 2	3	3	2	1	2	1	1	0	1	1	1	2	3	2	2
CO 3	3	3	2	1	2	1	1	0	1	1	1	2	3	2	2
CO 4	3	3	2	2	2	1	1	0	1	1	1	3	3	3	2
CO 5	3	3	3	2	2	1	1	0	1	1	1	3	3	2	3
Average	**3**	**2.8**	**2.2**	**1.4**	**2**	**1**	**1**	**0**	**1**	**1.2**	**1**	**2.6**	**2.8**	**2.4**	**2.2**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P76	**POWER QUALITY**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on the power quality problems
- To teach on causes and mitigation of voltages sags and interruptions
- To familiarize overvoltage problems
- To inculcate the sources and effect of harmonics in power systems
- To impart knowledge on various methods of power quality monitoring.

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

Terms and definitions: Overloading - under voltage - over voltage. Concepts of transients – short duration variations such as interruption - long duration variation such as sustained interruption. Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT-II **VOLTAGE SAGS AND INTERRUPTIONS** **9**

Sources of sags and interruptions - estimating voltage sag performance. Thevenin's equivalent source - analysis and calculation of various faulted condition. Voltage sag due to induction motor starting. Estimation of the sag severity - mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches.

UNIT-III **OVERVOLTAGES** **9**

Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners. Lightning protection – shielding – line arresters - protection of transformers and cables. An introduction to computer analysis tools for transients, PSCAD and EMTP.

UNIT-IV **HARMONICS** **9**

Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - harmonic distortion – voltage and current distortion - harmonic indices - inter harmonics – resonance. Harmonic distortion evaluation - devices for controlling harmonic

distortion - passive and active filters. IEEE and IEC standards			
UNIT-V	**POWER QUALITY MONITORING**		**9**
Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer – quality measurement equipment - harmonic / spectrum analyzer - flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring			
	Total Contact Hours	**:**	**45**
Course Outcomes:			
At the end of the course the student will be able to:			
●	Understand the various power quality problems		
●	Know sources and mitigation of voltage sag and interruptions		
●	Realize about overvoltage and its mitigation methods		
●	Evaluate various harmonic effects		
●	Understand and analyze power system operation, stability, control and protection		
Text Book(s):			
1	Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill,2004		
2	Arindam Ghosh and Gerard Ledwich, 'Power Quality Enhancement Using Custom Power Devices' Springer 2002 2nd edition.		
3	C.Sankaran, ' Power Quality' CRC Press, 2002		
4	PSCAD User Manual		
Reference Books(s) / Web links:			
1	G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994)		
2	M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions', (New York: IEEE Press, 1999		
3	G.J.Wakileh, "Power Systems Harmonics – Fundamentals, Analysis and Filter Design," Springer 2007		
4	E.Aeha and M.Madrigal, "Power System Harmonics, Computer Modelling and Analysis, " Wiley India, 2012		
5	R.S.Vedam, M.S.Sarma, "Power Quality – VAR Compensation in Power Systems," CRC Press 2013.		
6	Eswald.F.Fudis and M.A.S.Masoum, "Power Quality in Power System and Electrical Machines," Elseviar Academic Press, 2013		
7	J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', Wiley, 2011		

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	3	3		2		3	2				3	3	3	
CO 2		3	3		2		3	2				3	3	3	
CO 3			3		2		3	2				3	3	3	
CO 4			3		2		3	2				3	3	3	
CO 5	1		3		2		3	2				3	3	3	
Average	**1**	**3**	**3**		**2**		**3**	**2**				**3**	**3**	**3**	

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P77	**APPLICATIONS OF IoT IN ELECTRICAL ENGINEERING**	**PE**	**3**	**0**	**0**	**3**

Objectives:		
●	To introduce the fundamentals of IoT	
●	To learn about various IoT related protocols	
●	To impart knowledge on design methodology	
●	To build simple IoT Systems using Arduino and Raspberry Pi	
●	To develop IoT infrastructure for popular applications	
UNIT-I	**FUNDAMENTALS**	9
Evolution of IoT-IIoT and Industry 4.0-IoT Characteristics-IoT Vs M2M- IoT Levels – Domain Specific IoTs- IoT		

Reference Architecture.		
UNIT-II	**IoT PROTOCOLS**	9
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.		
UNIT-III	**IoT DESIGN AND CHALLENGES**	9
Devices and Gateway – IoT Edge:Sensors and activators, Communication Modules, Zigbee, RFID, Wi-Fi, Power sources – Local and Wide area networking – Everything as a Service (XaaS) – Challenges in IoT.		
UNIT-IV	**HARDWARE IMPLEMENTATION FOR IoT**	9
Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming – IoT Software – NOOBS/ENERGIA/MQTT – Interfaces – Communications Programming.		
UNIT-V	**CASE STUDIES**	9
Smart Grid, Smart Metering , Energy management system – Industrial automation – Smart Agriculture System – Smart Cities.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the student will be able to	
●	Understand the reference architecture and various IoT levels
●	Comprehend the various IoT related protocols
●	Analyse the design methodology and constraints in IoT
●	Design simple applications using Arduino and Raspberry Pi
●	Evaluate applications of IoT in real time scenario
Text Book (s):	
1	Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015
2	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
Reference Books(s) / Web links:	
1	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols‖, Wiley, 2012
2	Jan Holler, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.
4	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN : 978-1-118-47347-4, Wiley Publications

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3			3	3	3	2				3	3	3	3
CO 2	3	3			3	3	3	2				3	3	3	3
CO 3	3	3			3	3	3	2				3	3	3	3
CO 4	3	3	3	3	3	3	3	2				3	3	3	3
CO 5	3	3			3	3	3	2				3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**				**3**	**3**	**3**	**3**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P78	**HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To understand the concept, planning of DC power transmission and comparison with AC Power transmission.
●	To provide knowledge on the analysis of HVDC converters.
●	To study about the HVDC system control.

●	To impart knowledge on harmonics and design of filters.	
●	To learn the model and analysis the DC system under study state.	
UNIT-I	**INTRODUCTION**	
DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in HVDC technology – DC breakers – Operating problems – HVDC transmission based on VSC – Types and applications of MTDC systems.- HVDC links in the world		9
UNIT-II	**ANALYSIS OF HVDC CONVERTERS**	
Line commutated converter – Analysis of Graetz circuit with and without overlap – Pulse number – Choice of converter configuration – Converter bridge characteristics – Analysis of a 12 pulse converters – Analysis of VSC topologies and firing schemes.		9
UNIT-III	**CONVERTER AND HVDC SYSTEM CONTROL**	
Principles of DC link control –Converter control characteristics – System control hierarchy – Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control – Higher level controllers – Control of VSC based HVDC link		9
UNIT-IV	**REACTIVE POWER AND HARMONICS CONTROL**	
Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters		9
UNIT-V	**POWER FLOW ANALYSIS IN AC/DC SYSTEMS**	
Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – Solution of AC/DC power flow-Simultaneous method- Sequential method-–Protection Systems in HVDC Substation-HVDC Simulator		9
	Total Contact Hours : 45	

Course Outcomes:	
●	Realize the concept, planning of DC power transmission and comparison with Power transmission.
●	Formulate and Solve mathematical related to HVDC converters.
●	Develop models and concept of HVDC system control
●	Analyze the harmonics and design of filters.
●	Understand DC system under steady state
Text Book(s):	
1	Padiyar, K. R., "HVDC power transmission system", New Age International (P) Ltd., New Delhi, Second Edition, 2010.
2	Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience, New York, London, Sydney, 1971.
3	Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", NewAge International (P) Ltd., New Delhi, 1990
Reference Books(s) / Web links:	
1	Kundur P., "Power System Stability and Control", McGraw-Hill, 1993.
2	Colin Adamson and Hingorani N G, "High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960
3	Arrillaga, J., "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983
4	S.Rao, "EHV-AC, HVDC Transmission and Distribution Engineering", Khanna Publishers,3rd Edition, 2012
5	S. Kamakshaiah, V. Kamaraju, "HVDC Transmission", Tata McGraw Hill Education Private Limited, 2011

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 2	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 3	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1

CO 4	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
CO 5	3	3	3	2	-	3	1	-	-	-	2	2	3	3	1
Average	**3**	**3**	**3**	**2**	**-**	**3**	**1**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**1**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P79	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**PE**	3	0	0	3

Objectives:

- To learn the reactive power control techniques
- To impart knowledge on static VAR compensators
- To provide knowledge on thyristor controlled series capacitors
- To get knowledge on voltage source converter based FACTS controllers
- To provide knowledge on application of FACTS controllers

UNIT-I **INTRODUCTION** 9

Review of basics of power transmission networks - Reactive power control in AC transmission line - Analysis of uncompensated AC Transmission line - Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer - Need for FACTS controllers - Types of FACTS controllers.

UNIT-II **STATIC VAR COMPENSATOR (SVC)** 9

Overview of different types of SVC - Voltage control by SVC - Characteristics of SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of SVC for power flow and fast transient stability studies.

UNIT-III **THYRISTOR AND GTO CONTROLLED SERIES CAPACITORS (TCSC and GCSC)** 9

Concepts of Controlled Series Compensation – Operation of TCSC – Different modes of operation of TCSC – Operation of GCSC - Analysis of TCSC – Modelling of TCSC and GCSC for load flow studies - Modelling TCSC and GCSC for stability studies.

UNIT-IV **VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS** 9

Static synchronous compensator (STATCOM): Principle of operation and V-I Characteristics of STATCOM - Static synchronous series compensator (SSSC): Operation of SSSC - Power flow control with STATCOM and SSSC – Unified power flow controller (UPFC): Operation of UPFC – Different modes of UPFC – Interline power flow controller (IPFC) – Dynamic voltage restorer (DVR).

UNIT-V **APPLICATION OF FACTS CONTROLLERS** 9

Applications: SVC- Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping. TCSC and GCSC - Improvement of the system stability limit – Enhancement of system damping. STATCOM - Steady state power transfer - Enhancement of transient stability – Case Study: Role of FACTS device in renewable energy integrated power system.

Total Contact Hours : 45

Course Outcomes: At the end of the course the student will be able to

- Realize the reactive power control techniques
- Understand the Static VAR compensators
- Know about the operation, modelling of TCSC and GCSC
- Realize the STATCOM, SSSC, UPFC and IPFC and their modelling
- Understand the application of FACTS controllers.

Text Book (s):

1 R.MohanMathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical TransmissionSystems", IEEE press and John Wiley & Sons, Inc, 2002.

2 Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible ACTransmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2011.

3 K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 2008.

Reference Books(s) / Web links:

1	A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
2	V.K.Sood, "HVDC and FACTS controllers – Applications of Static Converters in Power System", APRIL 2004 , Kluwer Academic Publishers, 2004.
3	Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, "Flexible AC Transmission System: Modelling and Control" Springer, 2012.
4	Emmanuel D. Rogdakis, Irene P. Koronaki, "Recent Advances in Renewable Energy", Bentham Science Publishers.
5	Nishant Kumar, "Superconducting Magnetic Energy Storage (SMES) System", IEEE
6	AminMohammad Saberian, Payam Farzan, "Role of FACTS Devices in Improving Penetration of Renewable Energy", IEEE

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	1	2	3	1	1	1	0	0	1	1	3	3	3	2
CO 2	2	1	2	3	1	1	1	0	0	1	1	2	2	2	2
CO 3	2	1	2	3	1	1	1	0	0	1	1	1	1	1	1
CO 4	2	2	2	2	1	1	1	0	0	1	1	2	2	2	2
CO 5	3	1	2	2	1	1	1	0	0	1	1	2	3	2	2
Average	**2.2**	**1.2**	**2**	**2.6**	**1**	**1**	**1**			**1**	**1**	**2**	**2.2**	**2**	**1.8**

PROFESSIONAL ELECTIVE – IV

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P81	**FIBER OPTICS AND LASER INSTRUMENTATION**	PE	3	0	0	3

Objectives:

- To learn the basic concepts of optical fibers and their properties.
- To impart knowledge on industrial applications of optical fibres.
- To study the fundamentals of laser.
- To provide knowledge on industrial applications of lasers.
- To expose the holography and Medical applications of Lasers.

UNIT-I	**OPTICAL FIBRES AND THEIR PROPERTIES**	9

Principles of light propagation through a fibre – Optical fibre modes, configurations and their properties - fibre materials - fibre fabrication vapour phase oxidization - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Fibre termination- Optical sources – Optical detectors.

UNIT-II	**INDUSTRIAL APPLICATION OF OPTICAL FIBRES**	9

Fibre optic sensors – Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT-III	**LASER FUNDAMENTALS**	9

Fundamental characteristics of lasers –Laser Diode Rate Equation - External Quantum Efficiency- Resonant Frequencies- Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.

UNIT-IV	**INDUSTRIAL APPLICATION OF LASERS**	9

Optical transmitter and Receiver designs - Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material –

Removal and vaporization.		
UNIT-V	**HOLOGRAM AND MEDICAL APPLICATIONS**	9
Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the student will be able to:	
●	classify the optical fibres and their properties.
●	Comprehend the key components of optical system used in industries.
●	Know the fundamentals of lasers.
●	Understand the new concepts of Laser applications in industries.
●	apply the knowledge of LASERs in medical field.
Text Book(s):	
1	John M. Senior, "Optical fiber communication principles and practice", 3rd edition, PHI, 2010.
2	R.P.Khare, "Fiber Optics and Optoelectronics", Oxford university press, 2008.
3	J. Wilson and J.F.B. Hawkes, "Introduction to Opto Electronics", Prentice Hall of India, 2001.
4	Keiser G, "Optical Fibre Communication", McGraw Hill, 1995.
Reference Books(s) / Web links:	
1	Asu Ram Jha, "Fiber Optic Technology Applications to commercial, Industrial, Military and Space Optical systems", PHI learning Private limited, 2009.
2	M. Arumugam, "Optical Fibre Communication and Sensors", Anuradha Agencies, 2002.
3	John F. Ready, Industrial Applications of Lasers, Academic Press, December 2012.
4	Monte Ross, "Laser Applications", McGraw Hill, 1968.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	1	1	1	1	1	1	1	1	1	1	3	1	1	2
CO 2	3	1	1	1	1	1	1	1	1	1	1	3	1	1	1
CO 3	3	1	3	1	1	1	1	1	1	1	1	3	1	1	2
CO 4	3	1	3	1	1	1	1	1	1	1	1	3	1	1	2
CO 5	3	3	3	1	3	1	2	1	1	1	1	3	1	1	2
Average	**3**	**1.4**	**2.2**	**1**	**1.4**	**1**	**1.2**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**1.8**

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19P82	**MICRO ELECTRO MECHANICAL SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:	
●	To impart knowledge on MEMS fabrication technology.
●	To expose students to Electrostatic and Thermal sensing and actuation by case studies.
●	To teach concepts of Piezoresistive sensing and Magnetic actuation by case studies.
●	To introduce the design and application of micro robotics.
●	To familiarize the use of the MEMS sensors and actuators in real time applications.

UNIT-I	**INTRODUCTION TO MEMS**	**9**
Overview, history and industry perspective, Microfabrication Technology-Crystal planes and Orientation, wet and dry etching, Lithographic process, Bulk, Surface Micromachining, LIGA process.		
UNIT-II	**ELECTROSTATIC AND THERMAL SENSORS AND ACTUATORS**	**9**
Electrostatic sensors-Parallel plate capacitor– Interdigitated Finger capacitor –Comb drive devices –Case Study, Thermal Sensing and Actuation-Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Case Study.		

UNIT-III	PIEZO RESISTIVE AND MAGNETIC SENSORS AND ACTUATORS	9
Piezoresistive sensors-Stress analysis of mechanical elements – Application, Magnetic Actuators-Micromagnetic components – Case Study, Shape Memory Alloys.		
UNIT-IV	**MICRO ROBOTICS**	**9**
Introduction-Micro Robotic System Overview, Micro Grippers – Micro Motors, Biomolecular Motors, Micro conveyers, Arrayed Actuator Principles for Micro robotic Applications Walking MEMS Micro robots, Micro robot powering, Case Study- Micro assembly.		
UNIT-V	**REAL TIME APPLICATION OF MEMS PRODUCTS**	**9**
Blood Pressure Sensor-Nova Sensor, Microphone-Knowels Microphone, Acceleration Sensors-MEMSIC, Gyroscope-Invensense Gyro		
	Total Contact Hours : 45	

Course Outcomes: Students will be able to

- Understand the MEMS Fabrication Process.
- Analyse the working and design of electrostatic and thermal sensing and actuation.
- Evaluate the fabrication and working of Piezoresistive sensors and magnetic actuators.
- Realize the design and role of micro robots in industrial applications.
- Apply the concepts of MEMS sensors and actuators in real time applications.

Text Book (s):

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012
2. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
3. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2001.

Reference Books(s) / Web links:

1. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002
2. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
3. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.
4. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	1	1	1	3	1	1	1	1	1	1	3	1	1	3
CO 2	3	3	3	1	3	1	1	1	1	1	1	3	1	1	3
CO 3	3	3	3	1	3	1	1	1	1	1	1	3	1	1	3
CO 4	1	1	3	3	1	3	1	1	1	1	1	3	1	1	3
CO 5	1	1	1	1	3	3	3	1	1	1	1	3	1	1	3
Average	**2.2**	**1.8**	**2.2**	**1.4**	**2.6**	**1.8**	**1.4**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P83	**SOFT COMPUTING TECHNIQUES**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To provide knowledge on neural networks and learning methods for neural networks
- To impart knowledge on neural network and its applications
- To inculcate the ideas of fuzzy sets, fuzzy logic and fuzzy inference system
- To impart knowledge on the basics of genetic algorithms and their applications in optimization and planning
- To familiarize the various hybrid soft computing techniques.

UNIT-I	INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS	9
Introduction to intelligent systems- Soft computing techniques - Single objective and multi-objective problems - Biological neuron – Artificial neuron – McCullock Pitt's neuron model – Supervised and unsupervised learning- Single layer – Multi layer feed forward network – Learning algorithm- -Back propagation network.		

UNIT-II	NEURAL NETWORKS	9
Feedback networks – Discrete time Hopfield networks – Kohonen self-organising feature maps– Applications of artificial neural network - Process identification – Neuro controller for inverted pendulum.		
UNIT-III	**FUZZY SYSTEMS**	**9**
Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules - Membership function – Knowledge base – Decision-making logic – applications of fuzzy logic systems		
UNIT-IV	**GENETIC ALGORITHMS**	**9**
Introduction - Gradient and Non-gradient search – GA operators – Representation – Selection – Cross Over – Mutation - constraint handling methods – applications to economic dispatch and unit commitment problems.		
UNIT-V	**HYBRID CONTROL SCHEMES**	**9**
Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine-RNN- Evolutionary Programming - Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS Tool Box.		
	Total Contact Hours : 45	

Course Outcomes: At the end of the course the student will be able to	
●	realize basics of soft computing techniques and learning methods of neural networks
●	analyze the problems using neural networks techniques.
●	know the basics of fuzzy systems.
●	understand the genetic algorithms and its applications.
●	know the various hybrid soft computing techniques.
Text Book (s):	
1	LauranceFausett, Englewood cliffs, N.J., "Fundamentals of Neural Networks", Pearson Education, 1994.
2	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Tata McGraw Hill, Third edition, 2010.
3	S.N.Sivanandam and S.N.Deepa, "Principles of Soft computing", Wiley India Edition, 2nd Edition, 2013.
Reference Books(s) / Web links:	
1	Simon Haykin, "Neural Networks", Pearson Education, 2003.
2	John Yen & Reza Langari, "Fuzzy Logic – Intelligence Control & Information", Pearson Education, New Delhi, 2003.
3	M.Gen and R,Cheng, "Genetic algorithms and Optimization", Wiley Series in Engineering Design and Automation, 2000.
4	Hagan, Demuth, Beale, "Neural Network Design", Cengage Learning, 2012.
5	N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford, 2013.
6	William S.Levine, "Control System Advanced Methods," The Control Handbook CRC Press, 2011.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 2	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 3	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 4	3	2	2	2	1	1	2	2	2	2	2	3	2	1	3
CO 5	3	2	2	2	1	1	2	2	2	2	2	3	2	1	3
Average	**3**	**2.6**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**2.6**	**1**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P84	FUNDAMENTALS OF BIOMEDICAL INSTRUMENTATION	PE	3	0	0	3

Objectives:

- To introduce the fundamentals of Biomedical Engineering
- To learn the communication mechanics in a biomedical system with few examples
- To study the measurement of important electrical and non-electrical parameters
- To understand the basic principles in imaging techniques
- To impart a basic knowledge in life assisting and therapeutic devices

UNIT-I	**FUNDAMENTALS OF BIOMEDICAL ENGINEERING**	9

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals – Basic components of a biomedical system- Review of Physiological systems -Physiological signals and transducers - Transducers – selection criteria – Piezo-electric, ultrasonic transducers - Temperature measurements - Fiber optic temperature sensors for Bio Medical applications

UNIT-II	**NON-ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURES**	9

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer –Plethysmography – Blood Gas analyzers, pH of blood –measurement of blood pCO2, pO2, finger-tip oximetry - ESR, GSR measurements

UNIT-III	**ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS**	9

Electrodes and amplifiers - ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current- Instruments for checking safety parameters of biomedical equipment

UNIT-IV	**IMAGING MODALITIES AND ANALYSIS**	9

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography –Different types of biotelemetry systems - Retinal Imaging – Imaging application in Biometric systems - Analysis of digital images

UNIT-V	**LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES**	9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialyzers – Lithotripsy - ICCU patient monitoring system - Nano Robots - Minimally invasive surgical techniques

Total Contact Hours	**:**	**45**	

Course Outcomes: On completion of the course, the students will be able to

- know the functioning of various instrumentation systems
- understand the applications of instrumentation systems to analyse bioelectric signals
- realize the safety parameters of biomedical equipment
- understand the techniques of medical imaging modalities
- comprehend the working of life assisting devices

Text Book (s):

1. Arumugam, “Bio-Medical Instrumentation”, Anuradha Agencies, 2003
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 3rd Edition, 2014
3. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice hall of India, New Delhi, 2007

Reference Books(s) / Web links:

1. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 1998
2. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., “Health Care Systems, Technology and Techniques”, Springer, 1st Edition, 2011

3	Ed. Joseph D. Bronzino, "The Biomedical Engineering Hand Book", Third Edition, Boca Raton, CRC Press LLC, 2006
4	Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and sons, New York, 4th Edition, 2012

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 2	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 3	3	3	2	2	1	1	2	2	2	2	2	3	3	1	3
CO 4	3	2	2	2	1	1	2	2	2	2	2	3	2	1	3
CO 5	3	2	2	2	1	1	2	2	2	2	2	3	2	1	3
Average	**3**	**2.6**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**2.6**	**1**	**3**

Subject Code	**Subject Name (Theory course)**	**Category**	**L**	**T**	**P**	**C**
EE19P85	**SMPS and UPS**	**PE**	**3**	**0**	**0**	**3**

Objectives: To impart knowledge about the following topics:

- Modern power electronic converters and its applications in electric power utility.
- Soft switched converters
- Ability to suggest converters for AC-DC conversion and SMPS
- Resonant converters and UPS
- Analyse various modes of operation of Dc-Dc converter
- Modern power electronic converters and its applications in electric power utility.

UNIT-I	**DC-DC CONVERTERS**	9

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

UNIT-II	**SWITCHED MODE POWER CONVERTERS**	9

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

UNIT-III	**RESONANT CONVERTERS**	9

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

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

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

UNIT-V	**POWER CONDITIONERS, UPS & FILTERS**	9

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

Total Contact Hours	**:**	45

Course Outcomes: On completion of the course, the students will be able to

- analyze the state space model for DC – DC converters
- Model and analyse the switched mode power converters
- understand the importance of Resonant Converters.

●	analyze the PWM techniques for DC-AC converters
●	Comprehend the components of filters and UPS.
Text Book (s):	
1	M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.
2	Simon Ang, Alejandro Oliva," Power-Switching Converters", Third Edition, CRC Press, 2010.
3	KjeldThorborg, "Power Electronics – In theory and Practice", Overseas Press, First Indian Edition 2005.
Reference Books(s) / Web links:	
1	Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006
2	Philip T Krein, "Elements of Power Electronics", Oxford University Press
3	Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006
4	M.H. Rashid – Power Electronics circuits, devices and applications- third edition Prentice Hall of India New Delhi, 2007.
5	Erickson, Robert W, "Fundamentals of Power Electronics", Springer, second edition, 2010.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	2	2	2	2	2	2	2	3	3	1	3
CO 2	3	3	2	3	3	3	2	2	2	2	2	3	3	1	3
CO 3	3	3	2	3	3	2	2	2	2	2	2	3	3	1	3
CO 4	3	2	2	2	3	3	3	2	2	2	2	3	2	1	3
CO 5	2	2	2	2	3	3	3	2	2	2	2	3	2	1	3
Average	**2.8**	**2.6**	**2.2**	**2.6**	**2.8**	**2.6**	**2.4**	**2**	**2**	**2**	**2**	**3**	**2.6**	**1**	**3**

PROFESSIONAL ELECTIVE – V

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**C**
EE19P86	**ELECTRIC ENERGY UTILIZATION AND CONSERVATION**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To learn the energy saving concept by different ways of illumination.
- To inculcate the different methods of electric heating and electric welding.
- To impart knowledge on the fundamentals and recent trends in electric traction.
- To provide knowledge on the concepts of energy management and audit.
- To impart knowledge on energy saving with the help of case studies.

UNIT-I ILLUMINATION **9**

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.

UNIT-II HEATING AND WELDING **9**

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding – ultrasonic welding.

UNIT-III ELECTRIC TRACTION **9**

Fundamentals of traction motors - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control – track equipment and collection gear - recent trends in electric traction- Hybrid Electric Vehicles.

UNIT-IV	ENERGY CONSERVATION AND AUDIT	9
Need of Energy Audit - Types of energy audit- Energy audit approach- understanding energy costs- Bench marking- Energy performance- Matching energy use to requirement-Maximizing system efficiencies- optimizing the input energy requirements- Energy Audit instruments.		
UNIT-V	**ENERGY SAVINGS AND CASE STUDIES**	**9**
Case study – simple calculations of energy savings and conservation in process equipment like boiler, heat exchanger, concept of energy saving in electrical and thermal unit.		
	Contact Hours : 45	

Course Outcomes: On completion of course, students will be able to

- realize the design of illumination systems with energy saving method.
- analyse the operation of various type of electric heating and electric welding.
- realize the various traction motor controls used in electric traction.
- estimate the energy audit approach with maximizing system efficiencies.
- evaluate the energy savings case study like boiler and heat exchanger

Text Book (s):

1	N.V. Suryanarayana, "Utilisation of Electric Power", Wiley Eastern Limited, New Age International Limited, 2nd edition, Reprint 2017.
2	J.B.Gupta, "Utilization of Electric power and Electric Traction", S.K.Kataria and Sons, 2013.
3	G.D.Rai, "Non-Conventional Energy Sources", Khanna Publications Ltd., New Delhi, 1997.

Reference Books(s) / Web links:

1	R.K.Rajput, "Utilisation of Electric Power", Laxmi publications Private Limited., 2007.
2	H.Partab, "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., NewDelhi, 2004.
3	C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New AgeInternational Pvt. Ltd., 2003.
4	S. Sivanagaraju, M. Balasubba Reddy, D. Srilatha, "Generation and Utilization of Electrical Energy", Pearson Education, 2010.
5	Donals L. Steeby, "Alternative Energy Sources and Systems", Cengage Learning, 2012.
6	Soni, Gupta and Bhatnagar, "A Course in Electrical Power", Dhanapat Rai & sons, 1987.
7	Dr. S.L.Uppal, "Electrical Power", Khanna Publications, 2007.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	2	3	3	3	1	1	1	3	3	1	2
CO 2	3	3	3	3	2	3	3	3	1	1	1	3	3	1	2
CO 3	3	3	3	3	2	3	3	3	1	1	1	3	3	1	2
CO 4	3	3	3	3	1	3	3	3	1	1	3	3	3	1	2
CO 5	3	3	3	3	1	3	3	3	1	1	3	3	3	1	2
Average	**3**	**3**	**3**	**3**	**1.6**	**3**	**3**	**3**	**1**	**1**	**1.8**	**3**	**3**	**1**	**2**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P87	**ENERGY MANAGEMENT AND AUDITING**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To impart knowledge on need for energy management and energy audit process.
- To study the concepts behind economic analysis and Load management.
- To understand energy management on various electrical equipment.
- To provide knowledge on various metering techniques for Energy Management.
- To learn the concept of lighting systems and cogeneration.

UNIT-I	INTRODUCTION	9
Need for energy management - energy basics- designing and starting an energy management program – energy		

accounting -energy monitoring, targeting and reporting-energy audit process.		
UNIT-II	**ENERGY COST AND LOAD MANAGEMENT**	9
Important concepts in economic analysis - Economic models-Time value of money-Utility rate structures- cost of electricity-Loss evaluation Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.		
UNIT-III	**ENERGY MANAGEMENT OF ELECTRICAL SYSTEMS**	9
Systems and equipment- Electric Motors-Transformers and reactors-Capacitors and synchronous machines.		
UNIT-IV	**METERING TECHNIQUES**	9
Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements- Metering techniques and practical examples.		
UNIT-V	**LIGHTING SYSTEMS & COGENERATION**	9
Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting Controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards Cogeneration: Forms of cogeneration - feasibility of cogeneration-Electrical interconnection		
	Total Contact Hours : 45	

Course Outcomes:

On the completion of the course, the students will be able to

- obtain knowledge on need for energy management and energy audit process.
- understand the concepts behind economic analysis and load management.
- analyse energy management on various electrical equipment.
- verify various metering techniques for energy management.
- estimate various types of lighting systems and cogeneration.

Text Book (s):

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

Reference Books(s) / Web links:

1	Reay D.A, "Industrial Energy Conservation", 1stedition, Pergamon Press, 1977.
2	IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE
3	Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 2	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 3	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 4	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19P88	**MICROCONTROLLER BASED SYSTEM DESIGN**	**PE**	3	0	0	3

Objectives:

- To learn the architecture of PIC microcontroller
- To study the use of interrupts and timers

●	To impart knowledge on the peripheral devices for data communication and transfer.	
●	To understand the functional blocks of ARM processor	
●	To study the architecture of ARM processors.	
UNIT-I	**PIC ARCHITECTURE AND INSTRUCTION SET**	9
Introduction to PIC Microcontroller–PIC 16C6x and PIC16C7x Architecture–PIC16cxx–- Pipelining – Program Memory considerations – Register File Structure – Instruction Set – Addressing modes – PIC programming in Assembly and C, Simple Operations.		
UNIT-II	**INTERRUPTS AND TIMER**	9
PIC micro controller Interrupts- External Interrupts-Interrupt Programming–Loop time subroutine – Timers-Timer Programming– Front panel I/O-Soft Keys– State machines and key switches– Display of Constant and Variable strings.		
UNIT-III	**PERIPHERALS AND INTERFACING**	9
I2C Bus for Peripherals Chip Access– Bus Operation-Bus subroutines– Serial EEPROM—Analog to Digital Converter–UART-Baud rate selection–Data handling circuit–Initialization – LCD and keyboard Interfacing -ADC, DAC, and Sensor Interfacing.		
UNIT-IV	**INTRODUCTION TO ARM PROCESSOR**	
ARM Architecture –ARM programmer's model –ARM Development tools- Memory Hierarchy –ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems.		
UNIT-V	**ARM PROCESSOR ORGANIZATION**	9
3-Stage Pipeline ARM Organization– 5-Stage Pipeline ARM Organization–ARM Instruction Execution- ARM Implementation– ARM Instruction Set– ARM coprocessor interface– Architectural support for High Level Languages – Embedded ARM Applications.		
	Total Contact Hours : 45	
Course Outcomes:		
●	Realize the architecture of PIC microcontroller.	
●	Analyse and solve problems involving Timers and Interrupts.	
●	Determine and apply computing platform and software for engineering problems.	
●	Analyse and use ARM processors in latest application	
●	Realize ethical issues, environmental impact and acquire management skills.	
Text Book (s):		
1	Peatman,J.B., "Design with PIC Micro Controllers", Pearson Education, 3rd Edition, 2004.	
2	Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.	
3	Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ' PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008 .	
Reference Books(s) / Web links:		
1	Mazidi, M.A., "PIC Microcontroller" Rollin Mckinlay, Danny causey Prentice Hall of India, 2007.	
2	Sriram. V.Iyer&Pankaj Gupta, "Embedded real time systems Programming", Tata McGraw- Hill, 2007	

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 2	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 4	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
CO 5	3	3	3	3	3	1	1	1	1	1	1	1	1	1	3
Average	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
EE19E89	SMART GRID	PE	3	0	0	3

Objectives:

- To provide knowledge on the concepts of Smart Grid and its present developments
- To learn the different Smart Grid technologies.
- To impart knowledge about different smart meters and advanced metering infrastructure.
- To understand the power quality management in Smart Grids
- To know about LAN, WAN and Cloud Computing for Smart Grid applications.

UNIT-I	INTRODUCTION TO SMART GRID	9

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

UNIT-II	SMART GRID TECHNOLOGIES	9

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

UNIT-III	SMART METERS AND ADVANCED METERING INFRASTRUCTURE	9

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

UNIT-IV	POWER QUALITY MANAGEMENT IN SMART GRID	9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT-V	HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS	9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Total Contact Hours	:	45

Course Outcomes:

- Understand the concepts of smart grid and its present developments.
- Realize about different smart grid technologies.
- Obtain knowledge about different smart meters and advanced metering infrastructure.
- Analyse power quality issues in smart grids
- Understand LAN, WAN and Cloud Computing for Smart Grid applications

Text Book (s):

1. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jian zhong Wu, Akihiko Yokoyama, "SmartGrid: Technology and Applications", Wiley.

Reference Books(s) / Web links:

1. Vehbi C. Güngör, DilanSahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati and Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards", IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids.
3. https://www.academia.edu/1526326/Smart_Grid_Technologies_Communication_Technologies_and_Standards
4. https://webuser.hs-furtwangen.de/~heindl/ebte-2014ws-Pre_Smart%20Grid%20Technologies_WS_14_15.pdf

COs/POs&PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3			3	3						3	2	3
CO 2		2	3			3	3						3	2	3
CO 3			3	3	2		3	3					3	2	3
CO 4						3	3						3	2	3
CO 5							3	3	3	3	3	3	3	3	3
Average	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.2**	**3**

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CS19301	**COMPUTER ARCHITECTURE**	**PE**	3	0	0	3

Objectives:

- To make the students familiar with a solid understanding of the fundamentals in computer architectures.
- To familiarize the students with the implementation of arithmetic and logical unit and floating-point operations
- To make the students quantitatively evaluate simple computer designs and their sub-modules.
- To expose the students with the relation of computer architecture to system software and the performance of application programs.
- To learn the memory system design and the I/O devices.

UNIT-I	**INTRODUCTION**	9

Overview of Computer Architecture – Computer components, Performance design & Assessment- Multicore, MICS & GPGPUS – Computer functions and Interconnection - Case Study: Evolution of Intel x86 architecture

UNIT-II	**ARITHMETIC & LOGIC UNIT**	9

Design of ALU, Integer Arithmetic: Addition, Subtraction, Multiplication and Division - Floating Point Arithmetic: Representation, Addition, subtraction, Multiplication & Division

UNIT-III	**CENTRAL PROCESSING UNIT**	9

MIPS Instruction Set: Machine instruction characteristics– Data path, Operations & operands, representing instructions, Logical operations – Instructions for decision making- Addressing modes - Case Study: Intel x86 Operation Types

UNIT-IV	**PARALLELISM**	9

Pipelining & Instruction cycle – pipelining strategy – pipeline hazards – dealing with branches – RISC & CISC – Super scalar – Instruction level parallelism – Flynn's taxonomy – Multithreading - Multicore Processor - Case Study: Key Elements of ARM 11 MPCORE

UNIT-V	**MEMORY & I/O**	9

Characteristics of memory systems – Hierarchy of memory – Cache design and measuring performance – I/O modules – Programmed I/O – Interrupts & its types – DMA – I/O Processors – Virtual memory – TLB – Case Study: RAID

Total Contact Hours	**:**	**45**

Course Outcomes:

- apply the knowledge of performance metrics to find the performance of systems.
- perform computer arithmetic operations.
- understand the impact of instruction set architecture on cost-performance of computer design.
- evaluate the performance of memory systems.
- develop the system skills in the content of computer system design

Text Book (s):

1. William Stallings, "Computer Organization and Architecture Designing for performance", PHI Pvt. Ltd., Eastern Economy Edition, Ninth Edition, 2013
2. David A Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann,5th Edition,2014.'

Reference Books(s) / Web links:

1	John P Hayes, "Computer Architecture and Organization", McGraw Hill, Third Edition, 2002.
2	V Carl Hamacher, Zvonks Vranesic and SafeaZaky, "Computer Organization", Sixth Edition, 2012.

COs/POs&PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	2	2	-	1	-	-	-	1	1	1	1	1	-	1
CO 2	3	3	3	1	1	-	-	1	1	1	1	1	1	-	2
CO 3	2	3	3	1	1	-	-	-	1	1	1	1	1	-	2
CO 4	3	3	3	1	1	1	1	-	1	1	2	1	1	-	2
CO 5	3	3	3	2	1	-	-	1	1	1	1	1	1	-	1
Average	**2.6**	**2.8**	**2.8**	**1.25**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.2**	**1.0**	**1.0**	**-**	**1.6**