JSS Mahavidyapeetha

JSS Science and Technology University

Sri Jayachamarajendra College of Engineering

Mysuru 570 006

Scheme of Teaching and Examination for I-VIII Semesters
Syllabus for I to IV Semesters of B.E. Program in E&EE

Applicable to 2016 and Later Batch of Students

Approved by B.o.S in E&EE on May 30, 2017

Department of Electrical & Electronics Engineering

Scheme Applicable to 2016 and Later Batch of Students

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY
SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU 570 006

Scheme of Teaching and Examination for B.E. in E&EE

SEMESTER I												
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA110	Engineering Mathematics-I	Maths	3	1	0	4	5	50	50	3
2	CH110	Engineering Chemistry	Chemistry	4	0	0	4	4	50	50	3
3	EC110	Electronic Devices and Circuits	E&C	4	0	0	4	4	50	50	3
4	CS110	Programming in C	CS/IS	4	0	0	4	4	50	50	3
5	ME120	Computer Aided Engineering Graphics	Mech./IP	2	0	2	4	4	50	50	3
6	CH12L	Engineering Chemistry Lab	Chemistry	0	0	1.5	1.5	3	50	50	-
7	CS12L	C Programming Lab	CS	0	0	1.5	1.5	3	50	50	-
8	HU110	Innovation	Humanities	2	0	0	2	2	50	50	-
9	HU130	Kannada	Humanities	-	-	-	-	2	50	-	-
				Total			25	31	Total		15

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit; 3 h of lab/Wk = 1.5 credits.

Scheme Applicable to 2016 and Later Batch of Students

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY,
FORMERLY SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU 570 006

Scheme of Teaching and Examination for B.E. in E&EE

SEMESTER II												
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA210	Engineering Mathematics-II	Maths	3	1	0	4	5	50	50	3
2	PH210	Engineering Physics	Physics	4	0	0	4	4	50	50	3
3	CV220	Elements of Civil Engineering and Engineering Mechanics	Civil	4	0	0	4	4	50	50	3
4	EE210	Basic Electrical Engineering	E&EE	4	0	0	4	4	50	50	3
5	ME210	Mechanical Engineering Science	Mech./IP	4	0	0	4	4	50	50	3
6	PH22L	Engineering Physics Lab	Physics	0	0	1.5	1.5	3	50	50	-
7	EC21L	Basic Electronics Lab	E&EE	0	0	1.5	1.5	3	50	50	-
8	HU220	Functional English	Humanities	2	0	0	2	2	50	50	-
				Total			25	29	Total		15

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit; 3 h of lab/Wk = 1.5 credits.

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Scheme of Teaching and Examination for B.E. Program in E&EE

SEMESTER III												
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA310	Transform Techniques	Maths	4	0	0	4	4	50	50	3
2	EE310	Network Analysis	E&EE	3	1	0	4	5	50	50	3
3	EE320	D.C. and Synchronous Machines	E&EE	4	0	0	4	4	50	50	3
4	EE330	Electrical and Electronic Measurements†	E&EE	3	0	1	4	5	50	50	3
5	EE340	Logic Design†	E&EE	3	0	1	4	5	50	50	3
6	EE350	Analog Electronic Devices and Circuits†	E&EE	3	0	1	4	5	50	50	3
7	HU310 HU410	Constitution of India / Environmental Studies	*	0	0	0	0	2	-	-	-
				Total			24	30	Total		18

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit. 3 h of lab/Wk = 1.5 credits.

* Faculty from the Department of Law or Environmental Engineering. CIE: Continuous Internal Evaluation; SEE: Semester End Examination.
† In these subjects having associated labs, 20% weightage will be given to the lab work and 30% weightage will be given to three CIE tests.
In subjects without associated labs, there will be three CIE tests and two other CIE events --- which may be assignment, or quiz, or any other type of evaluation --- as announced by the teacher at the beginning of the semester.

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Scheme of Teaching and Examination for B.E. Program in E&EE

SEMESTER IV											
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA410	Probability and Statistics	Maths	4	0	0	4	4	50	50	3
2	EE410	Electrical Power Generation	E&EE	4	0	0	4	4	50	50	3
3	EE420	Signals and Systems	E&EE	3	1	0	4	5	50	50	3
4	EE430	Field Theory	E&EE	4	0	0	4	4	50	50	3
5	EE440	Op-amps and Linear ICs†	E&EE	3	0	1	4	5	50	50	3
6	EE450	Transformers and Induction Machines	E&EE	4	0	0	4	4	50	50	3
7	EE46L	D.C. and Synchronous Machines Lab	E&EE	0	0	1.5	1.5	3	50	-	3
8	EE47L	Circuit Simulation and Signal Processing Lab	E&EE	0	0	1.5	1.5	3	50	-	3
9	HU310 HU410	Constitution of India / Environmental Studies	*	0	0	0	0	2	-	-	-
				Total			27	34	Total		21

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit. 3 h of lab/Wk = 1.5 credits.

* Faculty from the Department of Law or Environmental Engineering. CIE: Continuous Internal Evaluation; SEE: Semester End Examination.
† In this subject having associated lab, 20% weightage will be given to the lab work and 30% weightage will be given to three CIE tests.
In subjects without associated labs, there will be three CIE tests and two other CIE events --- which may be assignment, or quiz, or any other type of evaluation --- as announced by the teacher at the beginning of the semester.

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SEMESTER V												
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA510	Numerical Methods of Computation	Maths	3	0	1	4	5	50	50	3
2	EE510	Power Electronics	E&EE	4	0	0	4	4	50	50	3
3	EE520	Control Systems-I	E&EE	3	1	0	4	5	50	50	3
4	EE530	Microcontrollers†	E&EE	3	0	1	4	5	50	50	3
5	EE540	Electrical Power Transmission and Distribution	E&EE	4	0	0	4	4	50	50	3
6	EE550	Technical Communication and Professional Ethics	E&EE	3	0	1	4	5	50	50	3
7	EE56L	Transformers and Induction Machines Lab	E&EE	0	0	1.5	1.5	3	50	-	3
8	EE57L	Power Electronics Lab	E&EE	0	0	1.5	1.5	3	50	-	3
				Total			27	34	Total		24

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit. 3 h of lab/Wk = 1.5 credits.

CIE: Continuous Internal Evaluation; SEE: Semester End Examination.
† In this subject having associated lab, 20% weightage will be given to the lab work and 30% weightage will be given to three CIE tests.
In subjects without associated labs, there will be three CIE tests and two other CIE events --- which may be assignment, or quiz, or any other type of evaluation --- as announced by the teacher at the beginning of the semester.

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Scheme of Teaching and Examination for B.E. Program in E&EE

SEMESTER VI											
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	EE610	Power System Analysis and Stability-1	E&EE	3	1	0	4	5	50	50	3
2	EE620	Digital Signal Processing	E&EE	3	0	1	4	5	50	50	3
3	EE630	Switchgear and Protection	E&EE	4	0	0	4	4	50	50	3
4	EE640	High Voltage Engineering	E&EE	4	0	0	4	4	50	50	3
5	EE650	Control Systems-II	E&EE	4	0	0	4	4	50	50	3
6	EE66?	Elective-A (One from Group-A)	E&EE	4	0	0	4	4	50	50	3
7	EE67L	Control Systems Lab	E&EE	0	0	1.5	1.5	3	50	-	3
8	EE68L	Relay and High Voltage Lab	E&EE	0	0	1.5	1.5	3	50	-	3
				Total			27	32	Total		24

1 h of Lecture/Wk = 1 credit; 2 h of tutorial or lab/Wk = 1 credit. 3 h of lab/Wk = 1.5 credits.

Elective Group-A (Non-core)		
Sl. No	Subject Code	Subject
1	EE661	Operating Systems
2	EE662	Object Oriented Programming using C++
3	EE663	Advanced Energy Management (Suggested by Schneider Electric Company)
4	EE664	Digital System Design using HDL
5	EE665	Linear Algebra (offered by Dept. of Maths or Dept. of E&EE)

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SEMESTER VII											
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	EE710	Power System Analysis and Stability-2	E&EE	3	1	0	4	5	50	50	3
2	EE720	Industrial Drives and Applications	E&EE	4	0	0	4	4	50	50	3
3	EE730	Electrical Machine Design	E&EE	3	0	1	4	5	50	50	3
4	EE74?	Elective-B (One from Group-B)	E&EE	4	0	0	4	4	50	50	3
5	EE75?	Elective-C (One from Group-C)	E&EE	4	0	0	4	4	50	50	3
6	EE760	Foreign Language Course	Humanities	2	0	0	2	2	50	50	1.5
7	EE77L	Power Systems Simulation Lab	E&EE	0	0	1	1	2	50	-	3
8	EE78S	Seminar/Report on Technical Visit*	E&EE	0	0	0	--	--	50	--	--
				Total			23	26	Total		19.5

* For Seminar/Report on Technical Visit, there is no credit. However, student will be given a Cleared/Not Cleared status depending upon CIE.

Elective Group – B (Non-core)		Elective Group – C (Core)	
Subject Code	Course Title	Subject Code	Course Title
EE741	Digital Image Processing	EE751	Electrical Insulation Engineering
EE742	Fuzzy Logic Systems	EE752	Illumination Engineerring
EE743	Embedded Systems	EE753	Electrical Installation Design (Suggested by Schneider Electric)
EE744	VLSI Circuits and Systems	EE754	Photovoltaics
EE745	Optimization Techniques	EE755	Nonlinear Control Systems
EE746	Computational Intelligence	EE756	Applications of Electrical Discharge
		EE757	Testing and Commissioning of Electrical Equipment

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SEMESTER VIII												
Sl. No.	Subject Code	Subject	Teaching Department	Credits				Contact Hours/Wk	% Weight		SEE Duration in Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	EE810	Management, Electrical Estimation and Entrepreneurship	E&EE	4	0	0	4	4	50	50	3
2	EE82?	Elective-D (One from Group-D)	E&EE	4	0	0	4	4	50	50	3
3	EE83?	Elective-E (One from Group-E)	E&EE	4	0	0	4	4	50	50	3
4	EE84P	Project Work	E&EE	0	0	10	10	6	70	30	§
				Total			22	18	Total		9+

§ Approximately 1 hour per batch of students.

Elective Group – D (Core)		Elective Group – E (Core)	
Subject Code	Course Title	Subject Code	Course Title
EE821	Advanced Industrial Automation (Suggested by Schneider Electric)	EE831	HVDC Transmission
EE822	Renewable Energy Systems	EE832	Flexible A.C. Transmission Systems
EE823	Over-voltages and Insulation Coordination	EE833	Power System Operation and Control
EE824	Discrete Control Systems	EE834	Special Electrical Machines
EE825	Advanced Power Electronics		

EE110 Basic Electrical and Electronics Engineering

Lecture Hours/Week: 4
Total Hours: 46
Prerequisites: NIL

Prerequisite: NIL
CIE: 50 Marks
Corequisites: NIL

Credit Pattern (L:T:P) = 4:0:0 = 4
SEE: 50 Marks

Course Objective

The emphasis in this course is on teaching relevant electrical and electronics engineering concepts to engineers who will be users, not designers, of electrical, electromagnetic and electronic systems. Typically these engineers would specialize in branches other than electrical and electronics. The course should help the students to —

- Understand the function of components and equipment.
- Acquire the skills to properly utilize the aids that modern electrical technology can offer.
- Facilitating active cooperation with specialists in electrical engineering.
- Providing a basis for further studies in this area.

Course Outcomes

After completing this course, the student should be able to —

CO-1 : Analyze resistive D.C. circuits, single-phase A.C. circuits and discuss methods of improving power factor.

CO-2 : Describe types of power plants, transmission, distribution systems and power sector organization in India.

CO-3 : Explain the principle of operation and characteristics of rotating machines, transformers and compute performance parameters.

CO-4 : Explain domestic wiring, types of lamps, electricity tariff structure, features of smart metering and electrical safety.

CO-5 : Explain the basic electronic components – basic logic gates, ADC and DAC, sensors and probes used in measurements, and the working principle of UPS.

Note: Where ever necessary, exposure to real-time systems/lab may be included.

Course Articulation Matrix of EE110 -- Basic Electrical and Electronics Engineering																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE110.1	Analyze resistive D.C. circuits, single-phase A.C. circuits and discuss methods of improving power factor.	3	2	1	-	3	-	-	-	-	1	-	3	-	-	-
EE110.2	Describe types of power plants, transmission, distribution systems and power sector organization in India.	3	1	1	-	3	-	-	3	1	1	-	3	-	-	-
EE110.3	Explain the principle of operation and characteristics of rotating machines, transformers and compute performance parameters.	3	3	1	-	3	-	-	1	-	1	-	3	-	-	-
EE110.4	Explain domestic wiring, types of lamps, electricity tariff structure, features of smart metering and electrical safety.	3	1	1	-	3	-	-	3	1	1	-	3	-	-	-
EE110.5	Explain the basic electronic components – basic logic gates, ADC and DAC, sensors and probes used in measurements, and the working principle of UPS.	3	1	1	-	3	-	-	-	-	1	-	3	-	-	-
Over-all Correlation of EE110 to PO's		3.00	1.60	1.00	-	3.00	-	-	2.40	0.4	1.00	-	3.00	-	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1. Elementary Circuit and Network Theory

(a) Ohm's law. Kirchhoff's Laws. Concept of voltage and current source. Application of Kirchhoff's Laws by Mesh Analysis and Nodal Analysis to compute current, voltage and power in resistive networks with D.C. voltage source/s (Matrix approach to be emphasized in solving the equations). 4 Hours

(b) Basics of AC Sinusoidal Voltage generation. Concept of phase difference, average and effective values of sinusoids. Introduction to harmonics. Phasor representation of sinusoids. Concept of impedance and admittance representation in polar and rectangular forms. Analysis of circuits having R, L, C in different configurations using phasor diagrams. Illustrative examples (use of calculator for conversion and computation of complex numbers and matrix approach to solve equations is to be emphasized). Concept of maximum power transfer theorem (highlight impedance matching needed in electronic circuits). 4 Hours

(c) Definition of real power, reactive power, apparent power and power factor. Concept of complex power. Need for power factor improvement and methods to improve power factor. (The teaching faculty has to draw practical examples and explain the relevance and need to study) 4 Hours

2. Electric Power Systems

(a) Three-phase systems. Three phase E.M.F. generation. Meaning of phase sequence, star and delta connection (derivations not required. Only relations to be made known between voltage and current in star and delta connections). Balanced and unbalanced supply, balanced and unbalanced load. Formulas for three-phase power calculation. 3 Hours

(b) Conventional and new forms of energy sources and renewable energy sources. Block schematic diagram of thermal, hydel power plants, solar and wind generation. General structure of electrical power systems (generated voltage, standard transmission voltages, distribution voltages). Single line diagram representation of a power system. Power transmission and distribution by overhead lines and underground (UG) cables and lightning arrestor. Power sector structure in India. 5 Hours

3. Electrical Machines

Rotating Machines – classification of rotating machines based on principle of operation and types and their applications. Synchronous machine – alternator and motor applications. Induction motors

– Introduction to three-phase motors, types, construction, principle of operation, ratings and torque-slip characteristics, starters, applications. Introduction to single-phase induction motors, types and applications. Stepper motors – construction, working principle, ratings and applications. Transformers – single-phase transformers, principle of operation, E.M.F. equation. Computation of rating, power losses, importance of core loss, efficiency and regulation (derivation of equations not required). Classification of transformers based on their application. Autotransformer (representation and application). Three-phase transformers application (a photo/figure showing visible parts of a practical transformer connected to a load, near a mall/complex/building to be shown). 11 Hours

4. Domestic Electrical Installations

(a) Materials and components that are needed in domestic wiring – switch types, UG cables, cutouts, fuse box, metering/recording equipment (these are to be shown in the lab and also by videos). Wiring diagram for a house. Digital energy meter and smart meter. 4 Hours

(b) Basic principles of illumination engineering – types of lamps (LED lamps, arc lamps etc.) and applications. 3 Hours

(c) Computation of power requirements in buildings. Power requirements of common household electrical loads and appliances and electrical energy tariff details to be made known considering an electricity bill given by ESCOM. 4 Hours

(d) Electric shock and safety aspects. Need for earthing, recent trends/methods of earthing. Fuses and type of fuses and enclosures. MCB's and ELCB's – basic function, purpose and their importance. 4 Hours

5. Basics of Electronics Engineering

Review of logic gates and truth table. Concept of Analog and Digital signals. Block schematic of analog to digital convertors and digital to analog conversion. Sensors and electronic probes for measurement of temperature, pressure, velocity, discharge, dissolved oxygen (DO), conductivity, resistivity, etc. UPS, classification. Working of a UPS with a block diagram and calculating the desired rating of UPS. 10 Hours

References

1. E. Hughes, Dr. John Hiley, Ian McKenzie-Smith, and Dr. Keith Brown, ``Electrical and Electronic Technology", 10th Edition, Pearson, 2010.
2. Bernard Grob, “Basic Electronics”, 12th Edition, McGraw-Hill, 2016.
3. Albert Malvino and Jerald Brown, “Digital Computer Electronics”, 3rd Edition, McGraw-Hill Education, 2001.
4. N. N. Parker Smith, “Problems in Electrical Engineering”, Ninth Edition, CBS Publishers, New Delhi.
5. Learning materials available at *www.nptel.ac.in*
6. Lecture Notes.

EE210 Basic Electrical Engineering

Lecture Hours/Week: 4	Prerequisite: NIL	Credit Pattern (L:T:P) = 4:0:0 = 4
Total Hours: 56	CIE: 50 %	SEE: 50 %
Prerequisites: NIL	Co-requisites: NIL	

Course Objective

The emphasis in this course is on teaching basic electrical engineering concepts to engineers who will be specializing later in electrical and electronics engineering and related streams. The course should help the students to —

1. Understand and apply basic electrical network concepts.
2. Understand and apply basic concepts of magnetism and magnetic circuits.
3. Understand and apply concepts of electrical measurement and domestic wiring.
4. Understand the working of basic electrical machines.
5. Providing a basis for further studies in this area.

Course Outcomes

After completing this course, the student should be able to —

CO-1 : Determine the voltage, current, and power in a resistive network excited by D.C. source/s and apply the principles of electromagnetism and concepts of magnetic circuits, to solve numerical problems.

CO-2 : Determine voltage/s, current/s and power in a single-phase A.C. circuit and in a three-phase A.C. balanced circuit excited by a balanced supply.

CO-3 : Explain the function of transducers, sensors, different types of measuring instruments and their characteristics, different types of domestic wiring, different types of lamps, need for electrical safety and earthing.

CO-4 : Describe the working principle, types, characteristics and applications of D.C. motors, generators and solve simple problems on them.

CO-5 : Explain the working principle, types, characteristics and applications of transformers and induction motors, and solve simple problems on these electrical machines.

1. D.C. Circuits, Magnetic Circuits and Electromagentism

Ohm’s law, Kirchhoff's Laws, concepts of voltage and current source. Apply Mesh Analysis and Nodal Analysis to compute current, voltage and power in resistive networks excited by D.C. voltage source/s (writing network equilibrium equations in matrix form to be emphasized while solving problems). 5 Hours

MMF, reluctance, flux, flux density, field intensity in magnetic circuits. Analogy and differences between electric and magnetic circuits. Faraday's Laws. Lenz's Law. Fleming's Rules. Statically and dynamically induced E.M.F.'s. Concept of self and mutual inductance. Concept of coefficient of coupling. Energy stored in magnetic field. Illustrative examples. 6 Hours

2. Single-phase and Three-phase A.C. Circuits

Basics of sinusoidal voltage generation. Concept of phase difference, average and effective values of sinusoidally varying voltage or current. Introduction to harmonics. Phasor representation of a sinusoidally varying voltage or current. Concept of impedance and admittance. Representation of complex quantities in polar and rectangular forms. Analysis of single-phase A.C. circuits having combinations of *R*, *L*, and *C* with phasor diagrams. Definition of real power, reactive power, apparent power and power factor. Concept of complex power. Power factor improvement. Illustrative examples. 6 hours

Necessity and advantages of three-phase systems. Three-phase E.M.F. generation. Meaning of phase sequence, star and delta connection (no derivations only relations to be made known between voltage and current in star and delta connections), balanced and unbalanced supply, balanced and unbalanced load. Formulas for three-phase power calculation. Illustrative examples. (Practical examples and applications to be highlighted) 5 Hours

3. Measuring Instruments and Domestic Wiring

Working principle of commonly used instruments like ammeters, voltmeters, wattmeters, digital storage oscilloscope, energy meters. 7 Hours

Electrical materials/components needed for domestic wiring – switch types, under-ground cables, cutouts, fuse box, metering/recording equipment (to be shown in the lab and also by videos). Concept to be explained with wiring diagram for a house. Types of lamps, electric shock and safety aspects. Need for earthing, recent trends/concepts of earthing. Fuses, type of fuses and enclosures. MCB's and ELCB's – basic function, purpose and their importance and wiring. Computation of power requirements in buildings. 5 Hours

4. D.C. Machines

Working principle, constructional features, E.M.F. Equation, back E.M.F. and torque equation. Types of D.C. motors --- characteristics and applications. Necessity of a starter for motor. Illustrative examples. 11 Hours

5. Transformers and Induction Motors

Single-phase transformers – principle of operation, E.M.F. equation. Classification of transformers based on their application. Computation of power losses, efficiency and regulation of transformers (derivation of equations not required). Autotransformer (representation and application). Three-phase transformers application (a photograph or figure showing visible parts of a practical transformer connected to a load, near a mall/complex/ building to be shown) 5 Hours

Introduction to three-phase motors, types, construction, principle of operation, ratings and characteristics, starters, applications. Introduction to single-phase induction motors, types and applications. 6 Hours

References

1. E. Hughes, ``Electrical Technology", International Students 10th Edition, Pearson, 2010, Revised by John Hiley, Keith Brown, and Ian McKenzie Smith.
2. Rajendra Prasad, ``Fundamentals of Electrical Engineering", Prentice-Hall of India Pvt. Ltd., 2005, ISBN : 81-203-2729-2.

3. T. K. Nagasarkar and M. S. Sukhija, ``Basic Electrical Engineering'', March 2005, Oxford University Press, ISBN: 0-19-567392-1.
4. N. N. Parker Smith, `` Problems in Electrical Engineering'', 19th Edition, C.B.S. Publishers.
5. Lecture Notes.

Course Articulation Matrix of EE210 -- Basic Electrical Engineering

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE210.1	Determine the voltage, current, and power in a resistive network excited by D.C. source/s and apply the principles of electromagnetism and concepts of magnetic circuits, to solve numerical problems.	3	1	1	-	1	-	-	-	-	-	-	2	-	-	-
EE210.2	Determine voltage/s, current/s and power in a single-phase A.C. circuit and in a three-phase A.C. balanced circuit excited by a balanced supply.	3	1	1	-	1	-	-	-	-	-	-	2	-	-	-
EE210.3	Explain the function of transducers, sensors, different types of measuring instruments and their characteristics, different types of domestic wiring, different types of lamps, need for electrical safety and earthing.	1	1	1	-	-	-	-	-	-	-	-	2	-	-	-
EE210.4	Describe the working principle, types, characteristics and applications of D.C. motors, generators and solve simple problems on them.	2	1	1	-	-	-	-	-	-	-	-	2	-	-	-
EE210.5	Explain the working principle, types, characteristics and applications of transformers and induction motors, and solve simple problems on these electrical machines.	2	1	1	-	-	-	-	-	-	-	-	2	-	-	-
Over-all Correlation of EE210 to PO's		2.20	1.00	1.00	-	0.40	-	-	-	-	-	-	2.00	-	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)

PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

Scheme of Study and Syllabi Applicable to 2016 and Later Batches of Students of III and IV Semesters of B.E. Program in E&EE

Department of Electrical and Electronics Engineering

30 May 2017

JSS Mahavidyapeetha
JSS Science & Technology University
Sri Jayachamarajendra College of Engineering
Manasagangothri,
Mysore 570 006

Contents

Vision of the Department of Electrical and Electronics Engineering, JSS S&T University, Mysuru

Be a globally acclaimed centre dedicated to nurture academic, research, and professional excellence in the field of electrical and electronics engineering for the betterment of society.

Mission of the Department of Electrical and Electronics Engineering, JSS S&T University, Mysuru

- To strive for achieving the highest quality in the academic programs and research work to remain competitive in the changing world scenario.
- To transform each student into a confident, knowledgeable, honest and humane individual with ability to synchronize with emerging technologies and capability to solve real-life engineering problems.
- To serve the community and stake holders in the field of electrical and electronics engineering through collaborative research.

Program Educational Objectives (PEOs) of B.E. Degree Program in E&EE

PEO-1 To teach the fundamentals needed for students to become practicing engineers in the domain of electrical and electronics engineering in areas such as design, testing, and manufacturing.

PEO-2 To teach the fundamentals needed for students to continue their education in leading graduate and research programs in engineering and interdisciplinary areas to emerge as researchers, experts, and educators.

PEO-3 To help students develop lifelong learning abilities to maintain and enhance professional skills.

PEO-4 To nurture students to become individuals who will fulfill the needs of society in solving technical problems using engineering principles, tools and practices, in an ethical and responsible manner understanding environmental impacts.

PEO-5 To train students to demonstrate leadership skills in the workplace and function professionally in a globally competitive world.

Graduates Attributes (GAs)

Graduate Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The GAs are exemplars of the attributes expected of a graduate from an accredited programme. NBA has defined the Graduate Attributes of UG engineering programme are as follows:

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

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

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

GA-4 *Conduct Investigations of Complex Problems:* The problems — (i) that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline, (ii) that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions, (iii) that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement, durability, product life, etc.), (iv) which need to be defined (modeled) within appropriate mathematical framework. (v) that often require use of modern computational concepts and tools.

GA-5 *Modern Tool Usage:* Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

GA-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.

GA-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.

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

GA-9 *Individual and Team Work:* Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

GA-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.

GA-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 multi-disciplinary environments.

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

Program Outcomes (POs) and Program Specific Outcomes (PSOs) of B.E. Program in E&EE

After graduation, the students will be able to –

PO-1 Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.

PO-2 Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

PO-3 Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO-4 Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

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

PO-6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO-7	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.
PO-8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO-9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO-10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO-11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO-12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO-1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO-2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO-3	Implement ecofriendly energy systems for sustainable development.

III Semester

Applicable to 2016 Batch

Scheme of Study and Examination for III Semester of B.E. Program in E&EE

Sl. No.	Sub. Code.	Course Title	Teaching Dept.	Credits				Contact h/Wk	%		Exam Hours
				Lecture	Tutorial	Practical	Total		CIE	SEE	
1	MA310	Fourier Series, Integral Transforms and Applications	Maths	4	0	0	4	4	50	50	3
2	EE310	Network Analysis	E&EE	3	1	0	4	5	50	50	3
3	EE320	D.C. and Synchronous Machines	E&EE	4	0	0	4	4	50	50	3
4	EE330	Electrical & Electronic Measurements	E&EE	3	0	1	4	5	50	50	3
5	EE340	Logic Design	E&EE	3	0	1	4	5	50	50	3
6	EE350	Analog Electronic Devices and Circuits	E&EE	3	0	1	4	5	50	50	3
7	HU310 HU410	Constitution of India / Environmental Studies	*	0	0	0	0	2	-	-	-
				Total			24	30	Total		18

MA310 Fourier Series, Integral Transforms and Applications

Teaching Faculty: Credits: 4; Pattern: L:T:P=4:0:0
Hours/Week: 4 CIE: 50 Marks; SEE: 50 Marks

NOTE: Hourly lesson plan for covering this syllabus and topic-wise allocation of marks in the SEE will be provided by the teacher.

Course Outcomes

After completing this course the student should be able to

CO-1 Find the Fourier series expansion of a given function.

CO-2 Find Fourier transforms and also inverse Fourier transform of a given function apply it to solve practical problems.

CO-3 Apply Laplace transforms for solving differential equations.

CO-4 Apply Z-transforms to solve difference equations.

CO-5 Solve partical differential equations. Use special functions to solve problems.

1 Fourier Series

Introduction, Fourier series for even and odd functions; half-range expansions; practical harmonic analysis.

2 Fourier Transforms

Finite and infinite Fourier transforms, inverse transforms, applications to ordinary and partial differential equations; discrete Fourier transforms.Bessel's functions. Legendre functions and Legendre polynomials. Chebyshev polynomials.

3 Laplace Transforms and Inverse Laplace Transforms

Applications to ordinary and partial differential equations.

4 Z-transforms

Definition and properties. Inverse Z-transforms. Solution of difference equations using Z-transformers.

5 Partial Differential Equations

Formation of PDEs, Derivation of one-dimensional wave and heat equations; solutions of non-homogeneous and homogeneous PDEs; method of separation of variables; solution of Lagrange's linear PDE; D'Alembert's solution of wave equation; two-dimensional Laplace's equation; boundary value problems.

6 Special Functions

Series solutions of Differential equations. Bessel's functions. Legendre functions and Legendre polynomials. Chebyshev polynomials.

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.
2. Dyke, "An Introduction to Laplace Transforms and Fourier Series", Springer, 2005.
3. B V Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 2007.
4. Rudra Pratap, "Getting Started with MATLAB 7", Oxford University Press, 2005.
5. R J Schilling and S L Harries, "Applied Numerical Methods for Engineers", Thomson, Brooks/Cole, 2006.

EE310 Network Analysis

Total Lecture Hours	: 42		Credit Pattern L:T:P	:	3:1:0
Total Tutorial Hours	: 28		CIE, SEE Weightage	:	50%, 50%
Lecture Hours/Week	: 3		Prerequisite/s	:	EE210
Tutorial Hours/Week	: 2		Teaching Faculty	:	
Nature of Subject	: Core				

Course Outcomes

After completing this course the student should be able to

CO-1 Apply network reduction techniques, Node Voltage Method, Loop Current Method and network theorems to determine the response of the given network.

CO-2 Determine the response of circuits having mutual coupling and three-phase circuits having balanced or unbalanced load, excited by balanced supply.

CO-3 Determine the transient and steady-state behaviour of a network.

CO-4 Perform analysis of resonant circuits and apply Fourier analysis to networks.

CO-5 Apply Laplace transform techniques for network analysis and determine response of two-port networks.

Course Articulation Matrix of EE310 -- Network Analysis																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE310.1	Apply network reduction techniques, Node Voltage Method, Loop Current Method and network theorems to determine the response of the given network.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
EE310.2	Determine the response of circuits having mutual coupling and three-phase circuits having balanced or unbalanced load, excited by balanced supply.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
EE310.3	Determine the transient and steady-state behaviour of a network.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
EE310.4	Perform analysis of resonant circuits and apply Fourier analysis to networks.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
EE310.5	Apply Laplace transform techniques for network analysis and determine response of two-port networks.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
Over-all Correlation of EE310 to PO's		3.00	1.00	1.00	-	2.00	-	-	-	-	-	-	1.00	-	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Methods of Network Analysis

Scope of network analysis and network synthesis. Definitions and representation of two-terminal elements — linear, lumped, finite, passive, bilateral (LLFPB) and active elements. Circuit and network. Ideal and practical voltage and current sources. Source transformations. Source shifting. Independent and dependent sources. Loop and node (including super node and super mesh) methods of network analysis of circuits containing independent and/or controlled D.C. and/or A.C. sources. Choice between loop and node methods. Equilibrium equations by method of inspection. Star-delta transformations. Network reduction using Y-Δ transformations. 8 Hours

2 Network Theorems

Superposition, Reciprocity, Thevenin's and Norton's, Maximum Power Transfer and Millman's theorems. Applications to D.C. and A.C. circuits. 6 Hours

3 Coupled Circuits

Magnetically coupled circuits. Dot convention. Coupling co-efficient. Conductively coupled circuits. Analysis of coupled circuits with sinusoidal excitation. 4 Hours

4 Three-phase Circuits

Analysis of three-phase circuits with balanced and unbalanced loads. Neutral shifting. Measurement of active and reactive powers in three-phase circuits. 6 Hours

5 Transient Behavior and Initial Conditions

Behavior and representation of R, L, and C elements at a switching instant and for final steady state (initial and final conditions) for D.C. excitation. Evaluation of initial and final conditions in R-L, R-C, and R-L-C circuits with D.C. excitation. 6 Hours

Step response in series R-L, R-C, and R-L-C circuits, differential equations of performance and their solution. Time constant and its significance. Transients in networks excited by sinusoidal sources. 6 Hours

6 Resonant Circuits

Series and parallel resonance. Frequency response of series $R-L-C$ circuit and parallel circuit (series $R-L$ and series $R-C$ branches in parallel). Resonant frequency. Q factor and bandwidth. Locus diagrams. 6 Hours

7 Fourier Analysis

Periodic functions. Odd and even functions. Trigonometric Fourier expansion of non-sinusoidal periodic signals. Analysis of circuits excited by non-sinusoidal periodic waveforms. Effective value, average power and power factor. 10 Hours

8 Network Analysis using Laplace Transforms

Definition of Laplace transform and its inverse. Standard signals — step, ramp, parabolic, impulse and their Laplace transforms. Table of useful Laplace transforms (proof not required). Waveform synthesis of aperiodic and periodic signals using linear combination of step, ramp, parabolic and impulse functions. Gate functions. Initial value theorem. Final value theorem. Convolution theorem. Transform network. Application of Laplace transformation to network analysis. 10 Hours

9 Two-port Networks

Two-port network representation. Examples of practical two-port networks. Definition and mathematical modeling of z, y, h, and T parameters of networks with and without controlled sources. 8 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. William Hayt Jr., Jack E. Kemmerly, and Steven M. Durbin, "Engineering Circuit Analysis", 6th Edition, T.M.H., ISBN 0-07-048649-2
3. Van Valkenburg, "Network Analysis", Prentice-Hall.
4. David K. Cheng, "Analysis of Linear Systems", Narosa Publications, New Delhi.
5. DeCarlo and Lin, "Linear Circuit Analysis", Oxford University Press, 2nd Ed.
6. Edminister, "Electric Circuits", Schaum Series.
7. Roy Choudhury,"Networks and Systems", 2nd Edition, New Age International Publishers.
8. J. David Irwin and R. Mark Nelms, "Basic Engineering Circuit Analysis", 8th Edition, John Wiley.
9. N. N. Parker Smith, "Problems in Electrical Engineering", CBS.

EE320 D.C. and Synchronous Machines

Total Lecture Hours	:	56	Credit Pattern L:T:P	:	4:0:0
Lecture Hours/Week	:	4	CIE, SEE Weightage	:	50%, 50%
Practical Hours/Week	:	0	Prerequisite/s	:	EE210
Nature of Subject	:	Core	Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Explain construction, working and characteristics of D.C. generators and motors.

CO-2 Determine the performance characteristics of D.C. machines by conducting direct and indirect tests.

CO-3 Describe the construction and working of synchronous machine and determine voltage regulation by standard methods.

CO-4 Describe Two Reaction Theory of salient pole synchronous machine, power angle diagram, reluctance power, slip test, explain load characteristics of a stand-alone synchronous generator and the performance of synchronous generator connected to infinite bus.

CO-5 Describe V and inverted V curves, compounding curves, capability curves, phase swinging, hunting and damper windings, starting methods for synchronous motor and the use of synchronous condensers.

Course Articulation Matrix of EE320 -- D.C. and Synchronous Machines																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE320.1	Explain construction, working and characteristics of D.C. generators and motors.	3	2	1	-	1	-	-	-	1	1	-	3	2	-	-
EE320.2	Determine the performance characteristics of D.C. mahcines by conducting direct and indirect tests.	3	2	1	-	1	-	-	-	1	1	-	3	2	-	-
EE320.3	Describe the construction and working of synchronous machine and determine voltage regulation by standard methods.	3	2	1	-	1	-	-	-	1	1	-	3	2	-	-
EE320.4	Describe Two Reaction Theory of salient pole synchronous machine, power angle diagram, reluctance power, slip test, explain load characteristics of a stand-alone synchronous generator and the performance of synchronous generator connected to infinite bus.	3	2	1	-	1	-	-	-	1	1	-	3	2	-	-
EE320.5	Describe V and inverted V curves, compounding curves, capability curves, phase swinging, hunting and damper windings, starting methods for synchronous motor and the use of synchronous condensers.	3	2	1	-	1	-	-	-	1	1	-	3	2	-	-
Over-all Correlation of EE320 to PO's		3.00	2.00	1.00	-	1.00	-	-	-	1.00	1.00	-	3.00	2.00	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 D.C. Machines

(a) Construction, types of windings, E.M.F. equation. Types of excitation. Armature reaction. Interpoles. Compensating winding (qualitative analysis only). Terminal voltage, O.C.C. and load characteristics. of D.C .Generators, Torque equation of D.C. motor. Back E.M.F. in D.C. motor. Load characteristics and application of shunt, series, and compound motors. 10 Hours

(b) Speed control of motor by armature voltage control and field control. Losses and efficiency in D.C. machines. Testing of D.C. Machines by direct and indirect methods. Swinburne Test, Hopkinson Test, Field's Test. 10 Hours

2 Synchronous Machines

(a) Principle of working as a generator and as a motor. Types and construction. Non-salient pole synchronous generator – E.M.F. generated in a concentrated winding and distributed winding. Distribution and pitch factors. Armature reaction. Synchronous impedance. Equivalent circuit and phasor diagram. Voltage regulation. Open circuit and short circuit tests. Short Circuit Ratio. Determination of regulation by E.M.F., M.M.F, Z.P.F methods. 12 Hours

(b) Salient pole synchronous machines – Two Reaction Theory. Power angle diagram. Reluctance power. Slip test. Regulation in salient pole synchronous generator. Load characteristics of a stand-alone synchronous generator. Parallel operation of alternators. Synchronization of alternators to infinite bus bars. Methods of synchronization. Effect of change in excitation and prime-mover input on load sharing. 12 Hours

(c) Operating characteristics of a synchronous machine—power flow equations and power-angle characteristics. Performance on infinite bus at constant load with variable excitation and vice versa as a generator and as a motor. V and inverted V curves. Compounding curves. Capability curves. Phase swinging. Hunting and damper windings. Starting methods for synchronous motor. Synchronous condenser. 12 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. Dr. A. S. Aravinda Murthy, "Synchronous Machines and D.C. Motors", Pearson Education and Sanguine Technical Publishers, 2011.
3. Mulukutla S. Sarma and Mukesh K. Pathak, "Electric Machines", Cenage Learning, India Edition, 2009.
4. S. K. Bhattacharya, "Electrical Machines", Tata McGraw-Hill Education Pvt. Ltd., 2009.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", Second Editon, TMH.
6. Alexander Langsdorf, "Theory of Alternating Current Machines", TMH.
7. M. G. Say, "Performance and Design of A.C. Machines", C.B.S. Publishers.
8. Bhimbra, "Electric Machinery", Khanna Publishers.
9. A.E. Clayton and Hancock, "Performance and Design of D.C. Machines", E.L.B.S. Publication.
10. Wildy, "Electrical Machines, Drives and Power Systems", Pearson Education.

11. Stephen J. Chapman, “Electric Machinery Fundamentals”, McGraw-Hill Science/ Engineering/ Math; 4 Edition.

12. A. E. Fitzgerald, Jr. Charles Kingsley and Stephen D. Umans, “Electric Machinery”, McGraw-Hill, 6 Edition.

EE330 Electrical and Electronic Measurements

Total Lecture Hours	:	42	Credit Pattern L:T:P	:	3:0:1
Total Practical Hours	:	28	CIE, SEE Weightage	:	50%, 50%
Lecture Hours/Week	:	3	Prerequisite/s	:	Nil
Practical Hours/Week	:	2	Teaching Faculty	:	
Nature of Subject	:	Core			

Course Outcomes

After completing this course the student should be able to

CO-1 Perform error analysis of measurements and describe working principles of various types of electromechanical instruments, and methods of measuring frequency, power factor, real and reactive power in a practical circuit.

CO-2 Describe the working principle and applications of D.C. and A.C. bridges, working of Q-meter and vector impedance analyzer.

CO-3 Extend the range of a measuring instruments by using shunts, multipliers, CT's and PT's, determine errors in C.T. and P.T.

CO-4 Describe the working principle of various types of electronic instruments.

CO-5 Describe the working principle and applications of various types of transducers, and virtual instrumentation.

Course Articulation Matrix of EE330 -- Electrical and Electronic Measurements																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE330.1	Perform error analysis of measurements and describe working principles of various types of electromechanical instruments, and methods of measuring frequency, power factor, real and reactive power in a practical circuit.	3	2	1	-	1	-	-	-	1	-	-	2	2	2	-
EE330.2	Describe the working principle and applications of D.C. and A.C. bridges, working of Q-meter and vector impedance analyzer.	3	2	1	-	3	-	-	-	1	-	-	2	1	1	-
EE330.3	Extend the range of a measuring instruments by using shunts, multipliers, CT's and PT's, determine errors in C.T. and P.T.	3	2	1	-	3	-	-	-	1	-	-	2	1	1	-
EE330.4	Describe the working principle of various types of electronic instruments.	3	2	1	-	3	-	-	-	1	-	-	2	1	1	-
EE330.5	Describe the working principle and applications of various types of transducers, and virtual instrumentation.	3	2	1	-	3	-	-	-	1	-	-	2	1	1	-
Over-all Correlation of EE330 to PO's		3.00	2.00	1.00	-	3.00	-	-	-	1.00	-	-	2.00	1.20	1.20	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Errors in Measurement and Data Handling

Gross and systematic errors. Absolute and relative errors. Accuracy, precision, resolution, and significant figures. Measurement error combinations. Rules for rounding off. Treatment of random errors. Gaussian distribution. Combination of random errors. 6 Hours

2 Classical Electromechanical Instruments

(Since electromechanical instruments are rapidly becoming obsolete, only a cursory coverage of topics given here is suggested) Classification of electrical measuring instruments — absolute, secondary — indicating, recording, and integrating instruments. Permanent magnet moving coil (PMMC) instrument. Rectifier type instrument. Electrodynamometer type instruments. MI and electrostatic type meters. Reed type frequency meters. Phase sequence indicator. Analog multimeter. Measurement of power factor, real and reactive power in three-phase circuits. 5 Hours

3 Measurement of R, L, and C

Wheatstone bridge. Kelvin bridge. Megger and its use for the measurement of earth resistance. Location of cable open-circuit and ground faults. Measurements using classical A.C. bridges – Maxwell bridge, Anderson bridge, Wien bridge and Schering bridge. Transformer ratio bridge. Q meter. Vector impedance analyzer. 10 Hours

4 Extension of Instrument Ranges

Shunts and multipliers. Construction and theory of instrument transformers. Equations for ratio and phase angle errors of C.T. and P.T (derivations excluded). Measurement of errors of instrument transformers. Turns compensation, illustrative examples (excluding problems on turns compensation). 6 Hours

5 Electronic Instruments

Digital systems – quantization. Counters and timers. Analog to digital converters — flash type and successive approximation type, dual slope type. Digital multimeters. Digital panel meters for measuring current, voltage, active power and reactive power. Digital frequeny meter. Digital *RLC* meters. True RMS voltmeter. Digital Q meter. Electronic energy meter. Trivector meters. The CRT analog oscilloscope. Dual trace CRT oscilloscope — front panel details of a typical dual trace oscilloscope. Measurement of amplitude, phase, frequency, period, rise time, fall time. Use of Lissajous patterns. Digital storage oscilloscope. Oscilloscope probes. Virtual instrumentation. 9 Hours

6 Transducers

Classification and selection of transducers. Hall effect. Current and voltage transducers. Temperature transducers. Speed transducers — tacho generators, encoders. Photo-conductive and photo-voltaic cells. 6 Hours

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.

2. David A. Bell, “Electronic Instrumentation and Measurements”, Oxford University Press, 3rd Edition, 2015.
3. E. W. Golding and F. C. Widdies, “Electrical Measurements and Measuring Instruments”, Wheeler Student Edition, Reem Publications, 2011.
4. Melville B. Stout, “Basic Electrical Measurements”, Prentice Hall of India Pvt. Ltd., 2nd Edition, 1985.
5. A. K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation”, Dhanpatrai and Sons, New Delhi.
6. Cooper D. and A.D. Heifrick, “Modern Electronic Instrumentation and Measuring Techniques”, P.H.I.
7. John P. Beately, “Principles of Measurement Systems”, Pearson Education.
8. Harris, “Electric Measurements”, John Wiley.
9. Earnest Frank, “Electrical Measurement Analysis”, McGraw-Hill
10. S. Raghavendra, “Advanced Problems in Electrical Measurements”, Dwaipayana Publications.

Lab Experiments

Teacher can alter these experiments or give additional experiments.

1. Learning to use multimeters.
2. Learning to use CROs.
3. Learning to use different types of wattmeters.
4. Measurement of inductance and capacitance by any method which can be easily implemented in the lab (for example, by using an *R-L-C* meter).
5. Measurement of frequency and phase difference.
6. Measurement of three-phase active and reactive power.
7. Using instrument transformers in the measurement of voltage, current, and power.
8. Measurement of current, voltage, active power and reactive power using digital panel meters.
9. Measurement of earth resistance.
10. Learning to use virtual instrumentation for measurements.

EE340 Logic Design

Total Lecture Hours	: 42		Credit Pattern L:T:P	:	3:0:1
Total Practical Hours	: 28		CIE, SEE Weightage	:	50%, 50%
Lecture Hours/Week	: 3		Prerequisite/s	:	EC110
Practical Hours/Week	: 2		Teaching Faculty	:	
Nature of Subject	: Core				

Course Outcomes

After completing this course the student should be able to

CO-1 Design a combinational logic circuit for a given specification.

CO-2 Design combinational logic circuits using MSI components and describe the construction, working and application of Programmable Logic Devices (PLD's), Programmable Read-only Memories (PROMS)

CO-3 Describe Programmable Logic Arrays (PLA's), Programmable Array Logic devices (PAL's) and identify the properties of different logic families and select the appropriate family for a given application.

CO-4 Design registers, binary ripple counters, synchronous binary counters, counters based on shift registers.

CO-5 Design clocked Mealy and Moore sequential networks for a given specification.

Course Articulation Matrix of EE340 -- Logic Design																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE340.1	Design a combinational logic circuit for a given specification.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE340.2	Design combinational logic circuits using MSI components and describe the construction, working and application of Programmable Logic Devices (PLD's), Programmable Read-only Memories (PROMS)	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE340.3	Describe Programmable Logic Arrays (PLA's), Programmable Array Logic devices (PAL's) and identify the properties of different logic families and select the appropriate family for a given application.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE340.4	Design registers, binary ripple counters, synchronous binary counters, counters based on shift registers.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE340.5	Design clocked Mealy and Moore sequential networks for a given specification.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
Over-all Correlation of EE340 to PO's		3.00	3.00	1.00	1.00	3.00	-	-	-	-	-	-	2.00	-	3.00	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Combinational Logic Networks

Definition of combinational logic. Generation of switching equations from truth tables. Review simplification of switching equations using basic postulates of Boolean algebra. Canonical forms. SOP (m-notation) and POS (M-notation) forms of specifying switching functions. Karnaugh maps — 3, 4, variables and its use to minimize logical expressions. Incompletely specified functions (don't care terms). Simplifying maxterm equations. Quine-McCluskey minimization technique. Quine-McCluskey method using don't care terms. Reduced prime implicant tables. Decimal method of simplification. Map entered variables. 9 Hours

2 Logic Design with MSI Components and Programmable Logic Devices

Binary adders and subtractors. Carry look-ahead adder. Decimal adders. Comparators. Decoders and their use in logic design. Decoders with an ENABLE input. Encoders. Multiplexers and their use in logic design. Programmable Logic Devices (PLDs). PLD notation. Programmable Read-only Memories (PROMS). Programmable Logic Arrays (PLAs). Programmable Array Logic devices (PALs). 8 Hours

3 Logic Levels and Families

Logic levels. Integration levels. Output switching times. Propagation delay. Fan-out and fan-in. Transistor-transistor logic. 74/54 logic family. Wired logic. TTL with totem-pole output.

Three-state output TTL. Schottky TTL. MOSFET as a resistor. CMOS family. Comparison of TTL and CMOS logic families. 8 Hours

4 Flip Flops and Their Applications

The basic bi-stable element. The *S-R* latch. Application of *S-R* latch as a switch debouncer. The gated *S-R* latch. The gated *D*-latch. The master-slave *J-K* flip-flops. Edge-triggered *D*-flip-flop. Excitation table and characteristic equations of flip-flops. Registers. Counters. Binary ripple counters. Synchronous binary counters. Counters based on shift registers. Design of synchronous counters using *D*, *T*, or *SR* flip-flops. 9 Hours

5 Synchronous Sequential Networks

Introduction. Mealy and Moore Models. State machine notation. Structure and operation of clocked sequential networks. Analysis of clocked sequential networks — excitation and output expression, transition equations, transition tables, excitation tables, state tables, state diagrams. 8 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. Donald D. Givone, "Digital Principles and Design", TMH.
3. John Yarbrough, "Digital Logic: Applications and Design", Thomson Learning.
4. Ronald Tocci, "Digital Systems: Principles and Applications", Pearson/Prentice Hall.
5. Morris Mano, "Digital Logic and Computer Design", PHI.
6. R. P. Jain, "Modern Digital Electronics", 2nd Edition, TMH.

Lab Experiments

Teacher can alter these experiments or give additional experiments.

1. Simplification & realization of Boolean expressions(SOP POS forms) using logic gates.
2. Design of arithmetic circuits adders & sub tractors . 4-bit IC parallel adders. Complement arithmetic and decimal adders.

3. Design of comparators & code converters — Gray-binary, binary-Gray.
4. Logic design using multiplexers, decoders and demultiplexers.
5. Design of seven segment display using decoders.
6. Design of 3-bit synchronous and asynchronous counters of arbitrary modulo UP, DOWN and UP/DOWN using flip-flop
7. Design of counters of different types using IC's (not more than 4-bit).
8. Design shift registers using flip-flops — universal shift registers and shift register IC versions.

EE350 Analog Electronic Devices and Circuits

Total Lecture Hours	: 42	Credit Pattern L:T:P	:	3:0:1	
Total Practical Hours	: 28	CIE, SEE Weightage	:	50%, 50%	
Lecture Hours/Week	: 3	Prerequisite/s	:	EC110	
Practical Hours/Week	: 2	Teaching Faculty	:		
Nature of Subject	: Core				

Course Outcomes

After completing this course the student should be able to

CO-1 Describe the fundamentals of amplifiers and analyze a BJT amplifier circuits.

CO-2 Describe the stucture, working and modeling of MOSFETs.

CO-3 Analyze MOSFET amplifier circuits.

CO-4 Analyze feedback amplifiers, oscillators, and power amplifier circuits.

CO-5 Describe the working of basic building blocks of analog integrated circuits.

Course Articulation Matrix of EE350 -- Analog Electronic Devices and Circuits

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE350.1	Describe the fundamentals of amplifiers and analyze a BJT amplifier circuits.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE350.2	Describe the stucture, working and modeling of MOSFETs.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE350.3	Analyze MOSFET amplifier circuits.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE350.4	Analyze feedback amplifiers, oscillators, and power amplifier circuits.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
EE350.5	Describe the working of basic building blocks of analog integrated circuits.	3	3	1	1	3	-	-	-	-	-	-	2	-	3	-
Over-all Correlation of EE350 to PO's		3.00	3.00	1.00	1.00	3.00	-	-	-	-	-	-	2.00	-	3.00	-

Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"

Over-all correlation of a subject with a PO is the average value of correlation constant in that column.

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Introduction to Amplifiers

Amplifier fundamentals – circuit symbol, voltage gain, current gain, power gain, gain in decibels, input impedance, output impedance, power efficiency, amplifier saturation. Amplifying action of controlled sources. Amplifier types – voltage amplifier, current amplifier, transconductance amplifier, transresistance amplifier. Types of coupling multiple amplifier stages. Frequency response of an amplifier. Classification of amplifiers. Distortion in amplifiers. 4 Hours

2 BJT Amplifiers

Review of output characteristics of a BJT in CE configuration, D.C. load line and bias point. Purpose of biasing transistor and using coupling capacitors in amplifiers. Review of voltage divider biasing circuit, its design and trouble shooting. Biasing a BJT using collector-to-base feedback resistor. A.C. load line concept. Introduction to two-port networks. Transistor in CE configuration viewed as a two-port network. Low frequency hybrid model of BJT. Low frequency h-parameters of a BJT in CE configuration. Determination of low frequency h-parameters of a BJT in CE configuration from static characteristics. Analysis of CE small-signal BJT amplifier circuit operating at low frequency using h-parameters. CE amplifier with and without emitter resistance. CB amplifier and CC amplifier (Emitter Follower) comparisons. Miller's theorem and its dual. Application of Miller's theorem for analyzing a BJT amplifier circuit. The T-model of BJT. The hybrid-Π CE transistor model. Hybrid-Π conductances. Hybrid-Π capacitances. The $R-C$ BJT coupled amplifier. Transformer coupled BJT amplifier. 9 Hours

3 MOS Field Effect Transistors

Introduction. Comparison with BJT. MOSFETs – types, structure, circuit symbol. I_D-V_{DS} characteristics – cutoff, linear and saturation regions of operation. Derivation of expressions for I_D-V_{DS} characteristics. Threshold voltage. Channel length modulation. The Body effect. Temperature effects. Breakdown and input protection. Analysis of MOSFET circuits excited by only D.C. Large signal operation transfer characteristics, operation as a switch, operation as a linear amplifier. 4 Hours

4 MOSFET Amplifiers

MOSFET biasing in amplifiers – biasing by fixing V_{GS}, biasing by fixing V_G and connecting a resistance in the source, biasing using a drain to gate feedback resistor. Analysis of small-signal CS MOSFET amplifier using hybrid-Π and T models of MOSFETs. CS amplifier with source resistance. CG amplifier. CD amplifier. Gate capacitance effect, junction capacitances, high-frequency model of MOSFET, unity gain frequency of MOSFET. Frequency response of CS amplifier. 10 Hours

5 Feedback Amplifiers, Oscillators and Power Amplifiers

Classification. Feedback concept. Transfer gain with feedback. General characteristics of amplifiers with negative feedback. Input resistance, output resistance. Distinction between small signal amplifiers and large signal amplifiers. Class A large signal amplifiers. Transformer coupled audio power amplifier. Push-pull amplifiers. Class B operation. Efficiency of amplification. Oscillator operation. Phase shift oscillator. Wienbridge oscillator. Tuned oscillator circuits. Crystal oscillator. 8 Hours

6 Analog Integrated Circuit Building Blocks

Biasing BJTs and MOSFETs using a constant-current source. Current sources using BJT and MOSFETS. Current mirrors using BJTs and MOSFETS. The BJT gain stage and MOSFET gain stage. Differential amplifiers using BJT and MOSFETs 7 Hours

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.

2. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, “Microelectronic Circuits : Theory and Applications”, 6th Edition, Oxford Univesity Press, 2015.
3. Theodore F. Bogart Jr., Jeffrey S. Beasley, and Guilermo Rico, “Electronic Devices and Circuits”, 6th Edition, Pearson Education, 2013.
4. Jacob Millman and Christos C. Halkias, “Integrated Electronics: Analog and Digital Circuits and Systems”, McGraw-Hill Book Company.
5. David A. Bell, “Electronic Devices and Circuits”, Fourth Edition, PHI.
6. Robert L. Boylestad, Louis Nashelsky, and K. Lal Kishore, “Electronic Devices and Circuit Theory”, Pearson Education.
7. N. N. Bhargava, D.C. Kulshreshtra, S.C. Guptha, “Basic Electronics and Linear Circuits”, TMH.

Lab Experiments

Teacher can alter these experiments or give additional experiments.

1. Design and testing of single stage RC coupled amplifier for given specifications.
2. Design and testing of two-stage *R*-*C* coupled amplifier for given specifications.
3. Design and testing of Emitter follower for given specifications.
4. Design and testing of MOSFET CS amplifier for given specifications.
5. Design and testing of Class-B power amplifier for given specifications.
6. Design and testing of Current Series Feedback amplifier for given specifications.
7. Design and testing of Voltage Shunt Feedback amplifier for given specifications.
8. Design and testing of any one type of oscillator.
9. Design and testing a BJT current mirror.
10. Design and testing a MOSFET current mirror.

IV Semester

Applicable to 2012 and Later Batches

Scheme of Study and Examination for IV Semester of B.E. Program in E&EE

Sl. No.	Sub. Code.	Course Title	Teaching Dept.	Credits				Contact h/Wk	Marks		Exam Hours
				Lecture	Tutorial	Practicals	Total		CIE	SEE	
1	MA410	Probability and Statistics	Maths	4	0	0	4	4	50	50	3
2	EE410	Electrical Power Generation	E&EE	4	0	0	4	4	50	50	3
3	EE420	Signals and Systems	E&EE	4	0	0	4	4	50	50	3
4	EE430	Field Theory	E&EE	4	0	0	4	4	50	50	3
5	EE440	Op-amps and Linear ICs	E&EE	3	0	1	4	5	50	50	3
6	EE450	Transformers and Induction Machines	E&EE	4	0	0	4	4	50	50	3
7	EE46L	D.C. and Synchronous Machines Lab	E&EE	0	0	1.5	1.5	3	50	-	3
8	EE47L	Circuit Simulation and Signal Processing Lab	E&EE	0	0	1.5	1.5	3	50	-	3
9	HU310 HU410	Constitution of India / Environmental Studies	*	0	0	0	0	2	-	-	-
				Total			27	33	Total		24

- One hour/week of lecture is equal to 1 credit.
- Two hours/week of practicals is equal to 1 credit.
- Two hours/week of tutorial is equal to 1 credit.
- CIE : Continuous Internal Evaluation.
- SEE: Semester End Examination.

MA410 Probability and Statistics

Teaching Faculty: Credits: 4; Pattern: L:T:P=4:0:0
Hours/Week: 4 CIE: 50 Marks; SEE: 50 Marks

NOTE: Hourly lesson plan for covering this syllabus and topic-wise allocation of marks in the SEE will be provided by the teacher.

Course Outcomes

After completing this course the student should be able to

CO-1 Determine measures of central tendency and measures of dispersion for a given data.

CO-2 Fit curves for a given set of data and perform regression analysis.

CO-3 Apply Bernoulli's Theorem to solve problems on probability. Use probability distributions.

CO-4 Classify stochastic processes.

CO-5 Solve problems on Markov chains.

1 Introduction

Definition and treatment of data; measures of central tendency; measures of dispersion.

2 Curve Fitting

Method of least squares (line, second-order curves, exponential curve); correlation and regression analysis.

3 Probability and Stochastic Processes

Definition, addition and product theorems; total probability, conditional probability, compound probability; Baye's theorem. Discrete random variables and probability distributions – P.D.F. And C.D.F.; Bernoulli's theorem; Binomial distribution; Poisson distribution. Continuous random variables – Normal, Exponentioal, Gamma and Beta distributions. Joint Probability distributions – Joint probability and joint distribution of discrete variables; marginal probability distribution; independent random variable – expectation, variance, covariance and correlation; continuous random variables, associated joint probability function and marginal distributions – expectation, variance and correlation. Sampling Distributions – random sampling, sampling distribution of means; testing of hypothesis; type I and type II errors; significance level; tests of significance for large samples, of means and properties; test of significance for small samples, degrees of freedom, student's t-distribution. Markov Chains – Classification of stochastic processes; definition of probability vector; stochastic matrix and regular stochastic matrix; fixed point and fixed probability vector; Markov chain definition; transition probabilities and its matrix; higher transition probabilities; stationary distribution of regular Markov chains; irreducible Markov chain; absorbing state of a Markov chain.

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.
2. Richard Levin, "Probability and Statistics",
3. Richard A Johnson, "Probability and Statistics for Engineers"

EE410 Electrical Power Generation

Total Lecture Hours	: 56		Credit Pattern L:T:P	:	4:0:0
Lecture Hours/Week	: 4		CIE, SEE Weightage	:	50%, 50%
Practical Hours/Week	: 0		Prerequisite/s	:	Nil
Nature of Subject	: Core		Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Describe different types of electric power plants, basis for selection of site, general arrangement, layout, working of hydro and thermal power plants, and the adverse effects of burning fossil fuels on the environment.

CO-2 Describe the basis for selection of site, general arrangement, layout, safety aspects and working of nuclear, diesel-electric and gas turbine power plants.

CO-3 Describe various factors used to indicate power plant performance, factors to be considered for their interconnection and the method of improving power factor.

CO-4 Describe factors to be considered for location of substation, bus bar arrangement in substations, different substation equipment, reactors and capacitors.

CO-5 Describe the need for current limiting reactors, different types of grounding system employed in substations, and calculate symmetric short circuit MVA.

Course Articulation Matrix of EE410 -- Electrical Power Generation

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE410.1	Describe different types of electric power plants, basis for selection of site, general arrangement, layout, working of hydro and thermal power plants, and the adverse effects of burning fossil fuels on the environment.	3	2	3	-	3	-	-	3	1	1	-	1	3	-	3
EE410.2	Describe the basis for selection of site, general arrangement, layout, safety aspects and working of nuclear, diesel-electric and gas turbine power plants.	3	2	3	-	3	-	-	3	1	1	-	1	3	-	3
EE410.3	Describe various factors used to indicate power plant performance, factors to be considered for their interconnection and the method of improving power factor.	3	2	3	-	3	-	-	3	1	1	-	1	3	-	3
EE410.4	Describe factors to be considered for location of substation, bus bar arrangement in substations, different substation equipment, reactors and capacitors.	3	2	3	-	3	-	-	-	1	1	-	1	3	-	1
EE410.5	Describe the need for current limiting reactors, different types of grounding system employed in substations, and calculate symmetric short circuit MVA.	3	2	3	-	3	-	-	3	1	1	-	1	3	-	1
Over-all Correlation of EE410 to PO's		3.00	2.00	2.00	-	3.00	-	-	2.40	1.00	1.00	-	1.00	3.00	-	2.20

Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"

Over-all correlation of a subject with a PO is the average value of correlation constant in that column.

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Introduction to Electrical Power Generation

Wind, solar, fuel, tidal, geo-thermal, hydro-electric, thermal, diesel, gas, nuclear, diesel electric plants, gas turbine (block diagram approach only). Concepts of co-generation, distributed generation and hybrid power generation systems. 10 Hours

2 Hydro Power Generation

Selection of site, classification of hydro electric plants. General arrangement and operation. Hydro electric power station layout and control. 6 Hours

3 Thermal Power Generation

Introduction, main parts of a thermal power plant. Working. Plant layout. 4 Hours

4 Nuclear Power Station

Introduction. Adverse effects of fossil fuels. Pros and cons of nuclear power generation. Selection of site, cost, components, components of reactors. Description of fuel sources. Safety aspects of nuclear power generation. 6 Hours

5 Diesel and Gas Turbine Power Plants

Diesel electric plants and components. Choice and characteristics. Plant layout and maintenance. Simple gas turbine plants, components of gas turbine plants, plant layout, advantages of gas turbines plants over steam turbine plant. 6 Hours

6 Economics Aspects

Introduction. Terms commonly used in system operation — diversity factor, load factor, plant capacity factor, plant use factor, plant utilization factor, loss factor, load duration curve. Power factor improvement and tariffs. Energy-load curve. Interconnection of power stations. 8 Hours

7 Substations

Introduction. Types. Bus bar arrangement. Schemes. Location. Substation equipment. Reactors and capacitors. Current limiting reactors. Symmetric short circuit MVA calculations. 8 Hours

8 Grounding Systems

Introduction. Resistance grounding systems. Neutral grounding. Ungrounded system. Resonant grounding. Solid grounding. Reactance grounding. Resistance grounding. Earthing transformer. Neutral grounding transformer. 8 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. S. N. Singh, “Electric Power Generation Transmission and Distribution”, Prentice-Hall of India, New Delhi, 2008.
3. A. Chakrabarti, M. L. Soni, P. V. Gupta, U. S. Bhatnagar, “Power System Engineering”, Dhanpat Rai and Co.,
4. M. V. Deshpande, “Elements of Electrical Power Station Design”, A. H. Wheeler and Co.

EE420 Signals and Systems

Total Lecture Hours	: 56		Credit Pattern L:T:P	:	4:0:0
Lecture Hours/Week	: 4		CIE, SEE Weightage	:	50%, 50%
Practical Hours/Week	: 0		Prerequisite/s	:	Nil
Nature of Subject	: Core		Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Classify signals, perform basic operations on them, and test a system for its properties.

CO-2 Represent a linear system in time domain and determine the output of a given linear system by convolution in time domain.

CO-3 Represent signals and systems in frequency domain.

CO-4 Apply Z-transforms to analyze discrete-time systems.

CO-5 Describe the issues related to sampling of analog signals and reconstruction of analog signals from sampled discrete-time signal.

Course Articulation Matrix of EE420 -- Signals and Systems

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE420.1	Classify signals, perform basic operations on them, and test a system for its properties.	3	1	-	-	2	-	-	-	-	-	-	1	-	-	-
EE420.2	Represent a linear system in time domain and determine the output of a given linear system by convolution in time-domain.	3	1	-	-	1	-	-	-	-	-	-	1	-	-	-
EE420.3	Represent signals and systems in frequency domain.	3	1	-	-	1	-	-	-	-	-	-	1	-	-	-
EE420.4	Apply Z-transforms to analyze discrete-time systems.	3	1	1	-	1	-	-	-	-	-	-	1	-	-	-
EE420.5	Describe the issues related to sampling of analog signals and reconstruction of analog signals from sampled discrete time signals.	3	1	1	-	2	-	-	-	-	-	-	1	-	-	-
Over-all Correlation of EE420 to PO's		3.00	1.00	0.25	-	1.40	-	-	-	-	-	-	1.00	-	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
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PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Introduction

Definitions of a signal and a system. Signals and systems as seen in everyday life, and in various branches of engineering and science — electrical, mechanical, hydraulic, thermal, biomedical signals and systems as examples. Extracting the common essence and requirements of signal and system analysis from these examples. Classification of signals. Signal properties – periodicity, absolute integrability, determinism and stochastic character. Basic operations on signals. Elementary signals. Systems viewed as interconnections of operations. Properties of systems – linearity, causality, time invariance/variance, stability, memory, realizability, with examples.

12 Hours

2 Time Domain Representation of LTI Systems

Properties of LTI systems. Impulse response. Convolution integral and convolution sum. Differential and difference equation representations. Commutative, distributive, associative properties. Invertibility, causality, stability of LTI systems. Block diagram representations and analysis.

9 Hours

3 Frequency Domain Representation of Signals and LTI Systems

Exponential form of Fourier series of periodic continuous-time signals and discrete-time signals and their properties. Continuous-time Fourier Transform – properties, magnitude and phase representation. Discrete-time Fourier Transforms – properties, magnitude and phase representation. The idea of signal space and orthogonal bases of signals. 9 Hours

Periodic and semi-periodic inputs to an LTI system, the notion of frequency response and its relation to the impulse response. Magnitude-phase representation of frequency response of LTI systems. Analysis of first-order and second-order LTI systems using Continuous-time Fourier Transforms. Parseval's Theorem. Filtering. Simple *R*-*C* high pass filter and low pass filter.

9 Hours

4 *Z*-Transforms

Introduction, *Z*-transform, ROC. Properties of *Z*-transforms, inversion of *Z*-transforms, Transforms analysis of discrete-time LTI Systems. Computational structures for implementing discrete-time systems. Unilateral *Z*-transform and its applications to solve difference equations.

8 Hours

5 Sampling of Signals

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction — ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems. 9 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia, 2nd edition, 1997. Indian Reprint 2002.
3. Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2001.Reprint 2002.
4. Michel J Roberts, "Signals and Systems: Analysis of signals through Linear systems", Tata McGraw Hill, 2003.
5. H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2006.
6. David K. Cheng, "Analysis of Linear Systems", Narosa Publishing Company.
7. Relevant course materials available at http://nptel.iitm.ac.in/index.php

EE430 Field Theory

Total Lecture Hours	: 56	Credit Pattern L:T:P	:	4:0:0
Lecture Hours/Week	: 4	CIE, SEE Weightage	:	50%, 50%
Practical Hours/Week	: 0	Prerequisite/s	:	Nil
Nature of Subject	: Core	Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Explain Coulomb's and Gauss's laws and apply them to compute electrostatic forces and stresses in a system of static charge configurations.

CO-2 Explain and compute the potential field of system of static charges. Explain and compute charge distributions in a conductor under static condition.

CO-3 Explain and compute capacitance and energy stored for some practical configurations. Explain significance of Laplace and Poisson equations and apply them for field computations.

CO-4 State and explain basic laws of magneto statics, derive force expressions, explain and compute magnetic parameters under static field condition.

CO-5 Explain and interpret Faradays laws of induction and Maxwell's equations, applied to time varying field and compute the field parameters.

Course Articulation Matrix of EE430 -- Field Theory

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE430.1	Explain Coulomb's and Gauss's laws and apply them to compute electrostatic forces and stresses in a system of static charge configurations.	3	1	1	-	2	-	-	1	-	1	-	1	2	-	1
EE430.2	Explain and compute the potential field of system of static charges. Explain and compute charge distributions in a conductor under static condition.	3	1	1	-	2	-	-	1	-	1	-	1	2	-	1
EE430.3	Explain and compute capacitance and energy stored for some practical configurations. Explain significance of Laplace and Poisson equations and apply them for field computations.	3	1	1	-	2	-	-	1	-	1	-	1	2	-	1
EE430.4	State and explain basic laws of magneto statics, derive force expressions, explain and compute magnetic parameters under static field condition.	3	1	1	-	2	-	-	1	-	1	-	1	2	-	1
EE430.5	Explain and interpret Faradays laws of induction and Maxwell's equations, applied to time varying field and compute the field parameters.	3	1	1	-	2	-	-	1	-	1	-	1	2	-	1
Over-all Correlation of EE430 to PO's		3.00	1.00	1.00	-	2.00	-	-	1.00	-	1.00	-	1.00	2.00	-	1.00
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
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PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
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PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Time Invariant Electric Fields (Electrostatics)

Coulomb's Law and Electric Field Intensity: Experimental law of coulomb, electric field intensity, field due to continuous volume charge distribution, field due to line charge and field of a sheet of charge, field lines and sketches. 6 Hours

Electric flux density, Gauss's law and Divergence: Electric flux density, Gauss's law , application of gauss's law for some symmetrical charge distributions , application of gauss's law for differential volume element, divergence, max well's first equation in electrostatics, vector operator (delta) and the divergence theorem. 6 Hours

Energy and Potential: Energy expended in moving a point charge in an electric field, the line integral, potential difference and potential, potential field of a point charge, potential field of system of charges- conservative property, potential gradient, the dipole, energy density in the electrostatic field. 6 Hours

Current and Conductors: Current and current density, continuity of current, metallic conductors, conductor properties and boundary conditions 6 Hours

Dielectrics and Capacitance: The nature of dielectrics materials, boundary conditions for perfect dielectrics materials, capacitance, capacitance examples, current analogies. 4 Hours

Poisson's and Laplace's Equations: The derivation of Poisson's and Laplace's equation, uniqueness theorem, examples of the solution of Laplace's and Poisson's equations. 6 Hours

2 Time Invariant Magnetic Fields (Magnetostatics)

The Steady Magnetic Field: Biot-Savart Law, Ampere's Circuital Law, Curl, Stokes' theorem, magnetic flux and magnetic flux density, scalar and vector magnetic potentials. 6 Hours

Magnetic Forces, Materials and Inductance: Force on a moving charge, force on a differential current element, force between differential current elements, force and torque on a closed circuit, the nature of magnetic materials, magnetization and permeability, magnetic boundary conditions, the magnetic circuit, potential energy and forces on magnetic materials, inductance and mutual inductance. 6 Hours

3 Time Variant Electric and Magnetic Fields (Electromagnetics)

Faraday's Law: Emf induced by changing field within a stationary path (transformer emf), Emf induced in a moving conductor within a constant field (motional or generator emf). 5 Hours

Displacement Current and Maxwell Equations: Displacement current and its Interpretations, Maxwells equations in point form and its interpretations, Maxwell's equations in integral forum and its interpretations, the retarted potentials. 5 Hours

References

NOTE: Specific text book/s to be followed topic-wise will be prescribed by the teacher.

1. Course Materials.
2. William H. Hayt Jr. and John A. Buck, "Engineering Electromagnetics", T.M.H.
3. John D. Kraus and Daniel A. Fleisch, "Electromagnetics with Applications", McGraw-Hill.
4. Guru and Hiziroglu, "Electromagnetic Field Theory Fundamentals", Thomson Asia Pvt. Ltd.
5. Joseph Edminister, "Electromagnetics", Schaum Outline Series, McGraw-Hill.
6. Matthew N. O. Sadiku, "Elements of Electromagnetics", 4th Edition, Oxford University Press.
7. Relevant course materials available at http://nptel.iitm.ac.in/index.php

EE440 Op-amps and Linear ICs

Total Lecture Hours	:	42		Credit Pattern L:T:P	:	3:0:1
Total Practical Hours	:	28		CIE, SEE Weightage	:	50%, 50%
Lecture Hours/Week	:	3		Prerequisite/s	:	EC110, EE350
Practical Hours/Week	:	2		Teaching Faculty	:	
Nature of Subject	:	Core				

Course Outcomes

After completing this course the student should be able to

CO-1 Describe the equivalent circuit, ratings of op-amps and operating characteristics of their open-loop and configurations with negative feedback and interpret information given in the data sheets of op-amps.

CO-2 Use op-amps to perform mathematical operations on signals, convert voltage to current.

CO-3 Design active filters and oscillators using op-amps.

CO-4 Use specialized linear ICs for appropriate applications.

CO-5 Design power supplies using linear voltage regulators.

Course Articulation Matrix of EE440 -- Op-amps and Linear ICs

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE440.1	Describe the equivalent circuit, ratings of op-amps and operating characteristics of their open-loop and configurations with negative feedback and interpret information given in the data sheets of op-amps.	3	1	1	-	2	-	-	-	-	-	-	2	-	3	-
EE440.2	Use op-amps to perform mathematical operations on signals, convert voltage to current.	3	1	1	-	2	-	-	-	-	-	-	2	-	3	-
EE440.3	Design active filters and oscillators using op-amps.	3	1	1	-	2	-	-	-	-	-	-	2	-	3	-
EE440.4	Use specialized linear ICs for appropriate applications.	3	1	1	-	2	-	-	-	-	-	-	2	-	3	-
EE440.5	Design power supplies using linear voltage regulators.	3	1	1	-	2	-	-	-	-	-	-	2	-	3	-
Over-all Correlation of EE440 to PO's		3.00	1.00	1.00	-	2.00	-	-	-	-	-	-	2.00	-	3	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
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PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Operational Amplifiers

Introduction to op-amp. Block diagram representation of an op-amp. Ideal op-amp. Equivalent circuit of an ideal op-amp. Ideal voltage transfer curve. The practical op-amp – input bias current, input offset voltage, input offset current, CMRR, frequency response, compensation, slew rate. Interpretation of data sheets and characteristics of an op-amp. Open-loop op-amp configurations. 5 Hours

2 Op-amp with Negative Feedback

Block diagram representation of feed back configurations. Voltage series feed back amplifier — negative feed back, closed loop voltage gain, input resistance with feed back, output resistance with feed back, bandwidth with feed back, total output offset voltage with feed back, voltage follower. Voltage shunt feedback amplifier — closed-loop voltage gain, inverting input terminal at virtual ground, input resistance with feedback, output resistance with feedback, bandwidth with feedback, total output offset voltage with feedback. Current-to-voltage converter. Inverter. 6 Hours

3 General Linear Applications of Op-amps

D.C. and A.C. amplifiers. A.C. amplifiers with a single supply voltage. The peaking amplifier. Summing, scaling, and averaging amplifiers. Instrumentation amplifiers. Differential input and differential output amplifiers. Voltage-to-current converter with floating load. Voltage-to-current converter with grounded load. Very high input impedance circuit. The integrator. The differentiators. 7 Hours

4 Active Filters and Oscillatoars

Introduction. First and second order low-pass and high pass Butterworth filter design. Oscillators and their principles. Phase shift oscillator. Wien bridge oscillator. Square-wave, triangular-wave and sawtooth-wave generators. Voltage controlled oscillators. 7 Hours

5 Comparators and Converters

Basic comparator. Zero crossing detectors. Inverting and non-inverting Schmitt trigger circuits. Limitations of op-amp as comparators. Voltage limiters. High-speed and precision-type comparator. Window detector. Voltage-to-frequency and frequency-to-voltage converters. ADCs and DACs. Clippers and clampers – both positive and negative types. Absolute-value output circuit. Peak detector. Sample-and-hold circuit. Precision half-wave and full-wave rectifiers.
7 Hours

6 Specialized IC Applications

Universal active filter. Switched capacitor filter. The 555 timer. Astable and monostable multivibrators using 555 timer. Phase locked loops. Power amplifiers. 5 Hours

7 D.C. Voltage Regulators

Voltage regulators basics. Voltage follower regulator. Adjustable output regulator. Precision voltage regulators and integrated circuit voltage regulators. 5 Hours

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.

2. Ramakanth A. Gayakwad, “Operational Amplifiers and Linear ICs”, Pearson, 4th Edition, 2015.

3. Theodre F. Bogart, Jeffrey S. Beasley and Guilermo Rico, “Electronic Devices and Circuits”, Pearson, 6th Edition, 2013.

4. David A. Bell, “Operational Amplifiers and Linear ICs”, PHI, 2008.

5. Relevant course materials available at http://nptel.iitm.ac.in/index.php

Lab Experiments

Teacher may suggest experiments in addition to or other than building and testing the following:

1. Inverting and non-inverting comparators and ZCD.
2. Schmitt trigger.
3. Adder, subtractor, integrator and differentiators.
4. Inverting and non-inverting amplifier.
5. Precision half-wave and full-wave rectifiers.
6. Clippers and clampers.
7. Any one type of filter.
8. Any one type of oscillator.
9. Astable and monostable multivibrator using 555 timer.
10. Regulated D.C. supply.
11. A frequency multiplier using PLL IC.
12. A power amplifier.

EE450 Transformers and Induction Machines

Total Lecture Hours	:	56	Credit Pattern L:T:P	:	4:0:0
Lecture Hours/Week	:	4	CIE, SEE Weightage	:	50%, 50%
Practical Hours/Week	:	0	Prerequisite/s	:	EE210
Nature of Subject	:	Core	Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Describe the construction of transformers used in power systems, and determine the performance parameters of single-phase transformers.

CO-2 Determine the load shared by transformers operating in parallel, and explain the use of autotransformers.

CO-3 Describe various transformer connections for three-phase operation in various configurations and for three-phase to two phase conversion by Scott connection.

CO-4 Describe the working and characteristics of three-phase induction motor, and determine its performance parameters.

CO-5 Describe various methods of starting, control of three-phase induction motors and working principle and characteristics of different types of single-phase motors.

Course Articulation Matrix of EE450 -- Transformers and Induction Machines																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE450.1	Describe the construction of transformers used in power systems, and determine the performance parameters of single-phase transformers.	3	2	1	-	2	-	-	-	-	-	-	2	2	-	1
EE450.2	Determine the load shared by transformers operating in parallel, and explain the use of autotransformers.	3	2	1	-	2	-	-	-	-	-	-	2	2	-	1
EE450.3	Describe various transformer connections for three-phase operation in various configurations and for three-phase to two phase conversion by Scott connection.	3	2	1	-	2	-	-	-	-	-	-	2	2	-	1
EE450.4	Describe the working and characteristics of three-phase induction motor, and determine its performance parameters.	3	2	1	-	2	-	-	-	-	-	-	2	2	-	1
EE450.5	Describe various methods of starting, control of three-phase induction motors and working principle and characteristics of different types of single-phase motors.	3	2	1	-	2	-	-	-	-	-	-	2	2	-	1
Over-all Correlation of EE450 to PO's		3.00	2.00	1.00	-	2.00	-	-	-	-	-	-	2.00	2.00	-	1.00
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
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PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1 Introduction to Transformers

Principle of transformer action for voltage transformation. E.M.F. equations. Constructional details of shell type and core types of single-phase and three-phase transformers. Methods of cooling. Description of the following types of transformers — power transformer, distribution transformer, instrument transformer, tap changing of transformers, autotransformers. Modern trends in transformer technology. 4 Hours

2 Single-phase Transformers

Ideal transformer. Ideal transformer on no-load and on load with corresponding phasor diagrams. M.M.F. balance in the magnetic circuit. Current transformation ratio. Impedance referred to primary and secondary. 4 Hours

Practical transformer. Comparison with ideal transformer. Development of exact equivalent circuit. Approximate equivalent circuit. Opearation on no-load and on load. Phasor diagrams for different power factors of load. Performance parameters of transformers – losses, power efficiency and all-day efficiency, and regulation.

4 Hours

Testing of transformers — O.C. test, S.C. test and predetermination of efficiency and regulation. Sumpner's test. Parallel operation and load sharing (ideal and practical). Connection of single-phase transformer as an autotransformer. Comparison of copper used in an autotransformer and a two-winding transformer of same rating. Applications of autotransformers.

6 Hours

3 Three-phase Transformers

Three-phase transformer connections. Phase shit between primary and secondary and vector groups. Labeling of terminals. Choice of connection. Polyphase connections of single-phase transformers. Open delta and Scott connection. Parallel operation. Tap-changing and voltage control. Three-winding transformers — advantages and disadvantages, equivalent circuit. Inrush current phenomena in transformers. Standards related to transformers. 8 Hours

4 Three-phase Induction Motor

Rotating magnetic field — qualitative and mathematical analysis. Operating principle, construction, classification and types. Phasor diagram of induction motor on no-load and loaded. Three-phase induction motor as a generalized transformer. Derivation of equivalent circuit. Fictitious load resistance. Performance evaluation — output power, losses, torque, efficiency, current and power factor. Torque-slip characteristics (motoring, generating and braking regions). Current-power factor characteristics. Induction generator. 10 Hours

No-load and blocked rotor tests. Performance evaluation from circle diagram and equivalent circuit. Cogging and crawling. Double-cage and deep-bar motors — basic principle, equivalent circuit, and performance. 8 Hours

5 Starting and Control of Three-phase Induction Motor

Need for starter. DOL, Y-Delta and autotransformer starting. Rotor resistance starting. Automatic starters (any one type). Speed control by voltage, frequency, and rotor resistance variations. Standards related to three-phase induction motor. 6 Hours

6 Single-phase Induction Motor

Principle of operation (double revolving field theory). Slip-torque characteristics. Split-phase, capacitor start, capacitor start and capacitor run and shaded pole motors. Standards related to single-phase transformers. 6 Hours

References

NOTE: Specific text book/s to be followed will be prescribed by the teacher.

1. Course Materials.
2. Mulukutla S. Sarma and Mukesh K. Pathak, “Electric Machines”, Cenage Learning, 2009.

3. S. K. Bhattacharya, “Electrical Machines”, TMH, 2009.
4. Dr. A. S. Aravinda Murthy, “Transformers and Induction Motors”, Sanguine Technical Publishers, 2010.
5. Alexander Langsdorf, “Theory of Alternating Current Machines”, T.M.H.
6. M. G. Say, “Performance and Design of A.C. Machines”, C.B.S. Publishers.
7. I. J. Nagrath and D. P. Kothari, “Electric Machines”, 2nd Edition, T.M.H., ISBN 0-07-463285-X.
8. Kosov, “Electrical Machines and Transformers”, P.H.I.
9. Ashfaq Hussain, “Electrical Machines”, Dhanpatrai and Co.
10. B.H.E.L., “Transformers”, T.M.H.
11. Relevant course materials available at http://nptel.iitm.ac.in/index.php

EE46L D.C. and Synchronous Machines Lab

Total Practical Hours	:	42	Credit Pattern L:T:P	:	0:0:1.5
Lecture Hours/Week	:	0	CIE, SEE Weightage	:	100%, 0%
Practical Hours/Week	:	3	Prerequisite/s	:	EE320
Nature of Subject	:	Core	Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Determine magnetization characteristics and load characteristics of D.C. generators.

CO-2 Determine the performance characteristics of D.C. motor and control its speed.

CO-3 Determine the efficiency of D.C. machine by conducting various tests.

CO-4 Determine the voltage regulation of alternator and its performance when synchronized to infinite bus.

CO-5 Determine the direct and quadrature axis reactances of a salient pole alternator and V and inverted V curves of alternator when working as a synchronous motor.

Course Articulation Matrix of EE46L -- D.C. and Synchronous Machines Lab

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE46L.1	Determine magnetization characteristics and load characteristics of D.C. generators.	3	-	-	3	-	-	-	-	-	-	-	2	2	-	-
EE46L.2	Determine the performance characteristics of D.C. motor and control its speed.	3	-	-	3	-	-	-	-	-	-	-	2	2	-	-
EE46L.3	Determine the efficiency of D.C. machine by conducting various tests.	3	-	-	3	-	-	-	-	-	-	-	2	2	-	-
EE46L.4	Determine the voltage regulation of alternator and its performance when synchronized to infinite bus.	3	-	-	3	-	-	-	-	-	-	-	2	2	-	-
EE46L.5	Determine the direct and quadrature axis reactances of a salient pole alternator and V and inverted V curves of alternator when working as a synchronous motor.	3	-	-	3	-	-	-	-	-	-	-	2	2	-	-
Over-all Correlation of EE46L to PO's		3.00	-	-	3.00	-	-	-	-	-	-	-	2.00	2.00	-	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

1. O.C.C. of a shunt generator.
2. Load characteristics of a D.C. generator — for shunt and compound types.
3. Load test on a D.C. Motor
4. Speed control of D.C. motor by armature voltage control and flux control.
5. Swinburne’s test.
6. Ward Leonard method of speed control of D.C. Motor
7. Hoppkinson’s Test.
8. Fields test on series motors.
9. Voltage Regulation of Alternator by E.M.F., M.M.F. and Z.P.F. Methods.
10. Performance of synchronous generator connected to infinite bus — constant power and variable excitation and vice versa
11. Slip rest
12. V and inverted V curves of a synchronous motor.

EE47L Circuit Simulation and Signal Processing Lab

Total Practical Hours	: 42	Credit Pattern L:T:P	:	0:0:1.5
Lecture Hours/Week	: 0	CIE, SEE Weightage	:	100%, 0%
Practical Hours/Week	: 3	Pre/co-requisite/s	:	EE310, EE410, EE420
Nature of Subject	: Core	Teaching Faculty	:	

Course Outcomes

After completing this course the student should be able to

CO-1 Use SPICE for conducting operating point (OP) analysis of a circuit.

CO-2 Use SPICE for conducting transient analysis (TRAN) analysis of a circuit.

CO-3 Use SPICE for conducting frequency domain analysis (AC) of a circuit.

CO-4 Use higher level language like MATLAB or GNU Octave or Scilab for computations.

CO-5 Use a higher level language like MATLAB or GNU Octave or Scilab for simulation, and data visualization.

Course Articulation Matrix of EE47L -- Circuit Simulation and Signal Processing Lab																
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE47L.1	Use SPICE for conducting operating point (OP) analysis of a circuit.	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
EE47L.2	Use SPICE for conducting transient analysis (TRAN) analysis of a circuit.	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
EE47L.3	Use SPICE for conducting frequency domain analysis (AC) of a circuit.	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
EE47L.4	Use higher level language like MATLAB or GNU Octave or Scilab for computations.	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
EE47L.5	Use a higher level language like MATLAB or GNU Octave or Scilab for simulation, and data visualization.	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
Over-all Correlation of EE47L to PO's		3.00	3.00	-	-	3.00	-	-	-	-	-	-	2.00	-	2	-
Correlation levels are: 1 -- Slight (Low); 2 -- Moderate (Medium); 3 -- Substantial (High). No correlation is indicated by "-"																
Over-all correlation of a subject with a PO is the average value of correlation constant in that column.																

Program Outcomes (POs) and Program Specific Outcomes (PSOs)	
PO1	Apply the knowledge of mathematics, science, and fundamentals of electrical and electronics engineering to the conceptualization of engineering models.
PO2	Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO7	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.
PO8	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
PO9	Understand and commit to professional ethics and responsibilities and norms of engineering practice.
PO10	Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
PO11	Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
PO12	Recognize the need for, and have the ability to engage in independent and life-long learning.
PSO1	Apply knowledge of power systems and high voltage engineering to design, test, install, and operate systems in the power sector.
PSO2	Design analog and digital systems, test, and implement power electronic, control, and automation systems.
PSO3	Implement ecofriendly energy systems for sustainable development.

Suggested Experiments

Circuits to be simulated will be suggested by the faculty. For signal processing MATLAB, GNU Octave, Scilab, SciPy, or equivalent software may be used.

1. Verification of network theorems.
2. Determination of steady-state response of single-phase and three-phase A.C. circuits.
3. Time response of circuits.
4. Frequency response of circuits.
5. Time and frequency response of BJT amplifier circuits.
6. Time and frequency response of op-amp circuits.
7. Familiarization with MATLAB, or similar software like GNU Octave, or Scilab (experiments for this to be suggested by faculty).
8. Experiments on signal processing. (Simple experiments on principles taught in Signals and Systems should be suggested by the faculty).

Prerequisite: Knowledge of SPICE, MATLAB, GNU Octave, Scilab or SciPy. Students can refer to on-line manuals, or lab manuals prepared by faculty, or any available books.