Program Code: ESC107A

Course Title: Elements of Electrical Engineering

Course Leaders:

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Course Details

- Programme: **B. Tech. in Electrical Engineering**
- Department: **Electrical Engineering**
- Head of the Department: **Dr. K. Manickavasagam (hod.ee.et@msruas.ac.in)**
- Faculty: **Engineering & Technology**
- Dean: **Prof. H K Narahari (dean.et@msruas.ac.in)**

Why this Course

- Refer to B. Tech. Electrical Engineering Course Specifications

The objectives of the course are:

1. **To impart knowledge on electrical and electronic systems and their subsystems**
2. To enhance the understanding of the underlying engineering principles of electrical and electronic systems
3. To model, simulate and analyze the behaviour of electrical and electronic systems to predict and improve their performance
4. To design and build models of electrical and electronic systems to meet the specific needs
5. To impart training on instrumentation and testing of electrical and electronic systems

Why this Course Contd..

6. To train on industry standard simulation tools for simulation and analysis of electrical and electronic systems
7. To build and test electrical and electronic systems
8. To impart training on professional ethics, history, economics, social sciences and interactive skills relevant to professional practice
9. To provide a general perspective and opportunities for a career in industry, business and commerce .

The Course is being delivered to meet the highlighted objective of the course to meet the course aim.

Course Aim and Summary

- This course deals with basic principles and concepts of Elements of Electrical Engineering. Students are taught the fundamentals of circuit analysis, magnetic circuits, transformers and AC machine operation, fractional-kW motors and DC machines, measuring instruments, wiring and earthing techniques. In addition, wiring methods based on the type of electrical machine used for a given application will be taught using standard software tools.

Course Intended Learning Outcomes

After undergoing this course students will be able to:

1. State various laws of electric and magnetic circuits and explain their significance in engineering.
2. Explain AC, DC machines, transformers, measuring instruments and their applications
3. Explain special electric machines used in various engineering applications
4. Develop relationship to calculate performance of various AC and DC machines
5. Solve simple numerical problems on AC, DC machines, transformers, special electrical machines and measuring instruments
6. Solve complex numerical problems on AC, DC machines, transformers, special electrical machines and measuring instruments

Course Content

Circuit Analysis Techniques

Circuit elements, Simple RL and RC Circuits, Ohm's law, Kirchoff's law, Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Star Delta Transformation Voltage and Current Division Thevnin's and Norton's Theorems, Sinusoidal Forcing Function, Complex Forcing Function, Phasor Relationship for R, L and C, Impedance and Admittance, Phasor Diagrams, Response as a function of w.

Magnetic Circuits

Magnetic flux- flux density, reluctance, permeance-magnetic effect of electric circuit, Law of Electromagnetic induction, induced emf, self and mutual inductance, coupling co-efficient, inductance in series and parallel, Magnetic materials.

Course Content Contd..

Transformers and AC Machines

Ideal Transformer, Circuit Model of Transformer, Determination of Parameters of Circuit Model of Transformer, Voltage Regulation, Efficiency, Three Phase Induction Motor, Three Phase Synchronous Generator, Induced Voltage, Electromagnetic Torque, Equivalent Circuit of Three phase Induction Motor, Torque Speed Characteristics.

Fractional-kW Motors and DC Machines

Single Phase Induction Motors, Characteristics and typical Applications, Stepper Motors, Construction Features, Methods of Operations, DC Generator and DC Motor Analysis, Methods of Excitation, Speed Torque Characteristics and Speed Control of DC Machines.(Quantitative approach)

Course Content Contd..

Measuring Instruments and Domestic Wiring

Classification of Instruments, Essential features of Indicating Instrument, Deflecting, Controlling and Damping Mechanism, Moving Coil instrument, Moving Iron Instrument Induction type Instruments examples, Wiring materials and accessories, Types of wiring principles of earthing.

Method of Assessment Contd..

There are two components for assessment in this Course:

Component - 1: 50% weight (CE)

It has two sub components

Part A: Term Test: 25% Weight

Part B: Assignment: 25% Weight

Two tests will be conducted one at the end of 6th week and the other at the end of the 12th week, the average of two tests will be the marks scored in term test for a maximum of 25 marks.

Student is required to submit two word processed assignments each assignment is set for

25 marks, the average of two assignments will be the marks scored in assignment for a maximum of 25 marks.

Method of Assessment

Component - 2 : 50% weight

A 3 hour duration semester end examination will be conducted for maximum marks of 100 and will be reduced to 50% weight.

The assessment questions are set to test the learning outcomes. In each component certain learning outcomes are assessed. The following table illustrates the focus of learning outcome in each component assessed:

Intended Learning Outcome		1	2	3	4	5	6		
Component-1	A	X	X	X	X	X			
	B						X		
Component-2		X	X	X	X	X			

Both components will be moderated by a second examiner.

References

a. Essential Reading

1. Class Notes

2. Edward Hughes, (2002) Electrical and Electronics Technology, ELBS, 6th edition

3. Del Toro V., (2008) Electrical Engineering Fundamentals; PHI

b. Recommended Reading

1. Mittle, V.N., (2007) Basic Electrical and Electronics Engineering, Tata McGraw Hill Edition, New Delhi, (1st edition)

2. Delton Horn T., (1993) Abraham Pallas, Basic Electricity and Electronics, McGraw-Hill Limited, Europe

c. Websites

1. Basic Electrical Technology (2013) http://freevideolectures.com/Course/2335/Basic-Electrical-Technology/23

2. IITM Lectures (2013) http://www.nptel.iitm.ac.in/courses/108105017/

Course Delivery Schedule Contd..

Number of Subject Credits: 4 (3 Theory + 1 Tutorial)

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
1				Circuit elements		
2				Node Analysis and Mesh Analysis		
3				Superposition Theorem		
4				Tutorials		
5				Tutorials		
6				Thevnin Theorem		
7				Norton Theorem		
8				Circuit Element Impedance		
9				Tutorials		
10				Tutorials		
11				RL and RC Circuits,		
12				Phasor Relationship for R, L and C,		
13				Tutorials		

Course Delivery Schedule Contd..

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
14				Tutorials		
15				Tutorials		
16				Magnetic Effect of Electric Circuit		
17				Law of Electromagnetic Induction		
18				Tutorials		
19				Tutorials		
20				Classification of Induced EMF		
21				Mutually Induced E.M.F		
22				Tutorials		
23				Tutorials / Video session		
24				Magnetic Materials		
25				Group Discussion		

Course Delivery Schedule Contd..

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
26	Term Test 1 and Assessment Week					
27						
28						
29						
30						
31				Principle of Operation of a Transformer		
32				Ideal Transformer		
33				Circuit model of a Transformer		
34				Tutorials		
35				Tutorials		Assignment 1 Submission
36				OC and SC Test		
37				Tutorials		
38				Tutorials		

Course Delivery Schedule Contd..

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
39				3-Phase Induction Motor		
40				Equivalent Circuit of 3 - phase Induction Motor		Staff –Student Consultative Committee Meeting
41				Tutorials		
42				Tutorials		
43				Synchronous Generator		
44				Tutorials		
45				Video Demonstration on Induction Motor & Synchronous Generator		
46				DC Machines – Principle and Construction		
47				DC Generator (Types & Characteristics)		
48				Tutorials		
49				Tutorials		
50				DC Motor (Types & Characteristics)		

Course Delivery Schedule Contd..

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
51	Term Test 2 and Assessment Week					
52						
53						
54						
55						
56				Tutorials		
57				Tutorials		
58				Single Phase Induction Motor (Operating Principle)		
59				Single Phase Induction Motor (Characteristics)		
60				Stepper Motor		Assignment 2 Submission

Course Delivery Schedule Contd..

Lecture No.	Date	Time	Day	Topic	Delivered By	Additional Activity
61				Measuring Instruments		
62				PMMC		
63				MI Instruments		
64				Domestic Wiring		
65				Discussion		Obtaining Student Feedback Finalization of Attendance and Class Marks
	Semester End Examination					

Lecture 1

At the end of this lecture, student will be able to:

- Classify Circuit Elements
- Identify basic active and passive elements
- Define current, voltage, Resistance, Capacitance and inductance
- State and Illustrate Ohm's law
- State and solve Kirchoff's law

Lecture 2

At the end of this lecture, student will be able to:

- Perform source transformation, Voltage source to current source and vice versa
- Analyse mesh circuits using KVL
- Analyse nodal circuits using KCL

Lecture 3

At the end of this lecture, student will be able to:

- Explain linearity property
- State and analyze superposition theorem for any complicated linear bilateral network
- Reduce complicated network to simple network using star delta conversions

Lecture 4

At the end of this lecture, student will be able to:

- Solve problems on KCL
- Solve problems on KVL,
- Solve problems on Mesh and Nodal analysis

Lecture 5

At the end of this lecture, student will be able to:

- Solve problems on KCL, KVL, Mesh and Nodal analysis
- Compute equivalent resistance in electrical circuits

Lecture 6

At the end of this lecture, student will be able to:

- State and implement Thevenin's theorem on any complicate linear bilateral network

Lecture 7

At the end of this lecture, student will be able to:

- State and implement Thevenin's theorem on any complicate linear bilateral network

Lecture 8

At the end of this lecture, student will be able to:

- State and compute Maximum Power Transfer Theorem
- Describe Sinusoidal Forcing Function
- Solve Complex Forcing Function
- Define Impedance and admittance

Lecture 9

At the end of this lecture, student will be able to:

- Solve problems on Superposition Theorem

Lecture 10

At the end of this lecture, student will be able to:

- Solve problems on Thevenin's Theorem
- Solve problems on Superposition Theorem

Lecture 11

At the end of this lecture, student will be able to:

- Explain and analyze transient characteristics of RL and RC circuits

Lecture 12

At the end of this lecture, student will be able to:

- Analyze phasor Relationship for R, L, and C Elements
- Define phasor voltage-current relations
- Define angular Frequency (ω)

Lecture 13

At the end of this lecture, student will be able to:

- Solve problems on Thevenin's Theorem
- Solve problems on Norton's Theorem
- Solve problems on Source transformation

Lecture 14

At the end of this lecture, student will be able to:

- Solve problems on Voltage divider rule
- Solve problems on KCL and KVL
- Solve problems on Star-delta conversion

Lecture 15

At the end of this lecture, student will be able to:

- Solve problems on Star-delta conversion
- Solve problems on Superposition theorem
- Solve problems on circuit analysis

Lecture 16

At the end of this lecture, student will be able to:

- Define magnetic flux, flux density and reluctance
- Explain Right hand thumb Rule and cork screw rule
- Analyze Series Magnetic Circuits
- Derive relation between the magnetic and electric circuits

Lecture 17

At the end of this lecture, student will be able to :

- Describe Parallel Magnetic Circuits
- Explain Magnetic leakage and Fringing
- State Law of Electromagnetic Induction and apply to electrical circuits
- State Lenz Law and apply to electrical circuits

Lecture 18

At the end of this lecture, student will be able to:

- Solve problems on Magnetic Circuits

Lecture 19

At the end of this lecture, student will be able to:

- Solve Problems on series magnetic circuits
- Solve problems on Parallel magnetic circuits

Lecture 20

At the end of this lecture, student will be able to:

- Classify and analyze the effect of induced E.M.F's in electrical circuit
- Derive Self-Inductance for a given circuit

Lecture 21

At the end of this lecture, student will be able to:

- Explain Mutual Induced E.M.F
- Derive and explain mutual inductance
- Analyze the coupling coefficient for coupled magnetic circuits
- Explain dot convention and dot rules

Lecture 22

At the end of this lecture, student will be able to:

- Solve Self inductance
- Solve Mutual Inductance
- Solve B-H curve

Lecture 23

At the end of this lecture, student will be able to:

- Explain Diamagnetic and Paramagnetic Materials
- Analyze Magnetism and Diamagnetism
- Describe Ferro Magnetic Materials
- Analyze Eddy Current
- Solve B-H Curve

Lecture 24

At the end of this lecture, student will be able to:

- Describe the coupling effect for magnetic circuits
- Solve circuits involving coupled coils using Dot Rule
- Classify and explain properties of Magnetic Materials
- Analyze loss mechanism in the Magnetic Materials

Lecture 31

At the end of this lecture, student will be able to:

- State the meaning of "Transformer action”
- Describe physical characteristics of a transformer, including the basic parts, main core types and winding types
- Name the source and load windings of a transformer
- Explain the principle of operation of a transformer
- Classify the transformer based on turns ratio

Lecture 32

At the end of this lecture, student will be able to:

- Derive the EMF equation of Transformer and use it in calculations
- Identify the transformer ratings based on its name plate details
- Describe the properties of Ideal transformer
- Differentiate the Ideal and practical transformers
- Solve for primary voltage, secondary voltage, primary current and number of turns in the secondary given various transformer values

Lecture 33

At the end of this lecture, student will be able to:

- State the meaning of a "no-load condition" and “on-load condition" relative to a transformer
- Describe the operation of ideal transformer under on-load condition
- Construct a transformer on-load phasor diagram for different loads
- Derive the equivalent resistance and reactance referred to the primary and secondary side of a transformer

Lecture 34

At the end of this lecture, student will be able to:

- Solve the problems on the transformer principle of operation
- Solve the problems on the no-load phasor diagram

Lecture 35

At the end of this lecture, student will be able to:

- Solve the problems on the transformer E.M.F. equation
- Solve the problems on the on-load phasor diagram
- Solve the problem on the equivalent circuit of a transformer

Lecture 36

At the end of this lecture, student will be able to:

- Explain the need of Open Circuit (OC) and Short Circuit (SC) tests
- Conduct Open Circuit (OC) and Short Circuit (SC) tests
- Compute parameters of equivalent circuit and voltage regulation from the tests results

Lecture 37

At the end of this lecture, student will be able to:

- Solve the problems on the transformer tests

Lecture 38

At the end of this lecture, student will be able to:

- Solve the problems on the voltage regulation
- Solve the problems on the transformer efficiency

Lecture 39

At the end of this lecture, student will be able to:

- Explain electromagnetic phenomena in the Electrical Machines
- Discuss the constructional details of Induction Motor
- Describe the principle of operation of 3-phase Induction Motor
- Derive the expressions for Slip, Slip Speed, Voltage and Frequency Induced in the Rotor

Lecture 40

At the end of this lecture, student will be able to:

- Develop the equivalent circuit of 3 - phase Induction Motor
- Describe the torque-speed characteristics of 3 - phase Induction Motor
- Derive the Torque equation of 3 - phase Induction Motor
- Describe the power flow of 3 - phase Induction Motor

Lecture 41

At the end of this lecture, student will be able to:

- Solve the problems on the 3 – phase Induction Motors

Lecture 42

At the end of this lecture, student will be able to:

- Solve the problems on 3 – phase Induction Motors

Lecture 43

At the end of this lecture, student will be able to:

- Discuss the constructional details of Synchronous Generator
- Describe the principle of operation of Synchronous Generator
- Derive the expressions for Speed and Induced Voltage
- Develop the Equivalent Circuit of Synchronous Generator

Lecture 44

At the end of this lecture, student will be able to:

- Solve the problems on Synchronous Generators

Lecture 45

At the end of this lecture, student will be able to:

- Observe the Video Demonstration on **Induction Motor & Synchronous Generator**

Lecture 46

At the end of this lecture, student will be able to:

- Explain the basic principle of induced E.M.F. and electromagnetic torque
- Discuss the need for commutator
- Identify different parts of a DC machine and understand their function

Lecture 47

At the end of this lecture, student will be able to:

- Derive an expression for induced E.M.F.
- Classify DC Generators based upon methods of excitation
- Discuss Open Circuit and Load characteristics of DC Generators
- Explain the losses associated with DC machines

Lecture 48

At the end of this lecture, student will be able to:

- Solve problems on induced E.M.F.

Lecture 49

At the end of this lecture, student will be able to:

- Solve problems on DC generators

Lecture 50

At the end of this lecture, student will be able to:

- Classify DC Motors based upon methods of excitation
- Derive an expression for torque developed in a DC Motor
- Discuss Speed-Torque characteristics of DC Motors
- Explain methods of Speed Control

Lecture 56

At the end of this lecture, student will be able to:

- Solve problems on electromagnetic torque

Lecture 57

At the end of this lecture, student will be able to:

- Solve problems on speed control of DC motors

Lecture 58

At the end of this lecture, student will be able to:

- Describe Double Revolving Field Theory
- Explain the basic principle of operation
- Discuss the need for Auxiliary winding

Lecture 59

At the end of this lecture, student will be able to:

- Explain the Torque-Speed Characteristics
- Classify Single Phase Induction Motors based on construction and operation
- Discuss the need for Auxiliary winding

Lecture 60

At the end of this lecture, student will be able to:

- Differentiate Stepper Motor from conventional motors
- Classify Stepper Motors based on construction
- Explain the Stepper Motor Principle of Operation

Lecture 61

At the end of this lecture, student will be able to:

- Define and classify measuring Instruments along with examples
- Demonstrate different types of measuring instruments and their usage
- Describe the torques required for the Indicating Instruments

Lecture 62

At the end of this lecture, student will be able to:

- Describe the damping systems required for the Indicating Instruments
- Discuss the construction and working of PMMC instrument
- State advantages and disadvantages of Moving coil instruments
- Discuss the applications of MC instruments

Lecture 63

At the end of this lecture, student will be able to:

- Classify types of moving iron instruments
- Explain the construction and principle of operation of the moving iron attraction type and repulsion type instruments

Lecture 64

At the end of this lecture, student will be able to:

- Classify the types of Wiring
- Describe the advantages and disadvantages of different types of wiring
- Identify the wiring tools and materials
- Explain principles of earthing

Lecture 65

Discussion