Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **ELECTRICAL CIRCUITS**		Course Code	: **15EE21T**
Semester	: **II**	Course Group	: **Core**
Teaching Scheme in Hrs (L:T:P)	: **4:0:0**	Credits	: **4 Credits**
Type of course	:**Lecture + Assignments**	Total Contact Hours	: **52**
CIE	: **25 Marks**	SEE	: **100 Marks**

Pre-requisites	**:**Applied Science, Applied Mathematics-I and EEE in I- Semester Diploma.
Course Objectives	**:**Prepare the student to understand the working of Electrical Circuits.

COURSE TOPICS:

Unit Nos.	Topics	Teaching Hours	SEE Max. Marks
1	Introduction and DC circuits	14	40
2	Magnetism and magnetic circuits	06	15
3	Electromagnetic Induction	06	20
4	AC Principles and Vector Algebra	10	30
5	Single-phase AC circuits	10	30
6	Poly-phase AC circuits	6	10
Total		**52**	**145**

Course Outcomes:

On successful completion of the course, the student will be able to:

1. Understand different theorems and apply them on DC circuits.
2. Comprehend magnetic circuits with its laws and parameters.
3. Understand Electromagnetic Induction.
4. Comprehend the principles of AC fundamentals and Understand vector algebra
5. Understand various single phase AC parameters in R, L, C, R-L, R-C, R-L-C series and parallel circuits.
6. Understand Polyphase AC circuits.

Composition of Educational Components

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's Taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)	Total Marks (145)
1	Remembering	10	15
2	Understanding	55	80
3	Application	35	50
Total		**100**	**145**

Course Outcome linkage to Cognitive Level

Cognitive Level Legend: R- Remember, U- Understand, A- Application

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand different theorems and apply them on DC circuits.	***R/U/A***	2,8,10	14
CO2	Comprehend magnetic circuits with its laws and parameters	***R/U/A***	2,8,10	06
CO3	Understand Electromagnetic Induction.	***R/U***	1,2,3,8,10	06
CO4	Comprehend the principles of AC fundamentals and Understand vector algebra	***R/U/A***	1,2,8,10	10
C05	Understand various single phase AC parameters in R, L, C, R-L, R-C, R-L-C series and parallel circuits	***U/A***	2,8,10	10
C06	Understand Polyphase AC circuits.	***U/A***	2,8,10	6
		Total sessions		**52**

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE:

Unit No	Unit Name	Hour	Max. Marks per Unit	Questions to be set for (5marks) PART - A			Questions to be set for (10marks) PART - B			Marks weightage (%)
				R	U	A	R	U	A	
1	Introduction and DC circuits	14	40	1	1	-	-	1	2	30
2	Magnetism and magnetic circuits	06	20	1		1	-	1	-	10
3	Electromagnetic Induction	06	15	1	-	-	-	1	-	10
4	AC Principles and Vector Algebra	10	30	1	1	-	-	1	1	20
5	Single-phase AC circuits	10	25	-	1	-	-	1	1	20
6	Poly-phase AC circuits	6	15	-	1	-	-	-	1	10
	Total	**52**	**145**	**9 (45 Marks)**			**10 (100 Marks)**			**100**

COURSE-PO ATTAINMENT MATRIX

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
ELECTRICAL CIRCUITS	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**3**	**-**	**3**

LEVEL 3- HIGHLY ADDRESSED, LEVEL 2-MODERATELY ADDRESSED, LEVEL 1-LOW ADDRESSED.

METHOD IS TO RELATE THE LEVEL OF PO WITH THE NUMBER OF HOURS DEVOTED TO THE COS WHICH ADDRESS THE GIVEN PO.
IF ≥40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 3
IF 25 TO 40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 2
IF 5 TO 25% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

COURSE CONTENTS:

UNIT I

Introduction: Types of circuits- open, closed and short circuit; Linear, non linear circuits, passive active circuits and components, node, unilateral, bilateral circuits.

D.C circuits : Kirchhoff's laws, Ideal Voltage, Ideal Current source & conversion; Star - delta Transformation Network theorems-Thevinin's Theorm, Reciprocity Theorem, Superposition Theorem Maximum power transfer Theorem. Problems on KVL,KCL, star-Delta transformation and Network theorems.

UNIT II

Magnetism and Magnetic circuits: magnetic circuit, mmf, reluctance and mention their units, Absolute permeability and Relative permeability and mention their units, relationship between Flux, MMF and Reluctance ,Compare Electric circuit with magnetic circuit. Problems on magnetic circuits.

UNIT III

Electro Magnetic Induction: Magnetic field around a current carrying conductor, Cork Screw Rule and Right Hand Thumb Rule, Faraday's laws of Electromagnetic Induction, EMF induced in a coil; Types of induced emfs and their application ; Fleming's Right Hand Rule, Lenz's law; Self induced emf and Mutually induced emf and their application, Self inductance and Co-efficient of Self inductance, Mutual inductance and Co-efficient of Mutual inductance.

UNIT IV

A.C. Principles : Generation of Single phase AC voltage , Frequency, Amplitude, Cycle, Time period and their units ; Maximum value, RMS value, Average value, Form factor and Peak factor of a sinusoidal wave, Instantaneous value of Voltage and Current , phase and phase difference, Vectorial representation of AC quantities, Power and Power factor in AC circuits, problems on above.

Vector Algebra: Represent vectors in Rectangular, Trigonometric and Polar forms, Convert Rectangular form into Polar form and vice-versa and problems on R to P and P to R , Arithmetic operations on vectors, problems.

UNIT V

Single Phase AC Circuits : Current and Power in a pure resistive, pure inductive and pure capacitive circuit ; Capacitive reactance , Inductive reactance ,Impedance, Current, Power and Power factor of R-L, R-C, R-L-C series and parallel circuits, problems on R-L, R-C, R-L-C series and parallel circuits. Resonance, resonant frequency and Q-factor.

UNIT VI

Polyphase AC Circuits : Generation of 3-ph voltage, phase sequence, Star and Delta Connection in 3-ph system ,Relation between line voltage and phase voltage in 3-ph Star, Relation between line voltage and phase voltage in 3-ph Delta system. Equation for a 3-ph power, problems on 3 phase star and delta circuits.

REFERENCE BOOKS:

1. Electrical Technology by B.L. Theraja.
2. Electrical Technology by Hughes
3. Principles of Electrical Engineering by B. R. Gupta
4. Basic Electrical Engineering by V.K. Mehta &Rohit Mehta.
4. http://www.facstaff.bucknell.edu/mastascu/elessonshtml/eeindex.html - Welcome to Exploring Electrical Engineering.
5. Fundamentals Hand book of Electrical Science, Module 1, Basic Electrical Theory, Department of Energy, U. S. Department of Energy, June 1992.
6. http://www.freeengineeringbooks.com/Electrical/Basic-Electrical-Engineering.php

Course Delivery:

The Course will be delivered through lectures, classroom interaction, animations, group discussion, exercises and assignments.

Course Assessment and Evaluation:

	What		To Whom	Frequency	Max Marks Theory	Evidence Collected	Course Outcomes
Direct Assessment	CIE (Continous Internal Evaluation)	I A Tests	Students	Theory: Three IA tests for theory (Average marks of three tests will be computed).	20	Blue Books	1 to 6
		Assignments		Student Activity	05	Log of Activity	1 to 6
				TOTAL	25		
	SEE (Semester End Examination)	End Exam	Students	End Of the Course	100	Answer Scripts	All COs
Indirect Assessment	Student Feedback on course		Students	Middle Of The Course		Feed Back Forms	All COs
	End Of Course Survey			End Of The Course		Questionn-aire	All COs

***CIE** – Continuous Internal Evaluation ***SEE** – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Suggested Student Activities:

Each Student has to prepare a self hand written report of 3 pages considering any one of the following topics.

1. Report on different theorems and their practical applications.
2. Report on different materials used for electromagnets with their properties.
3. Applications of Electro Magnetic Induction, statically induced and dynamically induced emf, self and mutual induced emfs.
4. Perform Polar to Rectangular and vice versa operations on Computer package (Excel) and submit a report giving commands and formulae.
5. Practical applications of Single Phase AC Circuits and Three phase AC Circuits with their operating voltages and other electrical parameters.

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimension	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks **One activity on any one CO (course outcome) may be given to a group of FIVE students** **Grand Average/Total**						14/4 =3.5 ≈4				

Example only: MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY-
Task given- Industrial visit and report writing

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	I/II SEM		20
	Year:		

Name of Course coordinator : Units:__
CO's:____

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal Choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
1st Test/ 6 th week, 2 Feb 16, 10-11 AM	I SEM, E & E Engg	**Electrical Circuits**	20
	Year: 2015-16	Course code:	

Name of Course coordinator :
Units Covered :1 and 2
Course Outcomes : 1 and 2
Instruction :*(1). Answer all questions (2). Each question carries five marks*

Question No.	Question	CL	CO	PO
1	What are the types of Electrical circuits?	R	1	2,8,10
2	Explain the STAR-DELTA transformation? OR State Maximum Power Transfer theorem and explain.	U A	1	2,8,10
3	Define with SI units permeability, absolute permeability and relative permeability.	R	2	2,8,10
4	Show the relation between mmf, reluctance and flux. OR Compare magnetic circuit with electric circuit.	U A	2	2,8,10

CL: Cognitive Level, R-Remember, U-Understand, A-Application, PO: Program Outcomes

MODEL QUESTION PAPER

Electrical Circuits

Time: 3 Hours] **[Max. Marks: 100**

Instruction: 1) Part – A. Answer any **SIX** questions from a set of 9 Questions.
Each question carries 5 Marks.

2) Part – B. Answer any **SEVEN** questions from a set of 10 Questions.
Each question carries 10 Marks.

PART - A

(Answer any SIX Questions from this Section)

6 x 5 = 30

1. Define closed circuit, open circuit, and short circuit condition in a circuit.
2. State Kirchhoff's Voltage and Current laws.
3. Bring out the differences between magnetic circuit and electric circuit.
4. State Faraday's Laws of Electromagnetic induction.
5. Define mutually induced emf and explain it.
6. Draw a sinusoidal waveform and mark the following (i) max value (ii) instantaneous value (iii) time period (iv) frequency.
7. Differentiate between the terms 'in- phase' and 'out of phase' alternating quantities.
8. Mention the advantages of 3-phase system over single phase system.
9. Prove that line voltage is equal to phase voltage in a 3ph delta connected system.

PART - B

(Answer any SEVEN Questions from this Section) **10 x 7 = 70**

10. a)Define the following:
    i) bi-lateral circuit.
    ii) non-linear circuit.
    b) Explain Kirchhoff's Current Law with an example.

11. a) Define and mention the units :
    i) Reluctance

ii) MMF

b) State the Law relation between flux, mmf & Reluctance. Write the equation.

12. a) State and explain Lenz's law.
b)Compare magnetic circuit with electric circuit

13.a) State and explain Fleming's right hand rule.
b) A current of 5A flowing through a coil of 500 turns produces a flux of 20mWb. Find the co-efficient of self induction and the inductive reactance of the coil at 50Hz frequency.

14. a) Derive an expression for dynamically induced emf.
b) A coil of 500 turns is wound over a magnetic material of relative permeability 500. The length of the coil is 50cms and the diameter of the coil is 1cm. If a current of 5A is passed through the coil , find –(i) inductance of the coil (ii) energy stored in the coil.

15. a) Derive an expression for instantaneous value of voltage and current.
b) Explain power factor.

16.a) Derive the equation for power in a pure inductive circuit.
b) Two impedances Z1=(4+j6) and Z2=(6-j4) are connected in parallel across a 230V, 50Hz supply. Calculate – (i) impedance (ii) current (iii) p.f of the circuit.

17. a) Explain the generation of three phase voltage.
b) Explain STAR connected three phase system.

18 .a) Prove that line voltage is equal to √3 phase voltage in a 3ph star connected system.
b) List the methods of power measurement in a 3 ph system.

19.a) Explain 2-wattmeter method of measuring 3ph power.
b) Explain the meaning of a balanced 3ph system?

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Model Question Bank:

UNIT-1

INTRODUCTION AND DC CIRCUITS

Cognitive Level: REMEMBER

1. What do you mean by an Electrical circuit?
2. What are the types of Electrical circuits?
3. Define a DC circuit.
4. Define an AC circuit.
5. Define Direct Current.
6. Define Alternating Current.
7. What do you mean by circuit elements?
8. Define bi-lateral circuit.
9. Define uni-lateral circuit.
10. What do you mean by an active circuit?
11. What do you mean by a passive circuit?
12. What is a Branch?
13. What is a MESH?
14. What is a NODE?

Cognitive Level: UNDERSTAND

15. Mention the types of circuit elements and explain them.
16. Categorise the circuit elements and give examples.
17. Explain the closed circuit, open circuit and short circuit conditions in a circuit with neat circuit diagrams.
18. What is an electrical network?
19. How can you classify the electrical circuits based on the behaviour of the circuit elements with the change in the magnitude or direction of voltage or current ?
20. Define linear circuit.
21. Define non-linear circuit.
22. Explain the STAR-DELTA transformation?
23. Explain the DELTA-STAR transformation?

Cognitive Level: APPLICATION

24. State Kirchhoff's first law or Kirchhoff's current law.

25. State Kirchhoff's second law or Kirchhoff's voltage law.
26. Explain Kirchhoff's Current Law with an example.
27. Explain Kirchhoff's Voltage Law with an example
28. Explain the transformation of STAR-DELTA system to DELTA-STAR system with an example?
29. State Thevenin's theorem.
30. State and explain Thevenin's theorem.
31. State Reciprocity Theorem.
32. State and explain Reciprocity Theorem.
33. State Superposition theorem.
34. State Superposition theorem and explain.
35. State Maximum Power Transfer theorem and explain.

UNIT-II

MAGNETISM AND MAGNETIC CIRCUITS

Cognitive Level: REMEMBER

1. Define magnetic flux(Φ) and mention its SI unit.
2. Define magnetic field.
3. Define flux density, mention its SI unit and write the equation for flux density .
4. Define magnetic field strength or magnetic field intensity or magnetising force (**H**) and mention its SI unit.
5. Define magnetising force and mention its SI unit.
6. Define permeability.
7. Define absolute permeability, mention its unit and write the equation.
8. Define relative permeability, mention its unit and write the equation.
9. Define Magnetic Circuit.
10. Define Magneto motive force (mmf) ,mention its unit and write the equation.
11. Define Reluctance, mention its unit and write the equation.
12. Define Magnetic leakage.
13. Define Permeance (ρ) and write its equation.

Cognitive Level: UNDERSTAND

14. Write the SI units of the following (i) flux (ii) mmf (iii) reluctance.
15. Write the equation for magnetising force or magnetic field strength or magnetic field intensity.

16. State the Law of Reluctance.
17. Show the relation between mmf, reluctance and flux.
18. What is fringing?

Cognitive Level: APPLICATION

19. What is Leakage coefficient or Leakage factor (λ)? Write the equation.
20. Compare magnetic circuit with electric circuit.

UNIT-III

ELECTRO-MAGNETIC INDUCTION

Cognitive Level: REMEMBER

1. Define Electromagnetic Induction.
2. State Maxwell's cork screw rule.
3. State Right Hand Thumb rule.
4. State Faraday's Laws of Electromagnetic induction.
5. Mention the types of emf induced in a conductor.
6. Define dynamically induced emf and explain.
7. Define statically induced emf and explain.
8. Mention the types of statically induced emf's
9. Define self-inductance
10. Define mutual inductance (M).

Cognitive Level: UNDERSTAND

11. Distinguish between dynamically and statically induced emfs.
12. State the application of dynamically and statically induced emfs.
13. State Fleming's right hand rule.
14. State and explain Fleming's right hand rule.
15. State Lenz's law.
16. Define self induced emf and explain.
17. Define mutually induced emf and explain.
18. Distinguish between self-induced emf& mutually induced emf.
19. Define co-efficient of self inductance.
20. Define coefficient of Mutual inductance.
21. Distinguish between self and mutual inductance.

UNIT-IV

AC PRINCIPLES AND VECTOR ALGEBRA

Cognitive Level: REMEMBER

1. Define instantaneous value and write the equation.
2. Define amplitude or peak value or maximum value.
3. Define cycle of an alternating quantity.
4. Define frequency. Mention its unit.
5. Define time period and mention its unit.
6. Define RMS value or effective value of alternating current.
7. Define Form factor and write the equation.
8. Define crest factor and write the equation.
9. Define phase.
10. Define phase angle.
11. Define phase angle difference.

Cognitive Level: UNDERSTAND

12. Explain the generation of alternating voltage or current.
13. Draw a sinusoidal waveform and mark the following (i) maximum value (ii) instantaneous value (iii) Time period (iv) frequency.
14. Define average value of alternating current.
15. Explain the mid ordinate or graphical method of calculating the Average value.
16. Explain the analytical or integral method of calculating the Average value.

Cognitive Level: APPLICATION

17. Explain the mid ordinate or graphical method of calculating the RMS value.
18. Explain the analytical or integral method of calculating the RMS value.
19. Derive an equation for RMS value of alternating voltage and current.
20. Show that the R.M.S. value of a sinusoidal alternating current is 0.707 times the maximum value.
21. Derive an expression for instantaneous value of voltage and current.
22. Differentiate between the terms ‘in- phase’ and ‘out of phase’ alternating quantities.

UNIT-V

SINGLE PHASE AC CIRCUITS

Cognitive Level: UNDERSTAND

1. Define AC circuit.
2. Define resistance. Mention its unit.
3. Define inductive reactance, mention its unit and write its equation.
4. Define capacitive reactance, mention its unit and write its equation.
5. Define power factor.
6. Define leading power factor.
7. Define lagging power factor.
8. Define unity power factor.
9. Define zero power factors.
10. Explain leading and lagging power factor.
11. Write the equation for consumed by R-L series circuit.
12. What is Impedance triangle?
13. Explain power triangle.
14. Define apparent power. Mention its unit.
15. Define true power or useful power. Mention its unit.
16. Define reactive power or wasteful power. Mention its unit.
17. What is an inductive circuit?
18. What is a capacitive circuit?
19. Define impedance. Mention its unit.
20. Define series resonance.
21. Define resonant frequency and write the equation.
22. Define Q-factor.

Cognitive Level: APPLICATION

23. Classify single phase AC circuits.
24. Explain a pure resistive circuit.
25. Derive the equation for power in a pure resistive circuit.
26. Explain a pure inductive circuit.
27. Derive the equation for power in a pure inductive circuit.
28. Explain a pure capacitive circuit.
29. Derive the equation for power in a pure capacitive circuit.
30. Draw the circuit diagram, wave diagram and vector diagram for a pure resistive circuit.

31. Draw the circuit diagram, wave diagram and vector diagram for a pure inductive circuit.
32. Draw the circuit diagram, wave diagram and vector diagram for a pure capacitive circuit.
33. With a neat circuit diagram, wave diagram and vector diagram explain R-L series circuit.
34. With a neat circuit diagram, wave diagram and vector diagram explain R-C series circuit.
35. Write the equation for consumed by R-C series circuit.
36. With a neat circuit diagram, wave diagram and vector diagram explain R-L-C series circuit.
37. Write the equation for power consumed by RLC series circuit.
38. Explain the condition for series resonance.
39. State the condition for the series resonance.
40. Draw the Resonance curve.

UNIT-VI

POLYPHASE AC CIRCUITS

Cognitive Level: UNDERSTAND

1. Define poly phase system.
2. Mention the advantages of 3-phase system over single phase system.
3. Explain the generation of three phase voltage.
4. What is phase sequence?
5. Explain interconnected system.
6. Explain STAR connected three phase system.
7. Define phase voltage in a 3-phase system.
8. Define phase current in a 3-phase system.
9. Define line voltage in a 3-phase system.
10. Define line current in a 3-phase system.
11. State the relation between line voltage and phase voltage in star connected system.
12. State the relation between phase current and line current in star connected system.
13. What is the power consumed or supplied by 3ph star connected system?
14. What is the power consumed by 3ph Star connected system?
15. What is the power consumed by 3ph delta connected system?
16. What do you mean by a balanced 3ph system?
17. What do you mean by an un-balanced 3ph system?

Cognitive Level: APPLICATION

18. Prove that line voltage = √3. Phase voltage in a 3ph star connected system.
19. Prove that line current = phase current in a 3ph star connected system
20. Prove that line voltage = phase voltage in a 3ph delta connected system
21. Prove that line current = √3. phase current in a 3ph delta connected system
22. Explain DELTA connected 3ph system.
23. State the relation between line voltage and phase voltage in delta connected system.
24. State the relation between phase current and line current in delta connected system.
25. State the relation between line voltage and phase voltage in star connected system.
26. State the relation between phase current and line current in star connected system.

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