ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **ELECTRICAL CIRCUITS AND NETWORK**
Course Code : **313332**

I. RATIONALE

Electrical Circuits and Network are integral part of power system. This is one of the most important core electrical engineering course and a pre-requisite to learn advanced electrical courses. This course develops skills to apply principle of single and three phase AC circuits and network theorems to analyze and solve simple electric circuits related problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Diagnose and Rectify simple electric circuit and network related problems in industry.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Analyze the parameters of single-phase AC series circuits.
- CO2 - Analyze the parameters of single-phase AC parallel circuits.
- CO3 - Analyze the parameters of polyphase AC circuits.
- CO4 - Apply network reduction methods to solve DC circuits.
- CO5 - Apply network theorems to solve basic electrical circuits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313332	ELECTRICAL CIRCUITS AND NETWORK	ECN	DSC	4	-	4	-	8	4	3	30	70	100	40	25	10	50#	20	-	-	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Determine the current, voltage and draw vector diagram for the given AC series circuit. TLO 1.2 Calculate inductive, capacitive reactance and impedance for the given AC series circuit. TLO 1.3 Determine active, reactive, apparent power and power factor for the given AC series circuit. TLO 1.4 Determine resonant frequency, voltage magnification and Q-factor for the given R-L-C series circuit.	**Unit - I Single Phase A.C Series Circuits** 1.1 Generation of alternating voltage, Phasor representation of sinusoidal quantities. 1.2 R, L, C circuit elements it's voltage and current response. 1.3 R-L, R-C, R-L-C series A.C. circuits- vector diagram, active, reactive, apparent power, power triangle and power factor. (Simple Numerical). 1.4 Resonance in R-L-C series circuit- Graphical Representation, Resonance curve, Quality (Q) Factor. (Simple Numerical)	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Case Study Collaborative learning Presentations
2	TLO 2.1 Determine the current, voltage and draw vector diagram for the given AC parallel circuit. TLO 2.2 Calculate inductive, capacitive reactance and impedance for the given AC parallel circuit. TLO 2.3 Determine active, reactive, apparent power and power factor for the given AC parallel circuit. TLO 2.4 Determine resonant frequency, current magnification and Q-factor for the given R-L-C parallel circuit.	**Unit - II Single Phase A.C Parallel Circuits** 2.1 R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle. 2.2 R-L, R-C, R-L-C parallel A.C. circuits- vector diagram, active, reactive, apparent power, power triangle and power factor (Simple Numerical). 2.3 Resonance in parallel circuit- Graphical Representation, Resonance curve, Quality (Q) Factor. (Simple Numerical)	Lecture Using Chalk-Board Case Study Video Demonstrations Flipped Classroom Collaborative learning Presentations
3	TLO 3.1 Explain the principle of generation of 3-phase waveform. TLO 3.2 Compare of 3-phase circuit with 1-phase circuit. TLO 3.3 Calculate line, phase values and 3-phase power for star and delta connection. TLO 3.4 Explain the concept of balanced and unbalanced load condition.	**Unit - III Three Phase Circuits** 3.1 Generation of 3-phase alternating emf, Phase Sequence. 3.2 Comparison of 3-phase circuit with single phase circuit. 3.3 Types of three phase connections-star and delta, Relation between phase and line values. 3.4 3-Phase power- active, reactive and apparent power in star and delta connected system. 3.5 Concept of balanced and unbalanced load (Numerical on balanced load only)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study
4	TLO 4.1 Apply source transformation techniques for the given network. TLO 4.2 Reduce the given network by applying Star/delta and delta/star transformation. TLO 4.3 Apply Mesh analysis to solve the given network. TLO 4.4 Apply Node analysis to solve the given network.	**Unit - IV Network Reduction Methods for DC Circuits.** 4.1 Source transformation Techniques. 4.2 Star to delta and delta to star transformation. 4.3 Mesh Analysis. 4.4 Node Analysis.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Apply superposition theorem to determine the current in the given branch of a circuit. TLO 5.2 Draw Thevenin's equivalent circuit and determine load current in the given branch of a circuit. TLO 5.3 Draw Norton's equivalent circuit and determine load current in the given branch of a circuit. TLO 5.4 Apply maximum power transfer theorem to determine the maximum power in the given network. TLO 5.5 Apply Reciprocity theorem for the given network. TLO 5.6 Describe the procedure to solve the AC network theorem.	**Unit - V Network Theorems** 5.1 Superposition theorem. 5.2 Thevenin's theorem. 5.3 Norton's theorem 5.4 Maximum power transfer theorem 5.5 Reciprocity Theorem 5.6 Introduction to AC Network Theorem (No numerical for 5.6)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Trace the output waveforms across R L circuit to identify the phase difference and measure the amplitude. LLO 1.2 Observe the nature of current with respect to voltage in R-L series circuit. LLO 1.3 Operate various controls of CRO	1	*Determination of the phase difference between A.C voltage and current in a given R-L series circuit by using dual trace oscilloscope.	2	CO1
LLO 2.1 Trace the output waveforms across R C circuit to identify the phase difference and measure the amplitude. LLO 2.2 Observe the nature of current with respect to voltage in R-C series circuit. LLO 2.3 Operate various controls of CRO	2	Determination of the phase difference between A.C voltage and current in a given R-C series circuit by using dual trace oscilloscope.	2	CO1
LLO 3.1 Trace the output waveforms across R L C circuit to identify the phase difference and measure the amplitude. LLO 3.2 Observe the nature of current with respect to voltage for $X_L > X_C$ or $X_L < X_C$. LLO 3.3 Operate various controls of CRO	3	*Determination of the phase difference between A.C voltage and current in a given R-L-C series circuit by using dual trace oscilloscope.	2	CO1
LLO 4.1 Measure voltage, current and draw phasor diagram to find pf and verify the same.	4	*Determination of voltage, current and pf in a given R-L series circuit. Draw phasor diagram.	2	CO1
LLO 5.1 Measure active power and calculate reactive and apparent power for R-L series circuit and verify the same.	5	Determination of active, reactive and apparent power consumed in given R-L series circuit.	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Measure active power and calculate reactive and apparent power for R-C series circuit and verify the same.	6	*Determination of voltage, current and pf in a given R-C series circuit. Draw phasor diagram.	2	CO1
LLO 7.1 Measure active power and calculate reactive and apparent power for R-C series circuit and verify the same.	7	Determination of active, reactive and apparent power consumed in a given R-C series circuit.	2	CO1
LLO 8.1 Measure voltage, current and draw phasor diagram to find pf and verify the same. LLO 8.2 Observe the nature of current with respect to voltage for $X_L > X_C$ or $X_L < X_C$and interpret about the nature of the circuit.	8	*Determination of voltage, current and pf in a given R-L-C series circuit. Draw phasor diagram.	2	CO1
LLO 9.1 Measure active power and calculate reactive and apparent power for R-L-C series circuit and verify the same.	9	*Determination of active, reactive and apparent power consumed in given R-L-C series circuit.	2	CO1
LLO 10.1 Measure the resonant frequency and verify it by calculation. LLO 10.2 Using variable frequency supply obtain resonant condition for R-L-C series circuit	10	Resonance in given R-L-C series circuit using variable frequency supply.	2	CO1
LLO 11.1 Measure the inductance and capacitance to obtain the resonant condition. LLO 11.2 Measure current, voltage and draw vector diagram to obtain pf at resonance in R-L-C series circuit	11	*Resonance in given R-L-C series circuit using variable inductor or capacitor.	2	CO1
LLO 12.1 Measure voltage, current and draw phasor diagram to find pf and verify the same. LLO 12.2 Measure active power and calculate reactive and apparent power for R-L-C parallel circuit and verify the same.	12	*Determination of voltage, current, p.f., active, reactive and apparent power for given R-L-C parallel circuit.	2	CO2
LLO 13.1 Measure the resonant frequency and verify it by calculation. LLO 13.2 Obtain resonant condition for R-L-C parallel circuit by varying frequency or inductance and capacitance. LLO 13.3 Measure current, voltage and draw vector diagram to obtain pf at resonance in R-L-C parallel circuit.	13	Resonance in given parallel R-L-C circuit using variable frequency supply or variable inductor and capacitor.	2	CO2
LLO 14.1 Identify phase sequence of the 3-phase supply system and draw the waveforms.	14	*Phase sequence of 3-phase supply system.	2	CO3
LLO 15.1 Measure line and phase values for both balance and unbalance star connected load. LLO 15.2 Draw phasor diagram with the help of phase values and verify the line values.	15	*Determination of line and phase quantities of voltage and current for balanced & unbalanced three phase star connected load. Draw phasor diagram.	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Measure line and phase values for both balance and unbalance delta connected load. LLO 16.2 Draw phasor diagram with the help of phase values and verify the line values.	16	*Determination of line and phase values of voltage and current for balanced & unbalanced three phase delta connected load. Draw phasor diagram.	2	CO3
LLO 17.1 Measure active, reactive, and apparent power for balanced three phase star connected inductive / capacitive load.	17	*Determination of active, reactive, and apparent power for balanced three phase star connected inductive / capacitive load.	2	CO3
LLO 18.1 Measure active, reactive, and apparent power for balanced three phase delta connected inductive / capacitive load.	18	Determination of active, reactive, and apparent power for balanced three phase delta connected inductive / capacitive load.	2	CO3
LLO 19.1 Measure active, reactive, and apparent power for unbalanced three phase star connected inductive / capacitive load.	19	Determination of active, reactive, and apparent power for unbalanced three phase star connected inductive / capacitive load.	2	CO3
LLO 20.1 Measure active, reactive, and apparent power for unbalanced three phase delta connected inductive / capacitive load	20	Determination of active, reactive, and apparent power for unbalanced three phase delta connected inductive / capacitive load.	2	CO3
LLO 21.1 Measure current through the branch for given electric network and verify by applying mesh analysis.	21	*Verification of Mesh analysis method.	2	CO4
LLO 22.1 Measure current through the branch for given electric network and verify by applying node analysis.	22	*Verification of Node analysis method.	2	CO4
LLO 23.1 Measure current through the branch for a given DC electric network and verify by applying superposition theorem.	23	*Verification of Superposition theorem.	2	CO5
LLO 24.1 Measure Thevenin's equivalent circuit parameter for a given DC circuit and verify by applying Thevenin's theorem. LLO 24.2 Draw the Thevenin's equivalent circuit and verify the load current.	24	*Verification of Thevenin's theorem.	2	CO5
LLO 25.1 Measure Norton's equivalent circuit parameter for a given DC circuit and verify by applying Norton's theorem. LLO 25.2 Draw the Norton's equivalent circuit and verify the load current.	25	*Verification of Norton's theorem.	2	CO5
LLO 26.1 Measure load resistance to transfer maximum power for a given DC circuit and verify by applying maximum power transfer theorem.	26	*Verification of Maximum Power Transfer theorem.	2	CO5
LLO 27.1 Measure current through the branch for a given AC electric network and verify by applying superposition theorem.	27	*Verification of Superposition theorem for AC network.	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital Storage Oscilloscope: Dual Trace 50Mhz	1,2,3
2	Inductor 1.3 H, suitable range	1,3,4,5,8,9,10,12,13,27
3	Variable Frequency Generator	10,13
4	Capacitor Bank 5A, 250 V suitable range	10,13,17,18,19,20
5	Inductor Bank 5A, 250 V suitable range	10,13,17,18,19,20
6	Phase Sequence Indicator as per availability in the lab	14
7	Load Bank: Resistive, 3-Phase, 5 kW, 415 V	15,16
8	Dimmer: 3-Phase, 5 kVA	15,16,17,18,19,20
9	Capacitor 10 µF (micro-Farad) 250 V suitable range	2,3,6,7,9,10,12,13,27
10	DC Regulated Power Supply	21,22,23,24,25,26
11	Trainer Kit for Theorems	23,24,25,26
12	Load Bank: Resistive, 1-Phase, 1 kW, 230 V	26
13	Low Power Factor Wattmeter: Single Phase, 5/10 Amp, 250/500 V	5,17,18,19,20
14	Wattmeter: Single Phase 2.5/5 Amp, 200/400 V, Single Phase 5/10 Amp, 250/500 V	5,7,9,12,17,18,19,20
15	Rheostat- 18 ohm /10A, 250 ohm / 2A, 500 ohm /1 A, 720 ohm / 0.8A, suitable range	All
16	Ammeters MI Type: AC/DC, 0-5-10Amp,0-1.5 Amp,0-2.5Amp,0-0.5-1Amp	All
17	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V	All
18	Dimmer: 1-Phase,1kVA, 230V	All
19	Multimeter suitable range	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Single Phase A.C Series Circuits	CO1	14	2	6	8	16
2	II	Single Phase A.C Parallel Circuits	CO2	12	2	4	6	12
3	III	Three Phase Circuits	CO3	8	2	4	6	12
4	IV	Network Reduction Methods for DC Circuits.	CO4	10	2	4	6	12
5	V	Network Theorems	CO5	16	4	4	10	18
Grand Total				**60**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline mode of examination. End semester summative assessment of 50 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	3	2	3	-	-	3			
CO2	3	3	2	3	-	-	3			
CO3	3	3	1	3	-	-	3			
CO4	3	3	2	2	-	-	3			
CO5	3	3	3	3	-	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Gupta, B. R. Singhal, Vandana	Fundamentals of Electrical Networks	S.Chand and Co., New Delhi, 2005 ISBN : 978-81-219-2318-7
2	Theraja, B. L. ; Theraja, A. K.	A Text Book of Electrical Technology Vol-I	S. Chand and Co. Ramnagar, New Delhi, 2012; ISBN : 9788121924405
3	Saxena, S.B lal ; Dasgupta, K.	Fundamentals of Electrical Engineering	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 978-11-0746-435-3
4	Mittle, V.N. ; Mittle, Arvind	Basic Electrical Engineering	McGraw Hill Education, Noida, 2005 ISBN: 978-00-705-9357-2
5	Sudhakar, A Shyammohan, S.Palli	Circuit and network	McGraw Hill Education, New Delhi, 2015, ISBN : 978-93-3921-960-4
6	Mahmood Nahvi, Joseph Edminister	Schaum online series- Theory and problems of electric circuits	McGraw Hill Education, Newyork, 2013, ISBN: 978-00-701-8999-7
7	David A. Bell	Electric Circuits	Oxford University Press New Delhi, 2009; ISBN : 978-01-954-2524-6
8	M.E. Van Valkenburg	Network Analysis	Pearson Education ISBN: 9789353433123

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.cesim.com/simulations	Graphical representation of series and parallel resonance
2	https://ndl.iitkgp.ac.in/	NeworkTheorems
3	https://nptel.ac.in/	Single phase Series and Parallel Circuit, Three Phase Circuit

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Sr.No	Link / Portal	Description
4	http://vlabs.iitkgp.ac.in/asnm/	Series and Parallel Resonance, Network Theorems, Reduced Network Methods
5	https://vlab.amrita.edu	Single phase Series and Parallel Circuit, Three Phase Circuit, Series and Parallel Resonance
6	www.dreamtechpress.com /ebooks	Free reference books for more practice
7	www.nptelvideos.in/electrical engineering/ circuit theory	Network Circuit Theory

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**