Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

Program Code : **DE/EJ/ET/EN/EX/EQ/IE/IS/IC**

Semester : **Third**

Course Title : **Electric Circuits and Networks**

Course Code : **22330**

1. RATIONALE

In industry, to build and test electronic/electrical circuits in different situations knowledge of electric circuits and networks is very important. This course is intended to develop the skills to diagnose and rectify the electric network and circuit related problems in the industry. The concept and principles of circuit analysis lays the foundation to understand courses of higher level.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Diagonose the electrical and electronic circuits problems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Check the working of single phase a.c. circuits.
b. Check the resonance condition of electric/electronic circuits.
c. Check the functionality using the principles of circuit analysis.
d. Use network theorems to determine the various parameters in circuits.
e. Use two port networks to determine the circuit parameters.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

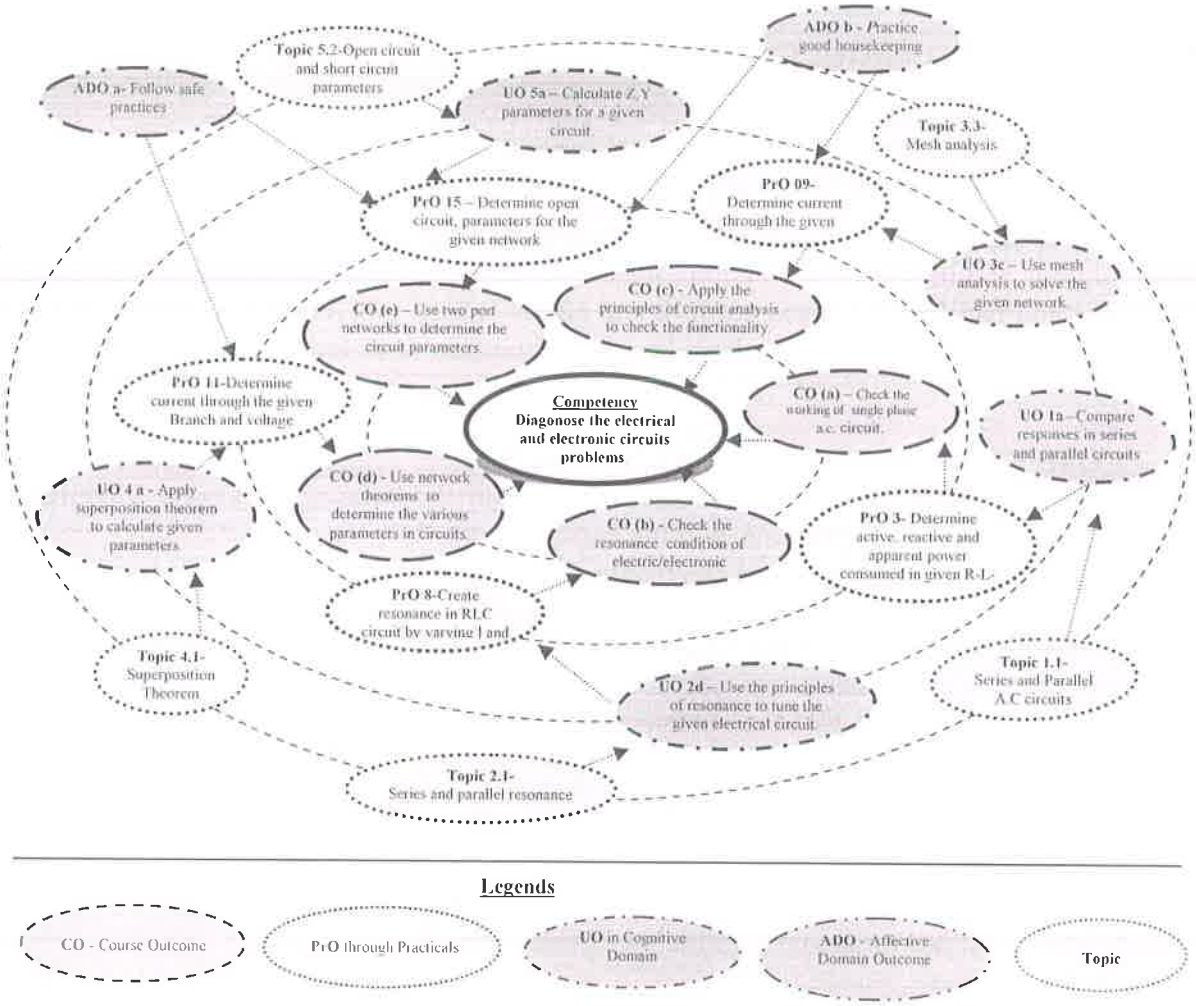

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Determine active, reactive and apparent power consumed in given R-L series circuit and draw phasor diagram.	I	02*
2	Determine active, reactive and apparent power consumed in given R-C series circuit and draw phasor diagram.	I	02
3	Determine active, reactive and apparent power consumed in given R-L-C series circuit and draw phasor digram.	I	02*
4	a. Measure currents in R-C parallel A. C. circuit. b. Determine p.f., active, reactive and apparent power in R-C parallel a.c. circuit.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	a. Measure currents in each branch of given R-L-C parallel a. c. circuit. b. Determine p.f., active, reactive and apparent power for given R-L-C Parallel circuit with series connection of resistor and inductor in parallel with capacitor.	I	02
6	Determine initial and final voltage across the capacitor at $t=0^-$ and $t=0^+$.	I	02
7	Determine initial and final current through the inductive coil at $t=0^-$ and $t=0^+$	I	02
8	Create resonance in given R-L-C circuit by varying L and C or by using variable frequency supply.	II	02*
9	Determine current through the given branch of a electric network by applying mesh analysis.	III	02
10	Determine voltage at the particular node and current through any given branch of the network by applying nodal analysis.	III	02*
11	Determine current through the given branch and voltage across the given element of circuit by applying superposition theorem .	IV	02*
12	Determine equivalent circuit parameter in a given circuit by applying Thevenin's and Norton's theorem .	IV	02
13	Determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem .	IV	02
14	Test the response of the given circuit by applying reciprocity theorem.	IV	02
15	Determine open circuit (Z) parameters for the given network.	V	02*
16	Determine short circuit (Y) parameters for the given network.	V	02
17	Determine transmission (ABCD) parameters for the given network.	V	02
	Total		**34**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices
b. Practice good housekeeping
c. Practice energy conservation
d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Ammeters MI Type: AC/DC, 0-1Amp,0-1.5 Amp,0-2.5Amp,0-5Amp.	1 to 17
2	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
3	Ammeters PMMC Type: DC, 0-1.5/3Amp, 0-2.5/5 Amp, 0-5/10Amp.	1 to 17
4	Voltmeter PMMC Type: DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
5	Wattmeter: Single phase 2.5/5Amp, 200/400V, Single phase 5/10Amp, 250/500V	1 to 17
6	Low power factor wattmeter : Single phase, 5/10Amp, 250/500V.	1 to 5
7	Wattmeter: Dynamometer type, single phase, 5Amp, 250V.	1 to 5
8	Power factor meters: AC, 230V,45-50-55 Hz , single phase, 5-10 Amp, 250V.	1 to 5
9	Digital storage oscilloscope 50MHz.	6 ,7
10	Trainer kit for all theorems.	9 to 17

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Single Phase A.C. Circuits	1a. Compare the A.C. responses in the given type of series and parallel circuits. 1b. Explain with sketches the phasor diagram of the given AC circuit. 1c. Calculate active, reactive, apparent	1.1 Series A.C. circuits: R-L, R-C and R-L-C circuits, impedance, reactance, phasor diagram, impedance triangle, power factor, active(real) power, apparent power, reactive power, power triangle

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	power and power factor for the specified circuit. 1d. Suggest the power factor improve technique for the given situation with justification. 1e. Calculate admittance,conductance and susceptance for the given circuit. 1f. Determine the equivalent impedance and admittance for the given circuit. 1g. Interpret the working of the given R,L, and C component using initial and final condition.	1.2 AC Series circuit by using complex algebra 1.3 Parallel AC circuits: Resistance in parallel with pure inductance and capacitance, series combination of resistance and inductance in parallel with capacitance 1.4 Concept of admittance, conductance and susceptance 1.5 Concept of initial and final conditions in switching circuits, Meaning of t = 0 -, t = 0+ and t = ∞. R, L and C at initial and final conditions
Unit-II Resonance in Series and Parallel Circuits	2a. Find the resonance condition for the specified series and parallel circuits. 2b. Calculate current, voltage and frequency for the given resonant circuit. 2c. Determine bandwidth and quality factor(Q) for the given series and parallel resonant circuit. 2d. Describe the procedure to tune the given electrical circuit using the principles of resonance.	2.1 Series and parallel resonance 2.2 Impedance and phase angle of a Series and parallel resonant circuits 2.3 Voltage and current in a series and parallel resonant circuit 2.4 Bandwidth of a RLC circuit(series and parallel resonance) 2.5 Quality factor (Q) and its effect on bandwidth (series and parallel resonance) 2.6 Magnification in series and parallel resonance circuits
Unit– III Principles of Circuit Analysis	3a. Use source transformation techniques for the given circuit. 3b. Convert the given star connection to delta connection and vice versa. 3c. Use mesh analysis to solve the given network. 3d. Solve the given network using nodal analysis. 3e. Diagnose the fault in the given circuit using the relevant technique(s).	3.1 Source transformation 3.2 Star/delta and delta/star transformations 3.3 Mesh analysis 3.4 Node analysis
Unit– IV Network Theorems	4a. Use superposition theorem to calculate the given parameters in the given circuit. 4b. Apply Thevenin's theorem to calculate the given parameters in the given circuit. 4c. Use Norton's theorem to calculate the given parameters in the given circuit.	4.1 Superposition theorem for both AC voltage and DC source 4.2 Thevenin's theorem 4.3 Norton's theorem 4.4 Maximum power transfer theorem 4.5 Reciprocity theorem 4.6 Superposition theorem

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4d. Calculate load impedance using maximum power transfer theorem for the given circuit. 4e. Use reciprocity theorem to analyse the given circuit.	
Unit –V Two Port Networks	5a. Calculate Z, Y, parameters for the given circuit. 5b. Find the ABCD parameters for the given circuit. 5c. Sketch the phasor diagram for the given T and π circuit with justification. 5d. Calculate Z and Y parameters to test whether the given circuit is reciprocal or symmetrical two port network .	5.1 Significance of two port network 5.2 Open circuit(Z) and short circuit(Y) Parameters 5.3 Transmission (ABCD) parameter 5.4 T and π representation of circuits 5.5 Reciprocal and symmetrical two port network(no derivation)

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Single Phase A.C. Circuits	10	04	04	06	14
II	Resonance in Series and Parallel Circuits	10	02	06	06	14
III	Principles of Circuit Analysis	10	04	04	06	14
IV	Network Theorems	12	04	06	08	18
V	Two port networks	06	02	04	04	10
Total		**48**	**16**	**24**	**30**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electric/electronic equipment and component.
d. Library / Internet survey of electrical circuits and network

e. Prepare power point presentation or animation for understanding different circuits behaviour.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***
The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs. Micro project report may be of four to five pages.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. **Single Phase A.C. series and parallel Circuits:** Prepare series and parallel circuit using variable R, L and C combination on the bread board. Measure the response and draw vector diagram. Also calculate power factor for the circuit. Write report on the same.
b. **Resonance in series and Parallel Circuits:** Prepare series RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the responses and calculate band width and Q-factor for the circuit. Write report on the same.
c. **Resonance in Series and parallel Circuits:** Prepare parallel RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the response and calculate band width and Q-factor for the circuit. Write report on the same.

d. **Principles of circuit analysis:** Prepare power , point presentation on source transformation, star delta transformation, mesh and nodal analysis and give presentation in the class room.
e. **Network Theorems:** Select suitable components for the given circuit and prepare the same on the bread board. Verify the following network theorem theoretically and practically.
   i. Superposition Theorem
   ii. Maximum power transfer theorem
   iii. Thevenin's theorem
   iv. Norton's theorem.
f. **Two Port Networks:** Design and prepare two port network on bread board for given values of open circuit Z parameter.
g. **Two Port Networks:** Design and prepare two port network on bread board for given values of short circuit Y parameter.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle, V.N. ; Mittle, Arvind	McGraw Hill Education, Noida, 2005, ISBN: 9780070593572
2	A Text Book of Electrical Technology Vol-I	Theraja, B. L. ; Theraja, A. K.	S. Chand and Co., New Delhi, 2006 ISBN: 978-81-219-2440-5
3	Fundamentals of Electrical Engineering	Saxena, S.B.; Dasgupta, K.	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 9781107464353
4	Circuit and network	Sudhakar, A. ; Palli Shyammohan, S.	McGraw Hill, New Delhi, 2006 ISBN : 978-0-07-340458-5
5	Electric Circuits	Bell, David A.	Oxford University Press New Delhi, 2009 ISBN: 9780195425246
6	Electric Circuit Analysis	Paranjothi, S.R.	New Age Publisher, New Delhi, 2011, ISBN: 978-81-224-3154-4
7	Fundamentals of Electrical Networks	Gupta, B.R ; Singhal, Vandana	S.Chand and Co., New Delhi, 2005 ISBN: 978-81-219-2318-7
8	Schaum's Outline of Electric Circuits	Edminister,Joseph A. Nahvi,Mahmood	McGraw Hill, New Delhi, 2013 ISBN: 9780070189997
9	Introductory circuit Analysis.	Boylested, R.L.	Wheeler, New Delhi , 2013 ISBN: 978-0023131615

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cesim.com/simulations
b. www.scilab.org/scilab
c. www.ni.com/multisim
d. www.youtube.com /electric circuits
e. www.dreamtechpress.com /ebooks
f. www.nptelvideos.in/electrical engineering/ circuit theory
g. www.learnerstv.com/free-engineering
h. electronicsforu.com/category/electronics-projects