Nirma University
Institute of Technology
Electrical Engineering Department

Course Policy

B. Tech. Semester-III **Academic Year: 2019-20**

Course Code & Name	**:**	**2EE301 Network Analysis and synthesis**
Credit Details	**:**	Lectures – 3, Tutorials – 1, Practical – 0, Credits – 4
Course Co-ordinator	**:**	Prof. Akhilesh Panwar
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Office	**:**	D – 307/5
Course Faculty	**:**	**1.** Prof. Akhilesh Panwar (Div A) **Visiting Hours**: Monday 10:45 – 11:15 am Odd Saturdays: 11:00 am – 01:00 pm **2. Prof Abirami Rajagopal(Div B)** **Visiting Hours**: Monday 10:45 – 11:15 am Odd Saturdays: 02:00 pm – 04:00 pm +91-79-71652-421 **3.** Prof. U. A. Patel Visiting Faculty
Queries by emails are encouraged		
Course Blog	**:**	https://2ee301nas.home.blog/

1. Introduction to the Course

1.1 *Importance of the course:*

The course Network Analysis and synthesis is a fundamental course offered to students of Semester-III B.Tech. in electrical engineering. It gives exposure to the topics such as network topology, methods of solving network equations, initial conditions in circuits, Laplace transform methods, electricity fundamentals, waveform synthesis, Network theorems etc. The course deals with understanding of basic methods of analysing and solving networks circuits behaviour of circuit elements like; R, L and C under various operating conditions. It also focuses on representation of any network in form of its network parameters. The understanding of this course is important as it lays the foundation for all other courses in electrical and electronic engineering. The course finds

applications in all branches of engineering and hence is essential for inter disciplinary learning and research.

1.2 *Objective of the course:*

The objective of this course is to provide a comprehensive knowledge of basics of network analysis and synthesis

1.3 *Pre-requisite:*

The students are expected to have the prerequisite knowledge of basic electrical engineering like concept of load, single phase and three phase voltage, impedance and admittance parameters, basic circuit laws. They are also expected to have the knowledge of mathematics such as algebra, calculus, geometry, complex numbers, differentiation, integration etc. Students are expected to review these concepts before coming to class.

1.4 *Course Outcomes (CO)*

COs are clear statements of the expectations for student achievements in the course.
At the end of the course, a student will be able to –

1. understand the basic laws, theorems and the methods of analysing electrical circuits.
2. analyse the properties of coupled circuits and usage of network graph to solve circuits.
3. obtain the transient and steady-state response of electrical circuits.
4. understand two port network and network synthesis.

1.5 *Syllabus:*

Basic Circuit Fundamentals
Basic definitions, Nature of sources, Phasor technique, Kirchhoff's laws, Mesh and Nodal Analysis, Super-mesh and Super-Node Analysis, Source transformation, Duality.

Coupled Circuits
Self and Mutual inductance, Coefficient of coupling, Dot convention, Tuned circuit, Single tuned circuits.

Network Theorems
Superposition, Thevenin's, Norton's, Maximum power transfer, Tellegen's, Millman's and Reciprocity theorem in DC and AC circuits.

Network Topology
Basic definitions, Formation of incidence, f-tie set and f-cut set matrix, relationship between matrices, Network equilibrium equations.

Time Domain Analysis
Initial conditions, Procedure for evaluating initial conditions, Transient analysis of DC & AC circuits.

Frequency Domain Analysis
Laplace transform of standard signals, Shifting theorem, initial and final value theorem, Solution of circuit equations by Laplace transform, Evaluation of circuit response for various signals.

Tow Port Networks
Classification of networks, Two port parameters ($Z, Y, ABCD, h$), Condition of Reciprocity and Symmetricity, Interrelations and Interconnections of two port networks.

Network Functions

Calculation of network functions, Poles and Zeros of network functions and their restriction, time domain behaviour from pole - zero plot. Hurwitz Polynomial, Properties of positive real function, necessary and sufficient conditions, basic synthesis procedure, synthesis of L-C, R-L and R-C driving point functions.

1.6 *Self-Study:*

The self-study components of the syllabus are declared at the commencement of the semester. Basic principles and methodology will be explained in the class. It is expected that the students put in at least two hours of self-study for every one hour of class room teaching. Further, around 10% of the questions will be asked from following topics:

Sr.	Topic	Hours
1	Substitution Theorem	01
2	Compensation Theorem	01
3	T-Network	01
4	Pi-Network	01
5	Lattice Network	01
	Total	05 hours

Students are expected to study above mentioned topics on their own. These topics will not be taught in the classroom. Students should refer books and other material available in the library for the same. Blogs and course website can also be referred for useful material on these topics.

1.7. *References:*

1. M E Van Valkenburg, Textbook of Network Analysis, Prentice Hall India.
2. A. Chakrabarti , Circuit Theory- Analysis and Synthesis, Dhanpat Rai & Co.
3. U. A. Patel, Textbook of Network Analysis and Synthesis, Mahajan Publishing House.
4. Akhilesh A. Nimje, Electrical Circuit Analysis and Synthesis, New Age International Publishers
5. William D. Stanley, Textbook of Network Analysis with Applications, Pearson Education (I) Ltd.
6. Franklin F. Kuo, Textbook of Network Analysis and Synthesis, Wiley India.
7. Charles A. Desoer and Ernest S. Kuh, Textbook of Basic Circuit Theory, Tata McGrawhill.
8. Lawrance P. Huelman, Textbook of Basic Circuit Theory, Prentice Hall of India.

Note: The latest edition of books should be referred.

1.8 *Tutorial details*

Laboratory experiments should be completed as per the given schedule. It is expected that a student does the same with full understanding of the concept, procedure and application involved.

Laboratory work will be based on above syllabus with minimum 12 experiments to be performed.

Sr. No.	List of Tutorials	Schedule*	Mapped CLO

1.	**Basic Circuit Fundamentals**	Week 1	1
2.	**Coupled Circuits**	Week 2	2
3.	**Network Theorems**	Week 3	1
4.	**Network Topology**	Week 4	2
5.	**Time Domain Analysis**	Week 5	3
6.	**Frequency Domain Analysis**	Week 6	3
7.	**Tow Port Networks**	Week 7	4
8.	**Network Functions**	Week 8	4

* Schedule is based on academic calendar.

2. ***Assessment Policy***

2.1 Component wise Continuous Evaluation (CE), Laboratory and Project Work (LPW) & Semester End Examination (SEE) weightage

Assessment scheme	**CE(100 marks)**			**SEE(100 marks)**
Component weightage	0.6			0.4
	Class Test 30% (30 marks)	Sessional Exam 40% (40 marks)	Assignment 30% (30 marks)	100 marks

2.2 Assessment Policy for Continuous Evaluation (CE)

Assessment of Continuous Evaluation comprises of three components.

1. Class Test will be conducted as per academic calendar. It will be conducted online/ offline for the duration of 1 hour and will be of 30 marks.
2. Sessional Exam will be conducted as per academic calendar. It will be conducted offline for the duration of 1 hour and 15 minutes and will be of 40 marks.
3. There will be 02 assignment during the course with weightage of 15 marks each. Assessment of the assignments will be carried out based on parameters like timely submission, neat and clean work, originality, involvement of the student, regularity, discipline etc. during the semester.

2.3 Assessment Policy for Semester End Examination (SEE)

A written examination of 3 hour duration will be conducted for the course as per academic calendar. It will carry 100 marks and marks obtained out of 100 will be converted as per weightage assigned.

3 *Lesson Plan:*

Sr.No	Topic	Hours	Mapped CO
1	Introduction to course	**01**	
Ch-1	**NETWORK EQUATIONS**	**06**	
1.1	Nature of Sources, Phasor Technique, Mesh/loop current analysis with along super mesh and examples (AC and DC)	02	**1**
1.2	Node voltage analysis along with super node and examples (AC and DC)	02	
1.3	Source transformation	01	
1.4	Duality	01	
Ch-2	**COUPLED CIRCUITS**	**03**	
2.1	Self and mutual inductance, coefficient of coupling	01	
2.2	Dot convention and related examples	01	
2.3	Tuned circuit, Single tuned circuit (To be covered after pole-zero and frequency domain analysis)	01	
Ch-3	**NETWORK TOPOLOGY**	**05**	**2**
3.1	Graph theory terminology, Complete incidence matrix, Concept of KCL and KVL with incidence matrix	01	
3.2	Tie-Set and Cut-Set matrix along with concept of KCL and KVL	01	
3.3	Formulation of network equilibrium equations and solution of current and voltage	02	
3.4	Problems based on network equilibrium equations	01	
Ch-4.	**NETWORK THEOREMS (DC and AC CIRCUITS)**	**06**	
4.1	Superposition theorem. (AC and DC)	01	
4.2	Thevenin's theorem (AC and DC)	01	
4.3	Norton's theorem. (AC and DC)	01	**1**
4.4	Thevenin's and Norton's theorem with dependent sources (AC and DC)	01	
4.5	Maximum power transfer theorem (AC and DC)	01	
4.6	Millimans and reciprocity theorem (AC and DC)	01	
Ch-5	**INITIAL CONDITIONS**	**05**	
5.1	Initial conditions in elements.	01	
5.2	Procedure for evaluating initial conditions in R-L and R-C networks	01	
5.3	Transient analysis of DC and AC circuits, Transient free condition for AC circuits (RL,RC)	03	
Ch-6	**FREQUENCY DOMAIN ANALYSIS**	**06**	**3**
6.1	Introduction and Laplace transformation of standard signals	01	
6.2	Shifting theorem, initial and final value theorem	01	
6.3	Solution of circuit equations by Laplace transforms.	01	
6.4	Application of Laplace transform for R-L & R-C circuits	01	
6.5	Application of Laplace transform for R-L-C circuits.	01	

6.6	Transient and steady state response of R-L and R-C circuit to various functions	01	
Ch-7.	**TWO PORT PARAMETERS**	**04**	
7.1	Classification of networks, Two port parameters(Z,Y,ABCD,h)	01	
7.2	Condition for reciprocity and symmetry	01	
7.3	Interrelations between different parameters	01	
7.4	Interconnection of different networks	01	
Ch-8	**NETWORK FUNCTIONS**	**05**	
8.1	Calculation of network functions., poles and zeroes of network function	02	
8.2	Physical significance of poles and zeros, Necessary conditions for driving point and transfer functions.	01	**4**
8.3	Time domain behaviour from pole zero plot	02	
Ch-9	**NETWORK SYNTHESIS**	**04**	
9.1	Hurwitz polynomial, its properties & necessary and sufficient conditions to test Hurwitz polynomial	01	
9.2	Positive real function, its properties & necessary and sufficient conditions to test Hurwitz polynomial	01	
9.3	Elementary synthesis procedure-synthesis of L-C driving point function	01	
9.4	Synthesis of R-L and R-C driving point functions.	01	
	Total	45	

8. Mapping of Session Outcomes (SO) with Course comes (CO)

Session No.	Session Learning Outcomes: After successful completion of the session, student will be able to	CLO
1	Understand importance, scope and policy of the course	-
Unit -1		
2	understand nature of sources of sources, phasor technique	01
3,4	interpret and apply the Kirchhoff's voltage and current laws for DC as well as of AC circuit	
5	solve electrical networks by mesh and node analysis for DC as well as of AC circuit	
6	Infer the source transformation and solve the network by using it	
7	design the dual of given network	
Unit -2		
8	understand the coupling between magnetic elements	2
9	solve the coupled circuit using dot convention procedure	
10	understand the frequency response of tuned circuit	
Unit-3		
11	understand Graph theory terminology, and procedure to solve for complete incidence matrix.	2
12,13	solve for Tie-Set and Cut-Set matrix along with concept of KCL and KVL	

14,15	formulate network equilibrium equations for determining current and voltage	
Unit -4		
15	analyze and solve electrical network by using Superposition theorem	1
16	analyze and solve electrical network by using Thevenin's theorem	
17	analyze and solve electrical network by using Norton's theorem	
18	analyze and solve electrical network by using Maximum power transfer theorem	
19	analyze and solve electrical network by using Reciprocity theorem	
20	analyze and solve electrical network by using Millman's theorem and Tellegen's theorem	
Unit -5		
21	infer the fundamentals of initial and final conditions in electrical networks	3
22,23	estimate the initial and final conditions of RL type electrical networks	
24,25	estimate the initial and final conditions of RC and RLC type electrical networks	
Unit -6		
26	infer the basic of Laplace transformations of standard test signals	
27	solve general circuit equations by Laplace transform	
28	design and analyze the Laplace equivalent circuits of RL and RC type electrical networks	
29,30	design and analyze the RLC type electrical networks in time and frequency domain by using the concepts of Laplace transformation	
31	Interpret the Partial fraction expansion and Heaviside's expansion theorem	
Unit -7		
32	interpret Relationship of two-port variables, evaluate Impedance and admittance parameters	4
33	evaluate Transmission parameters and hybrid parameters	
34	derive Interrelation between different parameter sets	
35	infer the interconnection of two-port network	
Unit -8		
36	evaluate the network functions for one-port and two-port network	
37	calculate network functions	
38,39	obtain poles and zeros of network	
40	obtain Time domain behavior from pole zero plot and predict the response of network	
Unit -9		
41	Interpret Hurwitz polynomial and its properties, Interpret the Positive real function and its properties	
42	Test the driving point immittances	
43,44	synthesize the electrical network from given transfer function by using cauer and foster form for RL, RC and LC functions	
45	**summarize** topics covered in the course and **express** the linkages with other course/'s	

9. Teaching-learning methodology

1. Lectures: Primarily Chalk and black board will be used to conduct the course. However, where required, Power Point Presentations (PPTs), Video Lectures, Simulations / Animations etc. will be used to enhance the teaching-learning process.
2. Assignments: Emphasis will be on self-exercise by the students and one to one interaction with students for clearing their doubts and problem solving.
3. Tutorials: Primarily Chalk and black board will be used to conduct the tutorial. The question will be from the ongoing chapter and not covered in the lecture components will be discussed in detail for improving the problem solving skills.

10. Active learning techniques

Active learning is a method of learning in which students are actively or experientially involved in the learning process. Following active learning techniques will be adopted for the course.

Activity 1 – Flipped Classroom

The Flipped Classroom is planned for following two topics.
(i) 'Norton's theorem' in chapter of Network Theorem
(ii) 'Interrelations of parameters' in chapter of two port parameters

The students will be given its material in advance and during a particular lecture after it, their queries will be answered and solved by the faculty member.

Activity 2 – Muddiest Point

The 'Muddiest Point' will be used as one technique to help in assessing where students are having difficulties in every lecture. The least understood topic will be explained in the last 10 minutes of the lecture.

11. Course Material

Following course material is uploaded on the course website: https://sites.google.com/a/nirmauni.ac.in/2ee301nas/home

- Course Policy
- Lecture Notes
- Books / Reference Books / NPTEL video lectures
- Assignments, Tutorials, Lab Manuals
- Question Bank
- Web-links, Blogs, Video Lectures, Journals
- Animations /Simulations, Softwares
- Advanced Topics

12. Course Outcome Attainment

Following means will be used to assess attainment of Course Outcomes.

- Use of formal evaluation components of continuous evaluation, tutorial/assignment, semester end examination
- Informal feedback during course conduction

13. Academic Integrity Statement

Students are expected to carry out term assignment under Continuous Evaluation (CE) component and LPW component independently. Copying in any form is not acceptable and will invite strict disciplinary action. Evaluation of corresponding component will be affected proportionately in such cases. Turnitin software may be used to check plagiarism wherever applicable. Academic integrity is expected from students in all components of course assessment.