# GUJARAT TECHNOLOGICAL UNIVERSITY

**INSTRUMENTATION & CONTROL ENGINEERING (17)**
**Bachelor of Engineering**
**Subject Code: 3131707**
**Semester – III**
**Subject Name: Network Analysis**

**Type of course:** Professional Core Course

**Prerequisite:** Fundamental knowledge of electric circuit sources and elements, basic mathematics (integration, differentiation, etc.)

**Rationale:** Students of IC Engineering need to possess good understanding of concepts and principles of passive circuit analysis and synthesis by applying various circuit laws and theorems. This is one of the foundation courses which are required to understand the concepts of advanced courses and develop skills that are needed in Electronics field.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 4 | 0 | 2 | 5 | 70 | 30 | 30 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs |
|---|---|---|
| 1 | **Coupled Circuit and Dot Conventions:** Magnetically Coupled Circuit, Faraday's law of Electromagnetic induction, Self-induced emf and self-inductance, Mutually induced emf and Mutual induction, Coefficient of coupling, Dot Convention, inductive coupling of series-parallel, Conductively coupled equivalent circuit. | 3 |
| 2 | **Nodal Analysis and Mesh Analysis of resistive Circuits:** Nodal Analysis of Circuits Containing Resistors and Independent and Dependent Sources – Source Transformation Theorem for circuits with independent sources – Source Transformation Theorem for circuits with Dependent sources –Nodal Analysis of Circuits Containing Dependent Sources - Mesh Analysis of Circuits with Resistors and Independent Voltage Sources- Mesh Analysis of Circuits with Independent Sources - Mesh Analysis of Circuits Containing Dependent Sources. | 5 |
| 3 | **Circuit Theorems and Their Application in Electric Networks:** Linearity of a Circuit and Superposition Theorem-Substitution Theorem-Compensation Theorem - Thevenin's Theorem and Norton's Theorem -Determination of Equivalents for Circuits with Dependent Sources -Reciprocity Theorem - Maximum Power Transfer Theorem - Millman's Theorem-Duality Theorem - Duality between Electricity and | 6 |

| | | |
|---|---|---|
| | Magnetism | |
| **4** | **Time domain response of First order RL and RC circuits:**<br>Mathematical preliminaries – Source free response –DC response of first order circuits – Superposition and linearity – Response Classifications | **4** |
| **5** | **Time domain response of Second order linear circuits:**<br>Discharging of a Capacitor through an inductor – Source free second order linear networks – second order linear networks with constant inputs. | **4** |
| **6** | **Initial Conditions:**<br>Initial conditions in elements, procedure for evaluating initial conditions, Solution of circuit equations by using Initial Conditions. | **4** |
| **7** | **Laplace Transform Analysis and its Applications:**<br>Notions of Impedance and Admittance – Manipulation of Impedance and Admittance- Notions of Transfer Function- Equivalent circuits for inductors and capacitors – Nodal and Loop analysis in the s-domain – Switching in RLC circuits- Switched capacitor circuits and conservation of charge | **5** |
| **8** | **Two –Port Networks :**<br>One port networks –Driving Port and Transfer function for one port and two port network, Poles and zeroes of network functions, Two port admittance Parameters (y parameters)– Admittance parameters analysis of terminated two- Port networks - Two port impedance Parameters (z-parameters) –Impedance and Gain calculations of terminated two- Port networks modeled by z-parameters – Hybrid parameters (h para)– Inverse Hybrid Parameters (g-para)- Transmission parameters (ABCD parameters)-Scattering parameters(S parameters)-Scattering Transfer parameters(T parameters) –reciprocity- Various Combinations of Two-Port network-Various Combinations of Two port n/w. | **7** |
| **9** | **Introduction to Network Topology:**<br>Linear Oriented Graphs (Connected Graph, Sub graphs and Some Special Sub graphs) - The Incidence Matrix of a Linear Oriented Graph -Kirchhoff's Laws in Incidence Matrix Formulation - Nodal Analysis of Networks – The Circuit Matrix of a Linear Oriented Graph- Kirchhoff's Laws in Fundamental Circuit Matrix Formulation - Loop Analysis of Electrical Networks – ( Loop Analysis of Networks Containing Ideal Dependent Sources- Planar Graphs and Mesh Analysis –Duality)- The Cut-set Matrix of a Linear Oriented Graph ( Cut-sets - The All cut-set matrix Qa- Orthogonality relation between Cut-set matrix and Circuit matrix - The Fundamental Cut-set Matrix Qf - Relation between Qf , A and Bf) - Kirchhoff's Laws in Fundamental Cut-set formulation - Tie set -Tie set Matrix (F-loop matrix)- Tie set schedule. | **7** |

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**Suggested Specification table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **10** | **20** | **10** | **10** | **10** | **10** |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**


1. Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication
2. Network Analysis :- By M.E Van Valkenburg PHI Publication
3. Electric Circuits and Networks :- By K. S. Suresh Kumar – Pearson Education
4. Linear Circuits Analysis 2nd edition :-By DeCarlo/ Lin – Oxford University Press(Indian edition)
5. Engineering Circuit Analysis : - By W H Hayt, J E Kemmerly, S M Durbin 6th Edition TMH Publication
6. Graphs: Theory and Algorithms By K. Thulasiraman, m.n.s Swamy, Wiley Publication.
7. Electric Circuit Analysis By S N Sivanandam, Vikas Publishing House
8. Introductory Circuit Analysis by Robert Boylestad, Pearson


**Course Outcomes:**

| Sr. No. | | Marks % weightage |
|---|---|---|
| CO-1 | Apply dot convention & node convention analysis to various circuits. | 20 % |
| CO-2 | To apply node and mesh circuit analysis techniques and various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc. | 40% |
| CO-3 | Calculate Laplace Transform on one port and two port network. | 20% |
| CO-4 | To apply graph theorem to solving networks. | 20% |

**List of Experiments:**

1. To measure and calculate currents and voltages for a given resistive circuit and verify KCL and KVL**.**
2. To verify superposition theorem experimentally for a given resistive circuit consisting two independent sources**.**

3. To verify Thevenin's theorem experimentally for a given circuit**.**
4. To verify maximum power transfer theorem experimentally for a given circuit**.**
5. To verify reciprocity theorem experimentally for a given circuit.
6. To measure and calculate RC time constant for a given RC circuit.
7. To measure and calculate RC time constant for a given RL circuit**.**
8. To measure and analyze (settling time, overshoot, undershoot, etc.) step response of for a given series RLC circuit for following cases: (1) $\zeta = 1$ (critically damped system), (2) $\zeta > 1$(over damped system), (3) $\zeta < 1$ (under damped system). Choose appropriate values of R, L, and C to obtain each of above cases one at a time.
9. To measure and calculate Z-parameters for a given two-port system**.**
10. To measure and calculate Y-parameters for a given two-port system**.**
11. To measure and calculate h-parameters for a given two-port system**.**
12. To measure and calculate ABCD-parameters for a given two-port system.

**Major Equipment:**

1. Function Generator
2. Oscilloscope
3. Digital Multi-meter
4. DC Power Supply (0-30 V)

**List of Open Source Software/learning website:**

Multisim, PSPice, NGspice