

<b>COURSE TITLE</b>	<b>NETWORK ANALYSIS &amp; CONTROL THEORY</b>
<b>COURSE CODE</b>	<b>01EC0306</b>
<b>COURSE CREDITS</b>	<b>4</b>

**Objective:**

- 1 The objective of this course is to provide foundation in electrical circuit analysis, transient and frequency response, and introduce control system concepts including modeling, time response, and stability analysis for engineering applications.

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Use fundamental laws, theorems, and analysis techniques to analyze and solve electrical circuits.
- 2 Explain transient and steady-state behaviour of electrical circuits in time and frequency domains
- 3 Use various techniques of modelling control systems.
- 4 Study control systems and comment on time response, frequency response and stability.

**Pre-requisite of course:** Basic knowledge of Physics (electrical concepts), Fundamental understanding of electric circuits (Ohm's Law, KCL, KVL), Basic mathematics (differential equations)

**Teaching and Examination Scheme**

<b>Theory Hours</b>	<b>Tutorial Hours</b>	<b>Practical Hours</b>	<b>ESE</b>	<b>IA</b>	<b>CSE</b>	<b>Viva</b>	<b>Term Work</b>
3	1	0	50	30	20	0	0

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Network Analysis</b> Basic Electrical Quantities (Voltage, Current, Power, and Energy) and Passive Circuit Elements (Resistor (R), Inductor (L), Capacitor (C)), Kirchhoff's Laws – Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL), Mesh (Loop) Analysis Method, Nodal (Node Voltage) Analysis Method, Source Transformation Techniques, Network Theorems – I – Thevenin's Theorem and Norton's Theorem, Network Theorems – II – Superposition Theorem, Maximum Power Transfer Theorem, Star–Delta Transformation	7

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
2	<b>Transient Analysis &amp; Laplace Techniques</b> Introduction to First-Order Circuits – RL and RC circuits fundamentals, Analysis of First-Order RL Circuits – Transient and steady-state response, time constant, Analysis of First-Order RC Circuits – Charging/discharging behavior, switching characteristics, Second-Order RLC Circuits – Types of responses (overdamped, critically damped, underdamped), Transient and Steady-State Analysis – General behavior of electrical circuits, Differential Equation Modeling of Circuits, Laplace Transform and Its Properties, Circuit Analysis Using Laplace Transform – Including Initial Value and Final Value Theorems	8
3	<b>AC Analysis &amp; Frequency Response</b> Sinusoidal Signals and Phasor Representation, Impedance and Admittance in AC Circuits, AC Analysis of RL, RC, and RLC Circuits, Power in AC Circuits – Active, Reactive, Apparent Power and Power Factor, Resonance in Electrical Circuits, Frequency Response, Bandwidth, and Selectivity	6
4	<b>Control System Modeling</b> Introduction to Control Systems – Open-loop and Closed-loop systems, Mathematical Modeling and Transfer Function, Properties of Transfer Functions, Block Diagram Representation of Systems and Reduction Techniques, Signal Flow Graphs (SFG), Mason’s Gain Formula and Applications	6
5	<b>Time Response and Stability</b> Introduction to Time Response of Control Systems, Time Response of First-Order Systems, Time Response of Second-Order Systems, Time-Domain Specifications – Rise time, peak time, settling time, overshoot, Transient and Steady-State Response Analysis, Steady-State Error and Error Constants, Concept of Stability in Control Systems, Routh–Hurwitz Stability Criterion	8
6	<b>Frequency Response of Control Systems</b> Introduction to Root Locus Technique, Root Locus Construction Rules, Effect of Poles and Zeros on Root Locus, Frequency Response of Control Systems, Bode Plot Analysis – Magnitude and phase plots, gain margin, phase margin, Nyquist Plot and Stability Analysis, Polar Plot and Its Applications	7
<b>Total Hours</b>		<b>42</b>

#### Suggested List of Experiments:

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Tutorial</b> Students are supposed to solve numerical being asked in GATE Examination and other competitive entrance exams under the supervision of the faculty.	14
<b>Total Hours</b>		<b>14</b>

**Textbook :**

- 1 Engineering Circuit Analysis, W. H. Hayt, J. E. Kemmerly, and S. M. Durbin, New York: McGraw-Hill, 2012
- 2 Modern Control Engineering, K. Ogata, NJ: Prentice Hall, 2010

**References:**

- 1 Control Systems Engineering, Control Systems Engineering, I. J. Nagrath and M. Gopal, New Delhi: New Age International, 2007
- 2 Network Analysis, Network Analysis, M. E. Van Valkenburg, New Delhi: Pearson Education, 2006
- 3 Modern Control Systems, Modern Control Systems, R. C. Dorf and R. H. Bishop, New Delhi: Pearson Education, 2017

**Suggested Theory Distribution:**

The suggested theory distribution as per Bloom’s taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
5.00	10.00	30.00	30.00	20.00	5.00

**Instructional Method:**

- 1 The internal evaluation will be done based on the continuous evaluation of students in the class-room.
- 2 Tutorial sessions for problem-solving (GATE-oriented).
- 3 Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.
- 4 The course delivery method will depend upon the requirements of content and need of the students. The teacher in addition to conventional teaching methods (Chalk and Talk) may use any of the tools/techniques such as demonstration, role play, Quiz, brainstorming, Flipped class, Project based learning, Collaborative learning, MOOCs etc. for effective teaching.

**Supplementary Resources:**

- 1 [https://onlinecourses.nptel.ac.in/noc26\\_ee48/preview](https://onlinecourses.nptel.ac.in/noc26_ee48/preview)
- 2 <https://nptel.ac.in/courses/107106081>
- 3 <https://www.electronics-tutorials.ws/>
- 4 <https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/>
- 5 [https://youtu.be/lBC1nEq0\\_nk](https://youtu.be/lBC1nEq0_nk)