ELECTRIC CIRCUIT II
ENEE 151

Lecture : 3 | **Year : I**
Tutorial : 1 | **Part : II**
Practical : 3/2

Course Objectives:
To comprehensively understand and apply electrical circuit analysis techniques involving dependent sources, transient analysis, frequency response and bandwidth, and the concept and properties of two-port networks in circuit analysis.

1 Network Analysis (4 hours)

1.1 Mesh analysis with dependent and independent sources
1.2 Nodal analysis with dependent and independent sources
1.3 Application of matrix method in network analysis

2 Transients in Electric Circuit (3 hours)

2.1 Characteristics of various network elements
2.2 Procedure of evaluating initial conditions
2.3 Initial values of derivatives
2.4 Initial condition in the case of R-L-C network

3 Transient Analysis of R-L-C Circuit by Classical Method (10 hours)

3.1 Introduction
3.2 First order differential equation with constant coefficient
3.3 Higher order homogenous and non-homogenous differential equation with constant coefficient
3.4 Particular integral by method of undetermined coefficient
3.5 Response of R-L and R-C circuits with DC excitation
 3.5.1 DC excitation
 3.5.2 Exponential excitation
 3.5.3 Sinusoidal excitation
3.6 Response of series R-L-C circuits with
 3.6.1 DC excitation
 3.6.2 Exponential excitation
 3.6.3 Sinusoidal excitation
3.7 Response of parallel R-L-C circuits with
 3.7.1 DC excitation
 3.7.2 Exponential excitation

4 Review of Laplace Transformation (3 hours)

- 4.1 Definitions and properties valuable for network analysis
- 4.2 Laplace transform of different forcing functions
  - 4.2.1 Step and shifted step functions
  - 4.2.2 Ramp and impulse functions
  - 4.2.3 Sinusoidal functions
- 4.3 Heaviside's partial fraction expansion theorem

5 Transient Analysis Using Laplace Transform (6 hours)

- 5.1 Introduction
- 5.2 Response of R-L and R-C circuits with
  - 5.2.1 DC excitation
  - 5.2.2 Exponential excitation
  - 5.2.3 Sinusoidal excitation
- 5.3 Response of series R-L-C circuits with
  - 5.3.1 DC excitation
  - 5.3.2 Exponential excitation
  - 5.3.3 Sinusoidal excitation
- 5.4 Response of parallel R-L-C circuits with
  - 5.4.1 DC excitation
  - 5.4.2 Exponential excitation

6 Network Transfer Function and Frequency Response (8 hours)

- 6.1 Concept of complex frequency
- 6.2 Transfer functions of two port networks
- 6.3 Poles and zeros of networks
- 6.4 Magnitude and phase response
- 6.5 Bode diagrams
- 6.6 Band width, high-q and low-q circuits
- 6.7 Basic concept of filters: High-pass, low-pass, band-stop and band-pass filters

7 Fourier Series (3 hours)

- 7.1 Basic concept of Fourier series and Fourier analysis
  - 7.1.1 Trigonometric form
  - 7.1.2 Polar form
  - 7.1.3 Exponential form
- 7.2 Evaluation of Fourier coefficient for periodic non-sinusoidal wave forms in electric network

8 Two-Port Parameters of Network (8 hours)

- 8.1 Definitions of two-port networks
- 8.2 Parameters of two-port networks
  - 8.2.1 Open circuit impedance parameters
  - 8.2.2 Short circuit admittance parameters
  - 8.2.3 Transmission line parameters
  - 8.2.4 Inverse transmission line parameters
  - 8.2.5 Hybrid parameters
  - 8.2.6 Inverse hybrid parameters
- 8.3 Relationship and transformation between sets of parameters
- 8.4 Interconnection of two port networks
- 8.5 Condition for reciprocity and symmetry

Tutorial (15 hours)

Relevant numerical problems corresponding to each chapter and subchapter will be provided and practiced during the tutorials.

Practical (22.5 hours)

1. Transient response in first order passive circuit
   - Measure step response RL and RC circuit using oscilloscope
   - Relate time response to analytical transfer function calculation
2. Transient response in second order passive circuit
   - Measure step response RLC series and parallel circuit using oscilloscope
   - Relate time response to analytical transfer function and pole-zero configuration
3. Frequency response in first order passive circuit.
   - Measure amplitude and phase response and plot Bode diagram for RL and RC circuits
   - Relate Bode diagrams to transfer function and pole-zero configuration
4. Frequency response in second order passive circuit
   - Measure amplitude and phase response and plot Bode diagram for RLC circuits
   - Relate Bode diagrams to transfer function and pole-zero configuration
5. Simulation of Transient Response of First order and second order system
6. Simulation of Frequency Response of First order and second order system

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks Distribution *
1	4	6
2	3	6
3	10	12
4	3	4
5	6	8
6	8	10
7	3	6
8	8	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Van Valkenburg, M.E. (2019). Network Analysis. Pearson Education.
2. Hayt, W., Kemmerly, J., Phillips, J., Durbin, S. (2018). Engineering Circuit Analysis (10th ed.). McGraw-Hill Education.
3. Ciletti, M.D. (1988). Introduction to Circuit Analysis and Design (Latest Edition). Oxford University Press.
4. Soni, K.M. (2013). Circuits and Systems. S. K. Kataria & Sons.
5. Mithal, G. K. (2022). Network Analysis. Khanna Publishers.