Circuit Theory and Device (ECE215)

Offering: Monsoon Semester
Instructor (Monsoon – 2017): Mohammad Hashmi

Credits: 4
Pre-requisites: Basic Electronics, Linear Algebra
Co-requisites: Signals and Systems, Differential Equations
Post Condition (on student capability after successfully completing the course):

- To be able to analyze moderately complex electrical circuits
- To be able to synthesize simple electrical circuits (RLCs)
- To be able to find circuit response using Laplace transform
- To be able to understand signal superposition and Fourier transform
- To be able to use industry standard SPICE tools for simple circuit analysis

Brief Description:

This course intends to develop problem solving skills and understanding of circuit theory through the application of techniques and principles of electrical circuit analysis to common circuit problems. Subsequently, most common aspects such as filter realization and stability will be elaborated through frequency response analysis, feedback topologies etc. Broadly, the goals of the course are to inculcate understanding of: (a) waveforms, signals, transient, and steady-state responses of RLC circuits, (b) the ability to apply circuit analysis to AC circuits, and (c) advanced mathematical methods such as Laplace and Fourier transforms along with linear algebra and differential equations techniques for solving circuits problems.

Detailed Outline:

Week	Topics to be Covered
1	• Introduction (Lect-1) • Memristor and Logic Circuits (Lect-2)
2	• Second-Order Circuits - The Source Free Series RLC Circuit, The Source Free Parallel RLC Circuit • Second-Order Circuits – Step Response of Series and Parallel RLC Circuit, General Second Order Circuit, Second-Order Op Amp Circuits
3	• AC Circuits: Sinusoids, Phasors, Phasor Relationships for Circuit Elements, KCL in Frequency Domain, Impedance Combinations, Phase-Shifters, AC Bridges
4	• Sinusoidal Steady State Analysis: Nodal and Mesh Analysis, Superposition Theorem, Source Transformation, Thevenin and Norton Equivalent Circuits, Max Power Transfer Theorem • AC Power Analysis – Instantaneous and Average Power, Maximum Average Power, Maximum Power Transfer, Apparent Power and Power Factor

5	• Magnetically Coupled Circuits – Mutual Inductance, Energy in a Coupled Circuit, Linear and Ideal Transformers • Ideal Autotransformers, Transformer as an Isolation Device, Transformer as a Matching Device
6	• Frequency Response – Transfer Function, Bode Plot, Series Resonance, Parallel Resonance, Stability
7	• Passive and Active Filters Synthesis
8	• Intro to Laplace Transforms (LT), Properties, Inverse of LT (Simple, Repeated and Complex Poles), Convolution Integral • Circuit Element Models, Circuit Analysis, Transfer Functions, State Variables
9	• The Fourier Series, Symmetry, Filters, Circuit Analysis using Fourier Transforms
10	• Two-port networks (Impedance and Admittance Matrix), • Two port parameters Hybrid Parameters, Transmission Parameters
11	• Scattering Parameters, Skin Effect • Cascading of 2-port networks
12	• PN junction diode ideal and non-ideal characteristics • Forward bias, reverse bias, breakdown, tunneling, ohmic contacts
13	• Schottky diode, Light emitting diode, photo diode

Text Book:

- Fundamentals of Electric Circuits *5th Edition,* Charles K. Alexander and Mathew N. O. Sadiku
- Microelectronics Circuits by Sedra & Smith
- Microelectronics by B. Razavi

Reference Book:

- Network Analysis and Synthesis *3rd Edition,* Franklin F. Kuo

Methodology:

- Class lectures will be power point slides based and may be augmented by supplementary resources such as traditional chalk and board
- SPICE simulations will be incorporated to help students in understanding the concepts

Evaluation:

Class-Test (all compulsory): 20%;
Home Assignments and Labs (all compulsory): 30%
Mid-sem: 25%;
End-sem: 25%

Plagiarism Policy:

As per the institute guidelines