Master Course Description for EE-233 (ABET sheet)

Title: Circuit Theory

Credits: 5 (4 lecture; 1 lab)

UW Course Catalog Description

Coordinator: Mahmood Hameed, Assistant Teaching Professor, Electrical and Computer Engineering

Goals: To learn how to analyze electric circuits in the frequency domain; to calculate power for electric circuits; to recognize and analyze common filters such as low-pass, high-pass, band-pass, and band-reject both for passive and active circuits; to learn how to use laboratory instruments such as the function generator, oscilloscope, power supply, and multimeter for analyzing electric circuits that are built in the laboratory; to learn how to use Multisim to simulate and debug circuits before building them; to learn how to design an audio mixer (active low and high pass filters, equalizer, and microphone preamplifier using analog components); to learn how to write a standard lab report on your experiments; to prepare students for more advanced courses in circuit analysis and design.

Learning Objectives: At the end of this course, students will be able to:

- 1. *Identify* linear circuits, passive and active filters.
- 2. *Develop analytical models* for circuits in the frequency domain by using Kirchhoff's current and voltage laws, Ohm's law, mesh analysis, nodal analysis, Thévenin and Norton equivalents, phasor, and Laplace Transform techniques.
- 3. *Analyze* linear circuits and passive and active filters with sinusoidal inputs.
- 4. *Design* simple circuits and passive and active filters to meet given specifications.
- 5. *Derive* the power generated/absorbed in a circuit when there are sinusoidal inputs.
- 6. *Use* Multisim to verify the results of frequency domain circuit analysis.
- 7. *Measure* basic signal parameters (amplitude, frequency, delay, filter characteristics, etc.) using basic laboratory instruments: function generator, oscilloscope, power supply, and multimeter.

Textbooks: J.W. Nilsson and S.A. Riedel, *Electric Circuits*, 12th Ed., Pearson, 2022.

Prerequisites by Topic:

- 1. DC circuit analysis (EE-215)
- 2. Transient analysis of electric circuits in the time domain (EE-215)
- 3. Solution of first and second order linear differential equations
- 4. Manipulation of complex numbers

Topics:

1. Sinusoidal sources and responses, phasors, network theorems (2 weeks, Ch 9)

- 2. Complex power, power factor (1 week, Ch 10)
- 3. Laplace transformation definitions, properties, and techniques (1.5 weeks, Ch. 12)
- 4. Circuit analysis with Laplace Transforms, transfer functions (1.5 week, Ch 13)
- 5. Passive filters (1.5 weeks, Ch. 14)
- 6. Active filters (1.5 weeks, Ch 15)
- 7. Advanced topics (1 week)
- 8. Basic ECE laboratory, components, instrumentation, simulation, project demonstration (in Laboratory section, 10 weeks)

Course Structure: Lecture (4 hours / week), Laboratory (3 hours / week). Weekly homework. Three exams in class (two midterms and one final). Four lab reports. Laboratory project demonstration and test in last week.

Computer Resources: Use of Multisim simulation software for analysis of electrical circuits related to the content of the laboratory.

Laboratory Structure: In the laboratory part of the course, the students build a threechannel analog audio mixer with operational amplifiers, resistors, and capacitors. The project is broken up into four laboratories, each taking two weeks. Each lab is structured to have a pre-lab the first week and experimental work the second week. During the last week, the student teams demonstrate the functionality of the audio mixer and are tested on concepts learned in the laboratory. The students write a standard lab report for each of the four laboratories. Specifically, the laboratory part of the course covers the following areas:

- 1. Lab 1: To learn methods for characterizing an RC circuit, observe the response to step and sinusoidal functions, and gain familiarity with standard lab instruments (function generator, oscilloscope, power supply, and multimeter).
- 2. Lab 2: To read and get data from IC component specifications, such as op-amps, learn Multisim simulation to design electronic circuits, and analyze and measure characteristics of circuits built with op-amps. A voltage follower and a summing amplifier are calculated, built, and measured.
- 3. Lab 3: To understand the Bode plots of electronic circuits, such as integrators and differentiators, and analyze and measure characteristics of simple analog amplifiers built with op-amps. The preamplifier and output summing amplifier in the equalizer are designed and built.
- 4. Lab 4: To design filters from a given topology and specifications, analyze and measure the characteristics, and build the audio mixer. Band pass and band stop filters are designed and built. All parts of the audio mixing console are put together and tested.
- 5. Laboratory demonstration and test: Demonstrate functionality of the audio mixer and answer questions.

Grading: 25% Homework, 20% Laboratories, 5% Lab Test/Demonstration, 30% Two Midterms, 20% Final Exam

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

- (1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. **(H)** The lectures, homework, and laboratory assignments deal with the application of electric circuit theory to analyze and design passive filters and active op-amp filters. Mathematical formulations are commonplace throughout the course.
- (2) An ability to communicate effectively with a range of audiences. **(L)** Students, as part of a team, are required to write and submit a laboratory report for each lab, and to demonstrate their final lab project to the class.
- (3) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. (M) The students work in groups of three in the laboratory section of the course. They have to coordinate with each other to do the pre-labs, experiments, lab reports, and lab test.
- (4) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (M) The laboratory experiments require students to build circuits, collect data, and analyze data to demonstrate that the circuits perform as designed.

Prepared By: Linda Bushnell

Last Revised: 12/14/2018