

EE 213 Basic Circuit Analysis II

Credits: 4

Categorization of credits: engineering topic

Instructors or course coordinator: G. Arslan

Textbook and Other Required Materials:

Ulaby, Maharbiz, and Furse, *Circuit Analysis and Design*, 2018.

Designation: Required

Catalog Description:

EE 213 Basic Circuit Analysis II (4) (3 Lec, 1 3-hr Lab) Laplace transforms and their application to circuits, Fourier transforms and their applications to circuits, frequency selective circuits, introduction to and design of active filters, convolution, and state space analysis of circuits. A-F only. Pre: 211 or consent. Co-requisite: MATH 244 or MATH 253A.

Pre- and Co-requisites: Prerequisites: EE 211 or consent. Co-requisite: MATH 244 or MATH 253A.

Class/Lab Schedule: Three 50-minute lectures and a three-hour lab session per week.

Topics Covered:

LECTURES

- Sinusoidal Steady State (9 hours): Sinusoids including parameters, phasors, operations. Steady state circuit response including impedance, transfer function, Thevenin and Norton equivalents, Matlab solutions. Sinusoidal power including average power, maximal power transfer.
- Operational amplifiers (6 hours): Ideal characteristics including virtual open, virtual short, relation to real operational amplifiers. Steady state nodal analysis of biquads including Matlab solutions.
- Laplace transforms (9 hours): Motivation, definition, inversion, evaluation with tables and Matlab. Circuit analysis including step and impulse response of first and second order circuits. Poles including effect on circuit responses (for real and complex poles) and transfer function magnitude and phase. Initial conditions including equivalent circuits, Laplace transform solution of differential equations.
- State space analysis (6 hours): State variables, circuit analysis, sinusoidal steady state, differential equation solutions, Matlab solutions.
- Convolution (3 hours): Circuit response, properties, and Matlab solutions.
- Fourier Techniques (6 hours): Fourier transform including definitions, physical interpretation, properties, Matlab and table evaluation. Circuit applications, transfer function and impulse response, causality, and stability. Fourier series including definitions, physical interpretation, evaluation with Fourier transforms.
- Applications (3 hours): Filter realizations, FM stereo demultiplexing.

LABORATORIES

- Introduction to Matlab (1 lab session)
- Solving equations with Matlab including numeric and symbolic solutions (1 lab session)
- RC circuit responses (1 lab session)
- Introduction to op amp circuits including limitations of nonideal op amps (1 lab session)
- Laplace transforms via Matlab (1 lab session)
- Frequency and transient response of RLC circuits (1 lab session)
- Using Matlab to solve convolutions (1 lab session)
- State space representations and using Matlab for analysis (1 lab session)
- Biquad filters (1 lab session)
- Impedence, frequency, and gain scaling (1 lab session)
- Butterworth low pass filter design (2 lab sessions)

Course Objectives and Relationship to Program Objectives:

This is the second course on basic circuits. It covers fundamental methods of modeling and analyzing circuits behavior including Laplace and Fourier transforms, and convolutional and state space analysis. Students will be able to apply these methods to analyze and design simple circuits including filters. Matlab, a computer-aided design (CAD) tool, is introduced and used in assignments. [Program Objectives addressed by this course: 1, 2, 3.]

Course Outcomes and Their Relationship to Program Outcomes:

The following are course outcomes and the Program Outcomes (numbered 1-7 in square beraces “[]”) they address:

- Understand phasor representation of sinusoids, and the Laplace representation, convolutional determination, and Fourier representation of circuit responses. [1]
- Understand nodal, loop, and state formulation of sinusoidal steady state circuits. [1]
- Be able to design simple filters including a butterworth filter. [1, 2]
- Be able to to build and measure circuits, and to work in a team [5, 6]
- Be able to write up laboratory reports. [3]
- Be able to apply Matlab to analyze and design circuits. [1]

Contribution of Course to Meeting the Professional Component

Engineering topics: 100%

Computer Usage: About fifty percent of the homework problems, exams and laboratories involve the use of symbolic and numeric Matlab.

Design Credits and Features: There is a small amount of design, e.g., Butterworth filter design and realization. The course has 0.25 design credits.

Person(s) Preparing Syllabus and Date: N.T. Gaarder. November 19, 2003. Modified by A. Kuh, April 12, 2009; J. Yee, November 15, 2014; A. Ohta, Jan. 14, 2021.