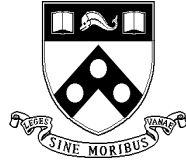


University of Pennsylvania



Electrical and Systems Engineering Department

Course Outline: ESE215 – Introduction to Circuits and Systems

Prerequisites: Physics 151, Co-requisite: Math 240

Suggested Textbook: J.D. Irwin and R.M. Nelms, Basic Engineering Circuit Analysis, 8th edition, or J.D. Irwin, A Brief Introduction to Circuit Analysis, J. Wiley and Sons, New York, (2005).

Course Coordinator: *Nabil Farhat*

Lecturers:

Nader Engheta, e-mail: engheta@seas.upenn.edu, Telephone: 215-898-9777, Room 215 Moore

Nabil Farhat, e-mail: farhat@ee.upenn.edu, Telephone: 215-898-5882, Room 368 Moore

Vukan Vuchic, e-mail: vuchic@seas.upenn.edu, Telephone: 215-898-8345, Room 273 Towne

Catalog Description: ESE 215/205 (1.5 course unit):

Principles of Circuits and Systems as applied to electrical, and non-electrical systems such as optical (plasmonic), fluidic, traffic, neural, electrochemical, and biological circuits. Class demonstration of computer simulations and laboratory work will be used to help in rapid understanding of concepts and applications.

Syllabus:

Week 1: (Source: Text and Class Notes; Instructor: Farhat)

Background – Philosophy and Motivation

Units and Basic Concepts

What is a circuit? What is a system?

Flow of an “entity” e.g. electric charge (electrons) in electrical circuits, ionic species in neural circuits, fluid/liquid in fluidic circuits, photons in optical circuits, cars/traffic in a transportation circuit/system, predator/prey in environmental/ ecological systems, molecular components in chemical circuits

Potential/energy that moves the flow

Conservation laws (i.e., conservation of “entities”). Examples: Kirchhoff’s Current Law (KCL), Kirchhoff’s Voltage Law (KVL) and their origins in the law of conservation of charge and electrostatic field theory.

Circuit elements defined based on the relationship between the flow in the element and the potential across the element. (Examples: R, L, C in electrical circuits, mass and spring in mechanical circuits).

A few words about (a) modeling, (b) analysis, and (c) synthesis of a circuit.

Weeks 2 – 7 (Source Text; Instructors: Farhat/Engheta):

Getting into analysis of a circuit:

Nodal and loop analysis techniques

Dependent and independent sources

Series and parallel combinations of circuit elements

Thevenin and Norton circuit equivalents

Operational Amplifiers

Concept of time constant and 1st and 2nd order circuits.

Concept of resonance and oscillation in 2nd order circuits

Concept of impedance and transfer functions

Time-harmonic systems and frequency analysis

Phasor and Phasor analysis tools

Weeks 8-10: (Text and Class Notes; Instructor: Farhat)

Nonlinearity

Examples of nonlinear circuit elements

Switching, relaxation oscillator

S-shaped and N-shaped I-V characteristics

Connection to neural circuits, integrate-and-fire (I&F) neuron model as an electrochemical circuit element

Relaxation oscillator with threshold nonlinearity

(LabView simulation)

A few words on Biological circuits

Weeks 10-11: (Class Notes and Other Sources; Instructor: Engheta)

Nano-scale circuit elements/components in nano-optics and Photonic Crystals as foundations for optical and optoelectronic circuits

Week 12: (Reference [1] and Class Notes; Instructor: Farhat)

Examples from ecological/environmental “circuits/systems”, e.g., predator-prey model as an example of stationary, oscillatory and complex behavior, lake ecosystem (pollutant model, or the food-chain model). Some of these will accompany computer simulations.

Week 13: (Class Notes and Other Sources: Instructor: Vuchic)

Systems concepts and methodology, examples from traffic flow and transportation systems

References:

1. E. Beltrami, Mathematics for Dynamic Modeling, Academic Press, Boston, (1987).
2. <http://online.redwood.cc.ca.us/instruct/donald/deproj/sp98/Gabe>. Also Google Belousov-Zhahotinski reaction for discussion and demonstrations.
3. <http://www.colorado.edu/physics/phet/web-pages/simulations-base.html>.

Course Organization:

Administrative Assistant: Drucilla Spanner
Room 366 Moore School
Tel: 215-898-6823
e-mail: spanner@ee.upenn.edu

Teaching Assistant: Ning Song
Room 379 Moore School
e-mail: ningsong@seas.upenn.edu
Tel: 215-898-7899

Grading:

- Weekly homework and/or EGrade On-Line Assessment
- Grade: Homework and Quizzes 1/3

Midterm 1/3

Final 1/3