ECE 491J Computational Methods in Electrical Engineering

New Course Spring 2025

Course Objectives: Introduce students to the basics and fundamental concepts of computational techniques with applications in the electrical engineering research areas and technologies. With the proliferation in using computers and software tools In modeling, design, simulation and characterization of electrical devices, systems and components, it is essential that electrical engineering students acquire fundamental understanding of computational methods and their applications. . Arming students with these invaluable methods and solution procedures in computational techniques would be of significant value in preparing them for long exciting, productive and successful   careers.

Background: It is well known that in introducing engineering concepts focus has often been placed on simple geometries and ideal sources and simple operating conditions to help students understand these concepts. This is because these simplifications allow simple mathematical operations or analytical solutions and, hence, maintain focus on the fundamental concepts in hand.

At some point in the curriculum, however, students need to deal with realistic engineering problems. In this case, simple analytical solutions will not be possible and it is necessary to use computational techniques. Through these computational methods, engineering designs, whether modeled in terms of known integral or differential equations, are converted into a set of simultaneous equations which could easily be solved using commonly available numerical analysis methods. In a way, this course offers for the first time, the missing link between several of the numerical analysis courses taught in the math departments and the engineering design tools required from a graduating engineering students.

Description: Focus will be placed on methods for transforming practical engineering problems to matrix equations that can be solved using Matlab , Python, etc.

Three popular computational methods that often used in modeling, simulating and characterization of electrical engineering systems and components will be described. This includes the Finite Difference method, Method of Moments, and the finite Elements method. These techniques are complementary and help effectively address wide variety of practical engineering problems.

Students are asked to write of three computer programs (using any language, mostly Matlab) with one of the programs being on each of the three described computational methods. Each of these programming assignments are designed to solve an engineering problem including the design of two conductor's transmission lines of different geometries, calculation of capacitance in a high frequency digital circuit, radiation from wire antennas (Circuit interference) and scattering by dielectric cylinder. Students also make power point presentations of their developed programs and obtained results.

Pre-and Co-requisites: ECE 160 or equivalent, ECE 211, and ECE213

Credits: 3

Designation: Elective in Electrical and Computer Engineering

Instructor or course coordinator. Dr. Magdy F. Iskander