UNIVERSITY OF MANITOBA | Electrical and Computer Engineering

ECE 4390 ENGINEERING COMPUTATIONS 4E
COURSE OUTLINE – FALL 2010

Course Objectives
To study the mathematical formulation and apply numerical techniques to the solution of practical problems encountered in electrical and computer engineering. Applications include circuit, transmission-line, and electromagnetic field modelling, both in the frequency and the time domain. Mathematical formulations include linear and non-linear systems of equations, linear and non-linear systems of ordinary differential equations, systems of partial differential equations, and integral equations. Optimization problems will be studied both as alternative mathematical formulations of the modelling problem as well as for design. Numerical discretization methods to be studied include finite differences, finite element and boundary element methods, as well as the Method of Moments.

Contact Hours
Lectures: 3 hours lectures/week (12:30-1:20 MWF Rm E2-350)
Laboratories: five laboratory sessions of 3 hours every other week (Rm E3-516) (4 credit hours)

Prerequisites
MATH 3132 Engineering Mathematical Analysis (or MATH 3100)
ECE 2240 Numerical Methods for Electrical Engineers

Course Content
The following topics will be covered:

1. Circuit modelling (frequency and time domain solutions).
   - Formal methods of formulating circuit equations – KCL, KVL, Modified Nodal Analysis (MNA).
   - Methods of solving systems of ODEs.
2. Multiconductor transmission-line (MTL) modelling.
   - Finite-difference solution of MTL equations.
3. Finite-differences for electrostatic and magnetostatic problems.
   - Laplace's equation and PUL matrices of MTLs.
   - Iterative matrix solution techniques (Successive-Over-Relaxation, conjugate-gradient).
4. Finite Element Method.
   - Variational method and development of functionals for PDE's.
   - FEM for the Laplace and Helmholtz equations.
   - Grid generation using Gmesh.
5. Finite-Difference Time-Domain solution of Maxwell's equations.
   - 2D and 3D, scattered and total field formulations.
   - Absorbing boundary conditions.
6. Modelling of antennas.
   - Pocklington's and Hallen's integral equations
   - Solution using Method of Moments.
7. Classical optimization methods.
   - Steepest descent, conjugate-gradient, and Newton methods.

Recommended Reference Books

- J. Vlach, K. Singhal, *Computer Methods for Circuit Analysis*, 2nd Ed., Van Nostrand Reinhold, 1994.
- M.N.O. Sadiku, *Numerical Techniques in Electromagnetics*, 2nd Ed., CRC Press, 2000. Available on-line from library: http://www.engnetbase.com/books/455/front.pdf
- Z. Elsherbeni, V. Demir, *The Finite-Difference Time-Domain Method for Electromagnetics with Matlab Simulations*, Scitech, 2009.

Course Website

http://www.ece.umanitoba.ca/~lovetri/cECE4390/index.html
(login: ece4390 password: student4390)

Evaluation

The final course grade is determined by the student's performance on the following:

Component	Value	Details
Laboratory programming assignments and quizzes	50%	MATLAB based programming assignments with one quiz at the end of each lab.
Final Examination	50%	A student must pass the final exam in order to pass the course.

Voluntary Withdrawal Date

Wednesday, November 17th, 2010.

Instructor

Prof. Joe LoVetri, Room: E3-546 EITC, Phone: (204) 474-6295, Email: Joe_LoVetri@UManitoba.Ca

Office Hours

Monday-Thursday 1:30-2:30PM or by appointment

Teaching Assistant

Gabriel Faucher, Room: E3-522 EITC, Email: umfauch2@cc.umanitoba.ca

Requirements/Regulations

- Attending the lectures and laboratories is essential for the successful completion of this course. Students must pass each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor *in a timely manner* if he or she is uncertain about his or her standing in the course. Students should familiarize themselves with Sections 7 and 8 of the *General Academic Regulations and Requirements* found in the UofM Undergraduate Calendar which deal with incomplete term work, attendance and withdrawal.
- No programmable devices or systems, such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices, are allowed in examinations unless approved by the course instructor.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism or any other form of cheating in examinations, assignments, laboratory reports or term tests is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty.