ELECTRICAL, COMPUTER, AND SYSTEMS ENGINEERING DEPARTMENT

COURSE SYLLABUS

ECSE-6966: Numerical Applications in Microelectronics

Course Catalog Description:

This project-oriented graduate course concerns application of numerical methods to simulate physical phenomena in Microelectronics. Unlike a broad introductory numerical methods course—the emphasis, here, are the skills, resourcefulness, and confidence to tackle specific problems in the shortest amount of time. Students are not expected to have had a previous formal course in numerical methods. However, they are expected to have good *working* familiarity with, at least, one programming language (C/C++ or MATLAB®, for example). As well, students must work individually, and in teams, to plan, develop, test, and report on application code. Project topics will vary, depending on personal interest and agreement with the instructor. Topics will generally be confined to the areas of semiconductor fabrication, solid-state physics, device simulation, IC-interconnect modeling, and circuit analysis.

Pre-Requisite Courses:

CSCI-1190 Beginning C Programming for Engineers, *or equivalent.*

At least one of: ECSE-2100 Fields and Waves I, ECSE-4220 VLSI Design, ECSE-4250 Integrated Circuit Processes and Design, ECSE-4720 Solid-State Physics.

Any substitutions or exemptions require prior instructor approval.

Co-Requisite Courses:

Senior Standing (with Instructor Approval), or Graduate Standing.

Prerequisites by Topic:

1. Competency using a programming language (*C/C++*, *MATLAB*®, or another similar one).
2. Calculus, linear algebra, differential equations.
3. Linear-circuit analysis (node and loop equations, steady state and transients, first-order *RC* networks, power).
4. Basic semiconductor fabrication, physics, and devices.

Textbook:
(and/or other required material)

1. *Applied Numerical Methods using MATLAB*®, W.Y. Yang *et al.* (RPI Bookstore, required)
2. *Numerical Computing with MATLAB*®, C. Moler (Free E-Book download, *www.mathworks.com/moler*, required).

References:

1. *MATLAB*® Software, RPI Site License (*helpdesk.rpi.edu*, "Accounts" & "Public Labs")
2. *The MathWorks* Web Site (*www.mathworks.com/academia*)
3. *MATLAB*® Tutorials (*www.mathworks.com/academia/student_center/tutorials*)

Course Coordinator:

Yannick L. Le Coz

Overall Educational Objective:

We wish to improve student skills, resourcefulness, and confidence in applying numerical methods to physical simulation in Microelectronics.

Course Learning Outcomes:

1. A team project—with individual contributions—entailing research, coding, and verification of, at least, one numerical method applied to simulation of a physical phenomenon within Microelectronics.
2. Practice in oral and written technical communication, both individually and as a member of a team.

How Course Outcomes are Assessed:

INDIVIDUAL:	*MATLAB*® Tutorials	10%
	Team-Meeting Participation	5%
	Mid-Term Project Presentation Slides	15%
	End-Term Project Presentation Slides	15%
	Final-Project Executive Summary (1 or 2 pages)	15%
	Final-Project Annotated Code & Flow Chart	20%
TEAM:	Mid-Term Oral Presentation	10%
	End-Term Oral Presentation	10%

Please Note: This course employs non-fractional grading ("A/B/C/D/F").

Relation to EE/CSE/EPE Outcomes:

N = none
M = moderate

H = high

Outcome	Level	Demonstrate Proficiency
	N, M, H	
Mathematics, science and engineering	M	Projects (research, coding)
Basic disciplines in Electrical Engineering	N	
Depth in Electrical Engineering	H	Projects (Microelectron-ics)
Basic disciplines in Computer & Sys. Eng.	N	
Depth in Computer and Systems Eng.	N	
Basic disciplines in Electric Power Eng.	N	
Conduct experiments and interpret data	N	
Identify, formulate and solve problems	N	
Design a system, component or process	M	Projects (coding)
Communicate in written and oral form	H	Mid-Term & Final Presen-tations (Oral, Written)
Function as part of a multi-disciplinary team	M	Projects, Team Meetings, Mid-Term & Final Presen-tations
Preparation for life-long learning	M	*MATLAB*® Tutorials; Pro-jects (research)
Ethical issues; safety, health, public welfare	N	
Humanities and social sciences	N	
Laboratory equipment and software tools	H	*MATLAB*®, *C/C++* (pos-sibly)
Variety of instruction formats	H	Introductory Lectures, Team Meetings, Open Shop (consultation with course staff)

Topics Covered:
(number of hours or classes for each)

1. *MATLAB*® self-learning introductory tutorials—10 Hours (approx., self-study)
2. General, introductory Lectures on possible team projects; including an over-view of relevant application areas and associated numerical techniques within Microelectronics: *Dopant Diffusion (Gauss-Siedel Method), Equilibrium Di-odes (Newton-Raphson Method), Quantum Transport (Crank-Nicholson Method), Parasitic IC-interconnect Capacitance Extraction (Floating Ran-dom-Walk Method), Circuit Simulation (Gear Method)*—3 Classes (approx.)
3. Informal, technical "Mini-Lectures", as needed throughout the term, covering various numerical methods and their coded implementation—2 Classes (approx.)
4. Team Meetings: individual student updates, regarding their team-project con-tributions; includes progress, results, and future plans—10 Classes (approx.)
5. Open Shop: individual, small-group, or team-project technical consultation with teaching staff—12 Classes (approx.)

Computer Usage:

Students use the *MATLAB*® computing language for project numerical analysis (with possible instructor-approved exceptions, such as *C/C++*). Extensive use of project numerical-analysis software is expected during and outside of scheduled

class meeting hours.

Laboratory Experiences: None

Design Experiences: None

Independent Learning Experiences:

1. *MATLAB*® tutorials (self-learning).
2. The Projects, themselves, and the manner in which the course is structured (Team Meetings, Open Shop), requires a significant amount of individual work: preliminary research, analysis, coding, and verification; outside of scheduled class hours.

Class/Lab Schedule:
(subject to change, see Official Spring ′08 RPI Course Schedule)

M Team Meeting, Th Open Shop, 2:00pm–3:20pm (This is a *Limited Enrollment Course*: 20 Students, maximum.)

Contribution to the Professional Component:

(a) College-Level Mathematics and Basic Sciences:	0 credit hours
(b) Engineering Topics (Science and/or Design):	3 credit hours
(c) General Education:	0 credit hours

Prepared by:	Yannick L. Le Coz
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