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Class Information

Description
Web Page

The course deals with numerical modeling of physical systems. It focuses on a number of numerical techniques based on both event/agent behavour (MD and MonteCarlo) and the use of finite differences for simulating distributed systems. Examples from the fabrication, operation and modeling of advanced devices for information technology are used. Topics: numerical techniques, physics of materials, quantum mechanics of solids, optical transitions, physical analysis and models for state-of-the-art electronic/optical technologies and materials. Technologies: MOS and III-V based transistors, solid-state optical devices, MEMS and nano-technology based devices.

Class Outline
Web Page

Course Requirements:

- Exam 35%
- Project: 45%
- PA Session Work (pass/fail): 20%

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Problem Assignments:

There are 10 problem assignments to be done during the term. The PA will be based on the work presented in the lecture for that week and will be short programing assignment

that can be completed (if you are prepared) in the 2 hour PA slot. At the end of the PA you will be assessed and is pass/fail.

You will get one free pass on a PA.

Project:

The project will involve the creation of distributed laser model based on the traveling wave model (TWM). You will build the model up weekly -- from a simple waveguide to a full laser. Each week there will be milestones presented that will incrementally build up the simulator. There will be two project reports -- one after the reading week and one at completion. Each week we will check that you have reached the milestone presented to you in the previous week.

When the project reports are due you should upload the repo in a zip file along with your report to CULearn.

Project marks will be distributed as:

- Milestone completion (5%)
- 1st Report (15%)
- Final Report (25%)

Late reports will be punished at 5%/day.

Although collaboration is encouraged mindless copying is not! So learning from others is good, but write your own code!

Course Structure:

- Tuesday lecture at 4-5:30 (ME 4494) -- this will present the theoretical material that the final exam will test.
- Thursday 4-5:30 (6030 Minto) -- This will be used for the Project. Typically I'll give a short presentation on the milestone of the week. We will then check that you have accomplished the previous weeks milestone. The remaining time will be a help session with the myself and the TAs. To obtain the 5% marks associated with the project milestones you need to attend this and show that you have completed them.
- Friday 4-6 (6030 Minto) -- This will be used for the PAs. You will need to show that you have completed the PA by the end of class. It is a pass/fail mark.

Toy Simulators and Git

A variety of modeling methods will be explored during the class (Monte-Carlo, Molecular Dynamics and Finite Difference are the primary ones.) Matlab code presenting "toy"

simulators used to illustrate these methods is in the git repository at 4700Code. For some of the PA sessions you will be modifying this code.

Students must create a Github account and use it for their project and PA sessions. For PA's you will use this account to download (clone) the course repo's for modification and to upload your own code. For the project you should use git locally to maintain a commit history and you use Github as a cloud based remote, however, make the assignment repository private on Github.

Resources

Google will produce a lot of useful stuff.

Recordings of last years lectures are still listed, however, the order I did the lectures is altered and the project structure and content is different. Logistics is not the same!

TAs

- Aaron English (aaron.english@protonmail.com)
- Jordan Dugan (jordandugan@cmail.carleton.ca)

Week 1 - Modeling Introduction and Source Version Control (Git)

Jan 10: Lecture: Modeling Approaches : (Rules, equations and fields. Analytical versus Numerical. What to Model? MD and Monte Carlo. Differential Eq.
PowerPoint Presentation

2 Years ago Recording

Last Years Recording

pdf

Jan. 12: Matlab review and help
PDF document

Jan 13: PA-1 Git PA
PDF document

For this first submission, please email me (aaronenglish (at) cmail dot carleton dot com) your github account name, and upload to your test repo a simple text file or snippet of code.

Installing git

Jan 13: Git Introduction
PDF document

Jan 13: Aaron's git guide, GitHub Guides, GitHub
PDF document

github guides
github help

Git Intro Recording

Week 2 - Project Introduction

Jan 17: LaserModelingProject
PowerPoint Presentation

pdf

Project Description
PDF document

The project description, laying out the goals, milestones, methodology and expectations

ProjectExpectations
Text File

This will contain a detailed description of the expectations for the Project and two

reports.

Jan. 19 and 20: Project work - milestone 1 (Propagation)
PowerPoint Presentation

Updated to fix indexing error on slide 2

Project Documentation

Three papers about the TWM and circuit simulation. The third one

maybe of most use.

Integration_of_Traveling_Wave_Optical_Based_Circuit_Simulator
PDF document

Obtaining_an_Operating_Point_Solution
PDF document

Implementation of Traveling Wave Models of Grating-Based Integrated Optical Devices for Circuit Simulation
PDF document

Week 3 - ElectroMagnetic Simulation - waveguide propagation and scattering (modes)

Jan 24: EM - Yee Cell, Waveguides and z propagation
PDF document

Recording

Jan. 26: Project work - milestone 2 (Gain and Detuning)
PowerPoint Presentation

Updated Project Description ProjectDesc1.pdf updates in blue.

Jan 27: PA-2 Ridge waveguides - Instructions
PDF document

Introduction

Jan 27: PA-2 Ridge waveguides - Code
Zip Compressed File

Jan 27: PA-2 Ridge waveguides - paper
PDF document

Week 4 ElectroMagnetic Simulation (Yee Cell FDFD/FDTD)

Jan 31: Yee Cell Lecture
PDF document

Recording

A Ring demo gif for FDTD
Image

What I could not get to display in the lecture.

LineSource
Image

An antenna demo gif for FDTD
Image

What I could not get to display in the lecture.

Feb 2: Project work - milestone 3 (Gratings)
PowerPoint Presentation

Feb 3: PA-3 Yee Cell
PDF document

introduction

Feb 3: PA-3 Yee Cell Code
Zip Compressed File

March 20: PA-10 Yee Cell code modification

Week 5 - Conduction, Electrostatics, SS Diffusion (iteration)

Feb 7: Conduction, Classical Solids, electrons, drift, resistance, hall effect, non-metals)
PowerPoint Presentation

Cond Code Recording

Feb 9: Project work - milestone 4 (Dispersion)
PowerPoint Presentation

Feb 10: PA-4 - Laplace equation by iteration
PDF document

Recording

Week 6 - Matrices and Diffusion, Harmonic Wave Equation, Eigenvalues and Modes (QM-SCE)

Feb. 14: Quantum Mechanics and Waves
PowerPoint Presentation

Code Recording

Feb 16: Project work - milestone 5 (Passive Example)
PowerPoint Presentation

Feb. 17: PA-5 Implicit solutions and modes
PDF document

Intro

Mapping Slides

Mapping
PDF document

Week 7 - Reading Week (Feb 20)

First Project Report Due - March 26 At Midnight

1st Project Report
Assignment

Due February 26 at 11:59 PM

Submit here

Week 8 - Time Domain Simulation - Transport and differential equations

Feb. 28: Transport and continuity equations (Kasap (5.1-5.6))
PowerPoint Presentation

Recording

March 2: Project work - milestone 6 (Carriers)
PowerPoint Presentation

March 3: PA-6 Transport code modification
PDF document

Introduction

This Years Intro

Week 9 - Circuit modeling and compact models

March 7: MNA and Compact modeling : (MNA formulation. Physical and non Physical compact models. Neural Nets. Convergence and robustness)
PowerPoint Presentation

Recording

March 9: Project work - milestone 7 (Optical Amplifiers)
PowerPoint Presentation

March 10: PA-7: MNA Building
PDF document

This was updated Wed. Morning to have the correct circuit schematic.

Recording When I went to do the introduction I realized that the wrong circuit schematic was in the document (Overleaf was grabbing a file of the same name from a different place). This resulted in a 5 min (2:50-8:30) period where all you can hear is my clicking and distress. I would remove it but my video editing skills are non-existent.

Week 10 - Device Models (Diodes/BJT/MOSFET)

March 14: Diodes, BJT and Mosfet device theory and compact modeling - Kasap (6.1-6.8)
PowerPoint Presentation

Recordings Part I and Part II.

March 16: Project work - milestone 8 (Lasers)
PowerPoint Presentation

March 17: PA-8 Device Compact Models
PDF document

Introduction

Week 11 - Molecular Dynamics modeling

March 21: Atomic structure, Bonding and Molecular Dynamics (Kasap (1.1- 1.8))
PowerPoint Presentation

MDCode

Last Years Recording

March 23: Project work - milestone 9 (Active Example)
PowerPoint Presentation

March 24: PA-9 - MD Code
PDF document

Last Years Recording

Week 12 - Monte-Carlo Modeling

March 28: Kinetic Theory and Monte-Carlo (Kasap (1.1- 1.8))
PowerPoint Presentation

MCCode Recording

March 30: Project work - Project Work
PowerPoint Presentation

March 31: PA-10 1D electron scattering and resistance
PDF document

Intro Recording

Week 13: Review

April 4: Review
PowerPoint Presentation

Recording

April 6 and 7: Project work
PowerPoint Presentation

Final Project Report Due - April 9 at midnight.

Final Project Report
Assignment

Due April 9 at 11:59 PM

Submit here.

Academic Accommodation

Academic Accommodation
Web Page