

NE-336

Micro and Nano systems Computer-Aided Design

Fall 2014

Nanotechnology Engineering Department
University of Waterloo

Calendar description:

Modeling and simulation. Lumped versus distributed approaches. Review of differential-equation systems, constitutive relations, boundary conditions, and solvers for complex, coupled transport problems pertinent to micro and nanosystems. Coupling strategies. Numerical schemes for nonlinear systems. Basic modeling and simulation of micro and nanosystems, and fluidic systems. Relevant nanotechnology applications: optical, thermal, mechanical, and fluidic microstructures, and nanoscale devices.

Instructor: Luis Ricardez, laricard@uwaterloo.ca,
Office: E6-3014, X38667.
Office hours: Thursdays, 3:00-4:00 pm.

Teaching Assistants:
-Shabnam Rasoulia, s4rasoul@uwaterloo.ca,
Office: E6-3110, Off. Hours: Mondays, 4:00-5:00 pm.
-Olzhas Tazabekov, otazabekov@uwaterloo.ca,
Office: EIT-4016, Off. Hours: Wednesdays from 4:30-5:30pm
-Desireh Sh-Asanjan, d2shojae@uwaterloo.ca,
Office: EIT-4114, Off. Hours: Fridays from 2:00-3:00pm

Lectures: W, 11:30am-12:20pm, QNC-1502
F, 10:30am-11:20am, QNC-2502
Th, 11:30-12:20pm, QNC-2502

Tutorials & Labs: 1:30-5:20pm, B1-370 (Sci-LAB)

Lectures, tutorial and lab sessions on the week of October 20-24th, 2014 are cancelled (Midterm exam week).

Make-up Lectures:

Date	Time	Room
September 12 th	9:30-10:20am	QNC-2502
September 26th	8:30-9:20am	QNC-2502
September 26 th	9:30-10:20am	QNC-2502
October 10th	8:30-9:20am	QNC-2502
October 10 th	9:30-10:20am	QNC-2502
November 7 th	9:30-10:20am	QNC-2502
November 21 th	9:30-10:20am	QNC-2502

Course Website:

<http://www.learn.uwaterloo.ca>

Course Software:

- MATLAB®
- COMSOL Multi-physics

Important Dates:

Midterm Exam 1.5 hr, Friday, Oct 24th 8:30-9:50 am., REV-200

Final Exam: 2.5 hr, dates and location TBA

Holiday (Thanksgivings day): Monday October 13th.

Textbooks:

- Transport Phenomena, Bird R., Stewart, W. and Lightfoot, E., Second edition, Wiley and Sons, 2007.
- Numerical Methods for Engineers and Scientists, Gilat, A., Subramaniam, V., Second Edition, Wiley and Sons, 2011.

Suggested References:

- Multiphysics modelling with finite element methods, Zimmerman, W., World Scientific, 2006.
- Numerical Methods for Engineers, Chapra, S.C. and Canale R.P., 5th Ed., 2006.
- Introduction to Finite Elements in Engineering, Chandrupatla, T. and Belegundu, A., Third edition, Prentice Hall, 2002.
- An introduction to Modeling of transport processes, Datta, A. and Rakesh, V., Cambridge, 2010.

Course Grading Breakdown:

Basic Marking Scheme:

Assignments:	10 %
Labs:	15 %
Midterm:	25 %
Final:	50 %
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Total:	100 %

IMPORTANT: You MUST pass the final exam (50% or more) to pass this course.

COURSE TOPICS

Part I Refreshment on Numerical methods

- Taylor Series
- Numerical differentiation
- Gauss-Seidel method
- LU decomposition
- Newton's method for nonlinear systems
- Empirical modeling: The least-squares method

Part II Numerical methods for ordinary differential equations

- Euler method
- Range-Kutta method
- Boundary-value problems

Part II Numerical methods for partial differential equations

- Finite difference methods
- Finite element analysis

Part III Mass transport

- Fick's law of binary diffusion (Molecular mass transport)
- Shell balances and boundary conditions
- Applications

Part IV Multi-physics problems

- Illustrative multi-physics problems
- Meshing techniques for multi-physics problems
- Post-processing analysis

Preliminary Lab Schedule

Lab	Sec. 201	Sec 202	Subject	TA in Charge
1	16/09	16/09	Refreshment on MATLAB	Shabnam
2	23/09	23/09	Numerical methods for ODEs using MATLAB	Olzhas
3	07/10	30/09	BVPs using MATLAB	Desireh
4	14/10	28/10	Introduction to COMSOL	Shabnam
5	11/11	04/11	Multi-physics modeling problem I	Olzhas
6	18/11	25/11	Multi-physics modeling problem II	Desireh

Note that the schedule assigned for each section is different to that shown on QUEST. Please follow this schedule.

Classroom Responsibilities:

http://www.eng.uwaterloo.ca/~ugoffice/html/course_responsibilities.html

Academic Integrity, Grievance, Discipline, Appeals and Note for Students with Disabilities: see www.uwaterloo.ca/accountability/documents/courseoutlinestmts.pdf

The text for this web site is listed below:

Institutional-required statements for undergraduate course outlines approved by Senate Undergraduate Council, April 14, 2009

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, <http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm>. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, <http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm>. For typical penalties check Guidelines for the Assessment of Penalties, <http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm>.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals, <http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm>.

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.