

# EE 5345, Summer 2003 (Syllabus Draft)

## Semiconductor Device and Process Simulation

(View at <http://www.uta.edu/ronc/5345/syllabus.htm>, download by clicking [syllabus](#))

**Instructor:** Professor R. L. Carter, [ronc@uta.edu](mailto:ronc@uta.edu), <http://www.uta.edu/ronc>, 532 Nedderman, office hours: 9:30 to 10:30 AM Monday and Wednesday, 817/273-3466, fax 817/272-2253.

**GTA:** Siddharth Nashiney <[nashineys@hotmail.com](mailto:nashineys@hotmail.com)>

**Course Learning Goals and Objectives:** To be able numerically simulate integrated circuit structures and devices (while understanding the limitations of the results obtained) with commercial Poisson equation solvers.

**Class Meetings:** Mon/Wed, 10:30 to 12:20 AM, 202 Nedderman Hall.

**Attendance Policy:** Attendance at every class session for the entire 110-minute period is strongly advised.

There will be no videotapes of the lectures available. Assignment 1 as given below must be submitted or you will be dropped from class. Some lectures will be posted at <http://www-ee.uta.edu/Online/carter/index.htm>

**Workstation Labs:** SunSolaris (Gamma2) – ELB

**Text** (On order for the Science and Engineering Library):

- *Semiconductor Device Physics and Simulation*, by Yuan and Liou, 0306457245, ©1998, Plenum Press. Listed as T in the assignments.

**Device Simulation Reference:** (If on reserve in the Science and Engineering Library, marked<sup>R</sup>)

- <sup>R</sup>*Semiconductor Devices: A Simulation Approach*, by Kevin M. Kramer and W. Nicholas G. Hitchon, ISBN 013614330X, ©1997, Prentice Hall, Upper Saddle River, NJ. Listed as KH in the assignments.
- *Medici User Manual*, ©2003, Synopsis, Inc. Listed as UM in the assignments.

**Device Electronics References:** (On reserve in the Science and Engineering Library)

- *Device Electronics for Integrated Circuits*, 3rd ed., by Richard S. Muller and Theodore I. Kamins with Mansun Chan, John Wiley and Sons, New York, 1986. Listed as D in the assignments.
- *Devices for Integrated Circuits : Silicon and III-V Compound Semiconductors*, by H. Craig Casey, John Wiley, New York, 1999. Listed as DI in the assignments.

**Spice References:** (Books on reserve in the Science and Engineering Library are marked<sup>R</sup>.)

- <sup>R</sup>*MicroSim PSpice for Windows, 2nd ed*, by Goody, Prentice-Hall, Upper Saddle River, N.J., ©1998.
- <sup>R</sup>*Computer-Aided Circuit Analysis Using PSpice* by Walter Banzhaf, Regents/Prentice Hall, Englewood Cliffs, NJ, ©1992
- <sup>R</sup>SPICE: A Guide to Circuit Simulation and Analysis Using PSpice, 3rd ed., by Paul W. Tuinenga, Prentice Hall, Englewood Cliffs, NJ, ©1995.
- *Schematic Capture with MicroSim Pspice: for Windows 3.1, 4<sup>th</sup> Ed.*, by Herniter, ©2000, Prentice-Hall
- PSpice<sup>TM</sup> is available by download from [Orcad](#) or from the UTA HKN chapter chapter at <http://hkn.uta.edu>.
- Prof. Dillon's excellent tutorial for PSpice<sup>TM</sup> is at <http://rock.uta.edu/dillon/pspice/>

**Use of e-mail:** Updates of class information are sent by e-mail. A log of e-mail messages sent to EE5345 students by me will appear at <http://www.uta.edu/ronc/5345/email.html>. Always include the course number, EE5345, in the Subject line of e-mail messages to me. Do [Assignment 1](#) on the first class day.

**Projects, Tests and Grading Formula:**

- The class will be conducted in a Seminar format. Each student will be making presentations of material from the text, and grades will be determined by presentations and class participation.
- The Final Exam will be a Written Summary Project Report due at noon August 11 (532 Nedderman).

**Grading Scale:**

- A = 90 and above
- B = 75 to 89
- C = 60 to 74
- D = 50 to 59
- F = 49 and below

**Project Assignments:** TBD

**Lectures:** Lecture notes, when published, are at <http://www-ee.uta.edu/Online/carter/index.htm>

**Course Schedule and Assignments:** See below for seminar presentation assignments. The guidelines for presentations are:

1. Each presentation should summarize the material assigned in 10 to 15 minutes. Time will be allowed at the end of the presentation for questions and answers.

2. Be sure to include the typical or default values MEDICI uses for parameters when the parameters are introduced in your presentation.
3. Define the physical meaning of variables like  $J$  (current density),  $E$  (electric field), etc., when introduced in your presentation.
4. Send your PowerPoint files to Siddharth Nashiney <[nashineys@hotmail.com](mailto:nashineys@hotmail.com)> for posting on the web site.
5. Your PowerPoint files will need to be updated with changes suggested in class.

**EE 5345 - Semiconductor Device Simulation - Summer 2003**

C#	Date	Day	Gr	Seminar Assignments				
	26-May-03	M		Memorial Day Holiday				
1	28-May-03	W		Attend class for assignments, and do Assignment 1 (see e-mail)				
2	02-Jun-03	M	1	Basic Eq.	UM 2-2	thru	Surface Rec.	UM 2-4
			2	Con-dep Lifetimes	UM 2-4	thru	Lattice-T indep Life	UM 2-5
			2	Boltzman Stats.	UM 2-10	thru	Boltzman Stats.	UM 2-10
			3	Bandgap and ...	UM 2-11	thru	Narrowing ...	UM 2-13
			4	F-D statistics	UM 2-14	thru	High Doping ...	UM 2-17
			5	Mobility Models	UM 2-22	thru	Aurora ... Model ...	UM 2-25
3	04-Jun-03	W	6	Carrier-Carrier ...	UM 2-26	thru	Phillips ...	UM 2-29
			1	Surface Scatt ...	UM 2-29	thru	Universal Mob ..	UM 2-32
			2	Perpendicular ...	UM 2-32	thru	eqn. 2-154	UM 2-35
			3	eqn. 2-155	UM 2-35	thru	eqn. 2-171	UM 2-38
			4	eqn. 2-172	UM 2-38	thru	Parallel Field ...	UM 2-41
			5	Disabling Parallel ..	UM 2-41	thru	Hewlett -Packard ...	UM 2-45
4	06-Jun-03	F	6	Lucent ...	UM 2-45	thru	Lucent ...	UM 2-47
	(9:00 AM)		1	Inversion and acc...	UM 2-47	thru	eqn. 2-227	UM 2-50
			2	after eqn. 2-227	UM 2-50	thru	Electric Field calc. .	UM 2-53
			3	Electric Field Comp	UM 2-53	thru	Comp. Mob. Mod.	UM 2-56
	09-Jun-03	M		no class				
	11-Jun-03	W		no class				
5	13-Jun-03	F	4	GSURFN res. ...	UM 2-56	thru	EJ.MOBIL and ...	UM 2-59
	(9:00 AM)		5	Electron - hole ...	UM 2-59	thru	Ohmic Contacts	UM 2-62
			1	Schottky Contacts	UM 2-62	thru	Nuemann Bound. ..	UM 2-65
			2	Interface Charge ...	UM 2-65	thru	Specification ...	UM 2-69
			3	Distr. Cont. Res.	UM 2-69	thru	Error Norms	UM 2-73
6	16-Jun-03	M	4	Convergence ...	UM 2-73	thru	Accelerating ...	UM 2-77
			5	When to choose ...	UM 2-77	thru	Par. C.DVMAX	UM 2-81
			1	Linear Matrix ...	UM 2-82	thru	Disadvantages	UM 2-85
			2	ILUCGS Solver	UM 2-86	thru	Grid Allocation	UM 2-89
			3	Coordinate Systems	UM 2-89	thru	Vertical Spacing	UM 2-93
7	18-Jun-03	W	4	Mesh Spacing Par.	UM 2-93	thru	Interpolation	UM 2-97
			5	Reading Doping ...	UM 2-97	thru	Undesirable eff ...	UM 2-101
			1	Transient Device ...	UM 2-101	thru	Basic Concepts	UM 2-105
			2	Sinusoidal Steady ..	UM 2-105	thru	Output	UM 2-109
			3	Self-Consistent ...	UM 2-109	thru	Examining Res ...	UM 2-113
8	23-Jun-03	M	4	Gate Current Ana ..	UM 2-113	thru	Insulator Pro. ...	UM 2-117
			5	Electron Scattering	UM 2-118	thru	Parameter Spec.	UM 2-122
			1	Reln. To Fowler - ...	UM 2-123	thru	Dir. Tunn. Meth. 3	UM 2-126
			2	Dir. Tunn. Meth. 4	UM 2-127	thru	the MATERIAL St.	UM 2-131
			3	Following the MODE	UM 2-131	thru	Comp. Semi. EB	UM 2-135
9	25-Jun-03	W	4	Boundary Cond.	UM 2-135	thru	Thermally Enh. ...	UM 2-139
			5	En. Bal. Post-Pro ..	UM 2-139	thru	Charge Boundary ..	UM 2-143
			1	Fowler-Nordheim	UM 2-143	thru	Constr. Of Cir ...	UM 2-147
			2	Multiple Device ...	UM 2-147	thru	Overriding default ..	UM 2-150
			3	Electric Field Terms	UM 2-150	thru	Physical Models	UM 2-154

10	30-Jun-03	M	4	Heterojunction ...	UM 2-154	thru	Device Eqn ...	UM 2-157
			5	Models for Comp ...	UM 2-157	thru	T dep. crossovers	UM 2-161
			1	Carrier mass ...	UM 2-161	thru	Virtual Nodes	UM 2-166
			2	Poisson Eqn. ...	UM 2-166	thru	Recombination	UM 2-169
			3	Modeling	UM 2-169	thru	Transient sim ...	UM 2-171
			3	Thermal Diffusion	UM 2-182	thru	Notes	UM 2-183
			3	Introduction	UM 3-1	thru	Statements w/o ...	UM 3-3
11	02-Jul-03	W	4	Parameters	UM 3-3	thru	Numerical Fctns	UM 3-7
			5	Logical Functions	UM 3-7	thru	Device Structure	UM 3-13
			1	Rectangular Mesh	UM 3-14	thru	Mesh Output	UM 3-21
			2	Description	UM 3-21	thru	New Automatic	UM 3-25
			3	Gridding Region	UM 3-26	thru	Smoothing Region	UM 3-31
12	07-Jul-03	M	4	X.MESH	UM 3-32	thru	Examples	UM 3-37
			5	ABC.MESH	UM 3-38	thru	Alignment	UM 3-44
			1	Example	UM 3-45	thru	Fig. 3-8	UM 3-50
			2	ELIMINATE	UM 3-51	thru	HIGH.ASP	UM 3-57
			3	DESCRIPTION	UM 3-57	thru	unnecessary details	UM 3-64
13	09-Jul-03	W	4	Unassigned Elemer	UM 3-64	thru	Fig. 3-15	UM 3-50
			5	REGION	UM 3-71	thru	Examples	UM 3-76
			1	Electrode	UM 3-77	thru	Examples	UM 3-82
			2	PROFILE	UM 3-82	thru	.. See also	UM 3-88
			3	PROFILE TYPES	UM 3-89	thru	CHOOSING	UM 3-94
14	14-Jul-03	M	4	REGRID	UM 3-95	thru	... smoothing	3-100
			5	Quadtree	3-100	thru	Fig 3-17	3-105
15	16-Jul-03	W	all	Report on Group Project Assignment				
16	21-Jul-03	M	all	Report on Group Project Assignment				
17	23-Jul-03	W	all	Report on Group Project Assignment				
18	28-Jul-03	M	all	Report on Group Project Assignment				
19	30-Jul-03	W	all	Report on Group Project Assignment				
20	04-Aug-03	M	all	Report on Group Project Assignment				
21	06-Aug-03	W	all	Report on Group Project Assignment				
22	11-Aug-03	M	all	Written Summary Project Report due at noon (532 Nedderman).				

**Notes:**

1. This syllabus may be changed by the instructor as needed for good academic practice. Use the "refresh" or "reload" function on your browser.
2. Quizzes and tests are open book (must have a legally obtained copy-no Xerox copies) OR one handwritten page of notes. Calculator allowed.
3. There will be no make-up, or early exams given. Attendance is required for all tests.
4. Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112—The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act – (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As a faculty member, I am required by law to provide “reasonable accommodation” to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels. In conformance with the Americans with disabilities Act, I state that, "If you require an accommodation based on disability, I would like to meet with you in the privacy of my office during the first week of the semester to make sure you are properly accommodated. Contact Mr. Jim Hayes (272-3364) for Information."
5. It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. “Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for

credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts.” (Regents’ Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22). ANY CHEATING WILL RESULT IN SEVERE PENALTIES. All work submitted must be original. If derived from another source, a full bibliographical citation must be given. See <http://www2.uta.edu/discipline/> for UTA policies. You will be expected to sign the document at [http://www.uta.edu/ronc/5340/COE\\_EthicsStatement\\_Fall02.htm](http://www.uta.edu/ronc/5340/COE_EthicsStatement_Fall02.htm)

6. If identical papers are submitted by different students, the grade earned will be divided among all identical papers.
7. A paper submitted for regrading will be compared to a copy of the original paper. If changed, points will be deducted.