# DEVICE MODELING: FROM PHOTOVOLTAICS TO MEDICAL PHYSICS

**The University of Toledo**
**Department of Physics and Astronomy/Department of Radiation Oncology**
**CNSM/COMLS**
PHYS 6980/8980 Special Topics in Physics, CRN#35411/35412

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**Offered**: Summer-II, 2016
**Class Location**: MH, room#4012
**Class Day/Time**: T/F, 1-3:30PM
**Credit Hours**: 2

## CATALOG/COURSE DESCRIPTION

*Course reserved for visiting lecturers and topics not covered otherwise*

*Course-specific description: The course teaches the basics of popular software packages and modeling approaches applicable to physics and engineering, including medical physics, photovoltaics, and other structures and devices.*

## COURSE STATEMENT

*Interdisciplinary MS/PhD course, targeting broad student audience in medical physics, photovoltaic, and electrical engineering, from the departments of Physics and Astronomy (CNSM), Radiation Oncology (COMLS), Electrical Engineering and Computer Sciences (COE), and others.*

*Multiple ongoing and emerging projects in photovoltaics and medical physics require proficiency in computer modeling of typical device structures that can be accomplished through similar approaches and utilizing the same software packages. The required techniques will be taught in this course and illustrated by a variety of modern technology examples.*

## STUDENT LEARNING OUTCOMES

*The goal is to develop skills allowing future specialists to independently perform the typical modeling tasks with popular software packages: AMPS, SCAPS, PSPICE, MCNP, and COMSOL. The modeling includes: radiation, light, and heat transport in biological systems and physical devices, electric and magnetic properties of complex systems, and electronic transport in related circuits. The applications will expand over radiation sources and detectors, distribution of electric, magnetic, and thermal fields in medical and photovoltaic devices of various configurations, device parameters and efficiency.*

## TEACHING METHODOLOGY

*The course will be taught through regular lectures, discussion of relevant approaches, and answering student questions. Since there is no standard textbook, covering all topics, the notes will be posted online for each lecture.*

*In addition to understanding general approaches to physical phenomena and device modeling, students will be expected to acquire some hands-on experience with most of the listed software package. By the end of the course, students will complete modeling projects of their choice, according to their individual research interests. The final grade will be derived based on 1) writing a short (within 1 page) proposal, including problem statement, defining relevant parameters, and identifying a software package most appropriate for the task; 2) demonstrating consistent progress towards the model implementation; 3) final project in-class presentation; 4) turning in a working model (program file) and a brief report of findings with relevant graphs and numerical results. Sample projects will be suggested by the instructor.*

**PREREQUISITES AND COREQUISITES**

*Consent of Department*

**REQUIRED INSTRUCTIONAL MATERIALS (TEXTS AND ANCILLARY MATERIALS)**

*The course will rely on lecture notes, handouts, and supplemental materials such as software manuals, published articles, and online references. The following software packages will be covered:*

*AMPS-1D software package – download at http://www.ampsmodeling.org/*

*SCAPS-1D website: http://scaps.elis.ugent.be/*

*PSPICE download at http://www.orcad.com/resources/orcad-downloads*

*MCNP5/MCNP6 – can request a copy from RSICC (https://rsicc.ornl.gov/CustomerService.aspx ), software is export-controlled; concise tutorial is available at http://www.mne.ksu.edu/~jks/MCNPprmr.pdf ; medical physics-oriented tutorial available at https://laws.lanl.gov/vhosts/mcnp.lanl.gov/pdf_files/la-ur-07-4133.pdf*

*COMSOL MultiPhysics – will be available at Physics & Astronomy computer lab. (For interested students, a 2-week evaluation copy can be obtained through visiting a workshop in Cleveland, OH, July 15th 2016); multiple introduction videos are available through COMSOL website, e.g., https://www.comsol.com/video/how-set-up-run-simulation-comsol-multiphysics*

*Additional supplemental reading materials and complete citations for each instructional material will be provided.*

**TECHNOLOGY EXPECTATIONS**

*Students are expected to have basic computer skills, and be familiar with Microsoft Word or similar for technical writing, Microsoft Excel or similar for compilation of simulated data and generation of graphs. Familiarity with the listed modeling software packages is not required, however, working knowledge of at least one package will be necessary for completion of the final modeling project by the end of the course.*

**UNIVERSITY POLICIES**

*Policy Statement on Non-Discrimination on the basis of Disability (ADA):*

*The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.*

**ACADEMIC ACCOMMODATIONS**

*The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations/adjustments in this course please contact the Student Disability Services Office.*

**ACADEMIC POLICIES**

*Students are expected to comply with the standard UT policies including student conduct, academic dishonesty, missed class policy, student grievances, etc.*
*http://www.utoledo.edu/law/studentlife/resources/handbook_policies.html*

**COURSE EXPECTATIONS**

*Attendance and class participation are expected; assignments will be accepted for full credit by the final exam date, no extra credit given*

**OVERVEW OF COURSE GRADE ASSIGNMENT**

*Final grades are based on scores according to the following combination*

*Proposal, due 2nd week of the course: 20%*

*Project progress: 20%*

*Final project presentation: 20%*

*Final project (working program file and a brief report), due by the final exam date: 40%*

*The final letter grades are derived according to the following grading scale:*

| 90-100 | 85-89 | 80-84 | 75-79 | 70-74 | 65-69 | 60-64 | 55-59 | 50-54 | 40-49 |
|---|---|---|---|---|---|---|---|---|---|
| A | A- | B+ | B | B- | C+ | C | C- | D | F |

**COURSE GUIDELINES**

*The regular class will meet twice a week for 2-2.5 hours sessions of lectures with individual consultations as needed; hands-on computer lab will follow every lecture.*

*Communication via e-mail is encouraged; individual appointments will be available upon request*

**SAFETY AND HEALTH SERVICES FOR UT STUDENTS**

*Please follow the link below for a comprehensive list:*
*http://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf*

**COURSE SCHEDULE**

| Week | Dates | Topic | Due dates |
|---|---|---|---|
| 1 | 06/28 | Device modeling introduction | |
| 1 | 07/01 | General overview: software packages and capabilities | |
| 2 | 07/05 | PV/p-n junction detector modeling: AMPS-1D | |
| 2 | 07/08 | PV/p-n junction detector modeling: SCAPS-1D | Project proposal due |
| 3 | 07/12 | COMSOL Multiphysics modeling intro | |
| 3 | 07/15 | COMSOL Multiphysics examples: device modeling, biological systems modeling | |
| 4 | 07/19 | Radiation transport Monte Carlo modeling overview | |
| 4 | 07/22 | MCNP5/6: capabilities and examples | Progress evaluation |
| 5 | 07/26 | PSPICE software package overview | |
| 5 | 07/29 | PSPICE for device non-uniformity modeling and other examples | |
| 6 | 08/02 | Final project presentation | Final project presentation |
| 6 | 08/05 | Final project presentation/turn in | Final project due |