PHYSICS 388
ADVANCED COMPUTATIONAL PHYSICS
INTRODUCTION TO BIO-OPTICS

FALL 2018

INSTRUCTOR Q. Su

ADDRESS Moulton Hall 312A Office hours: walk in
Phone: 438-5392 Email: qcsu@ilstu.edu

TEXT There will not be a textbook for the class. Mostly we have to rely on the lectures and taking notes.

OBJECTIVES In this first part of the advanced computational physics course we will introduce one of the youngest sciences: Bio-optical physics. At the beginning of the 21 st century, often regarded as the century of life sciences, non-invasive optical diagnostic techniques have great potential in the economic and early detection of cancers. Since the subject is non-traditional in today's physics education we will proceed with our survey slowly. The aim of such an endeavor is to gain appreciation on an emerging field by applying our existing knowledge and skills in theoretical and computational physics.

FORMAT Lectures will present the main ideas of the course and include topics that deserve emphasis. Apart from lectures and reading handouts, it is essential that you do many exercises. You will be given plenty of opportunity to do so. Homework will include problems related to or compliment of the classes. The computer projects will be hand-on opportunities for you to work out numerical results. They should help you in getting a better view of what's going on.

EXAM AND GRADING Grade for this part will be based on your performance on several (theoretical or computational) homework assignments, and a final exam. The breakdown (33.33 % of the whole class) will be as follows:

Homeworks	22.22 %
Final Exam	11.11 %

The final will be close-book but one 8.5" x 11" sheet of paper that you think will help you with difficult *equations* will be permitted. Math handbooks are allowed too.

The course grade will be determined by your performance on each of the three equal course parts.

HOMEWORK The solutions that you hand in should include steps of derivation. Computer parts should include a brief description of what you did, program listing, appropriate graph or data outputs. The program source file should be emailed to the instructor separately (the login name is qcsu on physics department mail). The programs should be well organized and clearly commented on each part. Homework will be collected on the announced due date. Late homework will lose points 10% daily. Incomplete homework will be given partial credit.

Up to this point you are probably quite used to the computer assignments in this department. New algorithms and techniques for the assignments will be discussed in the assignment or in class or the

assignments. You are expected to write out the programs on your own. The language will be FORTRAN and the machine will be entropy. We will be using supported softwares of the department, xlf, NCAR, NCSA-telnet (for mac users), kaleidagraph (for mac) and Mathematica. We may not have to use them all. An introductory manual about the use of the local RS6000 and the above softwares is around in Moulton 304 and 308.

TOPICS

Below is a tentative list.

Topics
Introduction to bio-optical physics
X-ray shadow-gram and IR light scatter-gram
A matrix model of X-ray image reconstruction
Micro- and macro-scopic views of light-tissue interactions
The Boltzmann equation (BE) for light
Interaction parameters for light-tissue systems
The scattering phase functions
A bi-directional model of light scattering
A Monte-Carlo algorithm to solve the BE
The photon density waves
The diffusion approximation