12998-214(16) Computational Physics A (3l, 3p)
(Introduction to Numerical Simulation in Physics)

2017

Course summary:

Simulations in basic physics systems developing a toolbox for numerical analysis. Topics change annually. Typical examples are the chaotic pendulum, planetary motion, integral equations for electromagnetic fields and waves.

Method of assessment: Flexible assessment

Prerequisite pass modules: Physics 114, 144
Prerequisite modules: Mathematics 114, 144
Co-requisite modules:

- *Physics 224*
- *Scientific Computing 272*

Language policy:

English only for a module:
Where the assigned lecturer is proficient to teach only in English;
or
Where all the students in the class group have been invited to vote by means of a secret ballot and those students who have voted, agree unanimously to the lectures being presented in English only.

Module relevance in programme:

The purpose of this module is to use computational techniques to illuminate laws of physics encountered in other physics modules. The problems we investigate numerically are derived from first-year and the other second-year physics modules. Following the modules in computational physics (this module and Physics 244, and also Physics 344) you should have experience in various numerical techniques that will help you to deal with physics problems throughout the physics programmes. As a matter of course you will also have gained experience in computer programming. The module is a prerequisite for the stream in theoretical physics, but generally complements the core of the programme in physics.

Outcomes of course:

- Insight into the physics of selected simple deterministic physical systems.
- Hands-on knowledge of selected concepts of physics (depending on the topic chosen in a given year) and their numerical implementation on the computer.
- Appreciation of the fundamentally different character of computational physics as compared to analytical physics.
- The ability to write and debug simple computer simulations of physical systems obeying differential equations.
- Appreciation of the importance and role played by numerical error and approximation in simulation.
- Developed skills in compiling and maintaining a record of own work and thoughts.
- Familiarity on intermediate level with the operating system currently used in the module and some of its numerical and graphical applications.
- Collaboration with other team members to plan and solve complex problems in a group.

- Exposure to new and exciting research fields in physics, and the finding resources to assist in research topics.
- Development of presentation skills, problem solving strategies and time management.

Lecturer:

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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for second year programme and its modules is Dr PH Neethling pietern@sun.ac.za

Course content:

Projects on deterministic physical systems using computer simulations. Changing from year to year, topics include applications of differential equations eg. planetary motion, chaotic pendulum, Lorentz force, Numerical solutions to integral problems are exemplified for electro-magnetic fields The focus is on applications to physics problems rather than sophisticated program code.

Study material:

Due to the nature of this module there is no single prescribed text book. Study notes and reference material will be handed out by the lecturer.
Some of the discussed applications are discussed in the textbook:

NJ Giordano, ***Computational Physics***, Prentice Hall (1997).

Other useful resources:

- R. de Vries, ***A First Course in Computational Physics***, Wiley, 1994.
- A.L. Garcia, ***Numerical Methods for Physics***, Prentice-Hall, 1994.
- W.H. Press et al., ***Numerical Recipes, 2nd ed.***, Cambridge University Press (various editions for different programming languages).

Learning opportunities:

The individual work on simulation projects constitutes an effective learning opportunity. Every lecture and tutorial is an opportunity to discuss the project work with the lecturer and fellow students.

Assessment:

Methods of Assessments

Assessment is based on "continuous assessment". Assessment via (approximately) weekly homework assignments that require students to numerically simulate deterministic systems, questions asked by the lecturer in tutorials, and inspection of students' notes and computer programmes. Depending on time available, students make oral presentations on own work or sections of the prescribed material.

Availability of marks:

Marks will be available within a reasonable time. Feedback is given in terms of written and oral commentary.

Calculation of class mark:

60 per cent of mark: homework (written notes and programs)
20 per cent of mark: classwork (including mini quizzes in the tutorial)
20 per cent of mark: project presentation (oral and/or essay)