12998-344(16) Computational Physics C
(Monte Carlo Methods in Physics) (3l, 3p)

2018

Course summary:

Generation and testing of random numbers. Statistics of data analysis. Analytic solutions, computer simulation and analysis of random systems such as random walks and the Ising model.

Method of assessment: Flexible assessment

Prerequisite module: Physics 214 or 314

Language policy:

Afrikaans and English in the same class groups:
During each lecture, all information is conveyed at least in English. Summaries and/or explanation of the core concepts will also be given in Afrikaans. Questions in Afrikaans and English will, at the least be answered in the language of the question. Students will be supported in Afrikaans and English during a combination of appropriate facilitated learning opportunities.

Module relevance in programme:

Monte Carlo algorithms are used extensively for numerical integration and simulation of complex structures of all kinds of physics and beyond. The course introduces, the necessary computational and statistical tools and concepts to write such codes and to analyse the data they produce. The simulation of a two-dimensional ferromagnet provides deep insights into phase transitions and especially benefits students following the honours statistical physics course (Physics 721), complementing the analytical approaches there. The third-year statistical physics module, Physics 314 provides a related introduction to, systems that we would want to study using computer simulations. The Physics 214, 244 modules in computational provide preparation useful to this course.

Outcomes of course:

- Insight into the physics of stochastic physical systems.
- Appreciation of the importance and role played by random number generators and their pitfalls.
- Basic knowledge of the application of statistical sampling theory to physics.
- Working knowledge of Monte Carlo simulation and its applications in physics and beyond.
- Familiarity with the operating system currently used in the module and a numerical computer language.
- The ability to write and debug computer simulations of stochastic physical systems.
- Developed skills in compiling and maintaining a record of own work and thoughts.

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 honours programme and its modules is Dr CM Steenkamp cmsteen@sun.ac.za

Course content:

Theory and application of statistics, including central limit theorem, sampling theory, inference and their application to experimental data. Generation and testing of random numbers. Importance sampling and the Metropolis algorithm. Analytical solution and simulation of random systems such as random walks and the Ising model. Simulation and analysis of second order phase transitions.

Tutorials:

One afternoon per week, used mainly for computer simulations.

Study material:

Lecture notes

Assessment:

Methods of Assessment
Continuous Assessment, based on

- evaluation of students' workbooks and computer programs.
- homework assignments and test based on the formal and analytical work covered.

Venue and time of assessment opportunities
Two to four evaluations of the student's notes and programs, spread evenly throughout the semester.

Availability of marks:
Turnaround time is typically one week. Feedback is given in terms of written and oral commentary as soon as possible.

Calculation of class mark:
40-60 percent of mark: results and interpretation of computer simulations.
40-60 percent of mark: analytical work covered.