NAZARBAYEV UNIVERSITY
SCHOOL OF SCIENCE AND TECHNOLOGY

Course Syllabus: PHYS 511 Computational Modeling and Simulation

Semester: Fall 2016 Lecture and Lab Times: Fridays 2:00 pm-5:30 pm in Room 7.212

Instructors:

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Course Description and Objectives

In Computational Modeling and Simulation (PHYS 511) course, students will acquire the knowledge and skills for solving various scientific problems and analyzing data using modern computational techniques. The course will include certain subjects related to the traditional numerical analysis (finding roots of systems of algebraic equations, numerical interpolation and extrapolation of data, numerical differentiation and integration, Fourier transforms) as well as the methods of simulating various systems and phenomena governed by ordinary and partial differential equations (Monte Carlo, finite element, and Galerkin methods). In the scope of the course, students will

- Learn the advantages and limitations of common numerical techniques
- Get acquainted with various scientific software and tools
- Use modern software development tools
- Practice writing flexible, efficient, and practical code in a modern language
- Learn the basics of parallel computations and programming
- Learn common techniques for analyzing and plotting data
- Practice writing reports in the scientific style

The course is designed to help the students gain experience carrying out computational tasks and data analysis. It will partly utilize the `Python` programming language (there will be an introduction to `Python`). In recent years, `Python` became a widely used general-purpose, high-level programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts and computational operations in a concise form. Moreover, it features a dynamic type system and automatic memory management and has a large and comprehensive standard library (e.g., numpy, matplotlib, etc). `Python` supports multiple programming paradigms, including object-oriented, imperative and functional programming styles. The course will also require students to use `Mathematica` – a powerful computer package widely used in various scientific disciplines. `Mathematica` encompases computer algebra and symbolic mathematical computations, numerical computations, visualization and statistics capabilities. In additional to `Python` and `Mathematica`, students will be expected to acquire familiarity with a computer language suitable for high-performance computing, such as `Fortran` or `C`.

Course Materials

The course material will be based on the following textbooks:

- Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, 6th edition, McGraw-Hill, 2010
- Computational Physics with Python, Mark Newman, CreateSpace Independent Publishing Platform, 2012
- Numerical Recipes, 3rd. edition, by W. H. Press, S. Teukolsky, W. Vetterling, and B. Flannery, Cambridge University Press, Cambridge, UK, 2007
- Python Scripting for Computational Science, Langtangen H. P., 3rd ed. 2008 (freely available for download online)

Course Assessment

Activity	**Weight**
Homework assignments	50%
Midterm exam	25%
Final exam	25%

A grade bonus of up to 5% will be awarded to students with 100% attendance and active participation (e.g. asking relevant questions during the class and answering instructor questions).
The midterm exam will take place approximately in the middle of the semester (the exact date will be communicated later), while the final exam will be at the end of the semester as scheduled by the registrar.

Course Policies and Academic Honesty

You are welcome and encouraged to work on the homework assignments with your fellow students. However, the work you submit should be *your own* and reflect your own understanding of the subject. All submitted homework problem sets and reports will be graded and returned to you during the semester. During exams, exchange of information with others is unacceptable, so is the use of phones and electronic devices. Anyone suspected of violating these guidelines will be charged with academic dishonesty and subject to NU's disciplinary procedures described in NU Student Code of Conduct and Disciplinary Procedures Handbook.

Attendance policy

Students are expected to attend both lectures and labs. Attendance of lectures is particularly important as the information provided during them may be a part of the examinations.

Office Hours Policy

Every student is encouraged to visit the instructor during office hours. It is mandatory for students with midterm grade below B to come to office hours at least once after midterm grades are posted. Please set up the appointments if the office hours provided are in conflict with your other academic endeavors.

Missed exams

Missed exams can be made up only if valid, documented excuse is presented for missing them. Note that all medical notes should be signed by NU doctor; notes from outside clinics will not be accepted. Same policy applies to excusing the missed lectures for students who either fall below 80% attendance or would like to receive the perfect attendance bonus.

Electronic resources

You are expected to regularly check your Nazarbayev University email for updates and announcements about the course. You are also required to use Moodle as determined by the instructor.