ASTE 499: Scientific Programming for Astronautics and Aerospace Applications Spring 2016

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Time: Monday 2:00 - 4:50 PM
Location: TBD
Instructor: Daoru Han
Office: RRB 233
Office Hours: Monday 10 - 11 AM or by appointment
Teaching Assistant: TBA

Course Description

Scientific programming and numerical analysis techniques with advanced languages such as FORTRAN and C/C++. This course presents scientific programming and numerical analysis techniques beyond that taught in a MATLAB-based numerical analysis class. During the course, each student will learn advanced programming languages such as FORTRAN, C, and C++, and develop and implement his/her own programs to solve typical problems in astronautical engineering and aerospace engineering. Topics to be covered include a) introduction to Linux operating systems (OS), command lines, and shell scripts; b) introduction to advanced programming languages - FORTRAN, C/C++; c) finite difference schemes for 1-D and 2-D partial differential equations in astronautics/aerospace applications; d) code profiling/tuning/optimization.

Learning Objectives

The goal of this course is to introduce advanced scientific computing environments and programming languages (beyond those taught in a MATLAB-based numerical method course) used in astronautics and aerospace engineering research. At the end of the semester students will have developed the knowledge of advanced programming languages including FORTRAN and C/C++, and the skills to apply these languages to implement numerical methods to solve some typical application problems in astronautics and aerospace engineering, and a foundation to develop new computing models using high-performance computing (HPC) facilities.

Recommended Preparation: AME 404 or equivalent;
Recommended Hardware/Software: A laptop computer capable of running Linux.

Course Notes

This is a hands-on programming course. Bringing your laptop to the class is highly recommended.

Recommended Readings

- *Classical Fortran: programming for engineering and scientific applications*, 2009, 2nd ed. (available in Leavey Library)
- *C programming: the essentials for engineering and scientists*, 1999 (available in Science Library)
- *Numerical recipes: the art of scientific computing*, 1986 (available in Science Library)

Homework Policy

Honor Code: Students are expected to follow the university honor code. You may discuss homework assignments with your instructor and classmates. For programming assignments discussion with peer students is not discouraged. However, all work submitted for a grade must be your own and independent work.

There will be homework programming assignments approximately once per week.

- Homework and Project must be submitted electronically on or before the designated due date.
- You will need to submit your package including the source code, makefiles (if any), executable, input files, and instructions on how to run your code (readme file) along with the report in one compressed file.
- Please do not email your codes to the instructor or TA asking for debugging. However, students are encouraged to consult us during the office hours and/or work in a group on debugging/testing the codes.

Project Policy

- Students are required to work on their projects all independently. You may not assist others on projects.

Grading Policy

Weighting:

Homework	40%
Mid-Term Project	20%
Final Project	40%
Total	100%

Grades:

90+:	A
85 - 90:	A-
80 - 85:	B+
75 - 80:	B
70 - 75:	B-
67 - 70:	C+
63 - 67:	C
60 - 63:	C-
57 - 60:	D+
53 - 57:	D
50 - 53:	D-
< 50:	F

Course Schedule

Note: The following schedule is tentative and subject to change as needed during the semester. Changes will be announced in class in advance.

Week (Date)	Topics
1 (1/11)	Introduction to Linux, shell scripts, command lines, text editors
2 (1/18)	(No class, Martin Luther King's Day)
3 (1/25)	Introduction to FORTRAN and C/C++; compilers/makefiles
4 (2/1)	Modules (FORTRAN), I/O, arrays
5 (2/8)	Matrices, matrix-vector multiplication, matrix-matrix multiplication
6 (2/15)	(No class, Presidents' Day)
7 (2/22)	A complete working program; mid-term project discussions
8 (2/29)	Profiling, tuning, multi-threading (OpenMP)
9 (3/7)	Finite difference methods; Poisson's equation; 1-D Poisson solver
10 (3/14)	(No class, Spring Recess)
11 (3/21)	Mid-term project report due; discussion on 1-D Poisson solver
12 (3/28)	2-D Poisson's equation, boundary conditions
13 (4/4)	2-D Poisson solver, final project discussions
14 (4/11)	Heat equation; 2-D heat equation solver
15 (4/18)	Introduction to plasma simulations
16 (4/25)	Final project discussion (final class)
17 (5/2)	(No class, Study Days)
18 (5/9)	Final project report due

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity or to the Department of Public Safety. This is important for the safety of the whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men provides 24/7 confidential support, and the Sexual Assault Resource Center webpage describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus unfeasible, USC Emergency Information will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.