CDS 351 - CSI 501
Introduction to Scientific Programming
Syllabus

Instructor: Dr. Fernando Camelli
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Date: Wednesday 4:30 pm – 7:10 pm
Place: Innovation Hall, room 326, Fairfax Campus
Office Hour: Wednesday from 3:00 pm to 4:00 pm
Prerequisites: Permission of instructor

Description:
This course focuses on elements of programming using C/C++ and Fortran languages. The main goal of this class is to familiarize students with basic concepts of programming in computational sciences. Students who complete this course should be able to develop their own code, program algorithms, manage the input and output of data, as well as compile and link codes with other libraries (i.e. LAPACK).

The following topics will be covered: basics of programming, prototyping, and algorithm programming. The programming concepts will be applied to basic problems in computational sciences, including computational geometry and computational mathematics.

In order to take this class, students must be familiar with basic concepts of analytic geometry and calculus, matrix algebra, and elementary differential equations.

Programming topics:

- Introduction to programming, pseudo code, basic logic for programming. Concept of variable and array in C/C++ and Fortran 90 (C++&F90). Basics of compilation.
- C/C++&F90 programming structures and styles.
- Operators and expressions, variable names and constants in C/C++&F90.
- First program "hello world" in C/C++&F90.
- Control of flow and logical expressions in C/C++&F90. Statements and blocks, if-else, else-if, switch, loops - while and for, loops - do - while, break and continue (Taylor's expansion of functions, numerical integration of functions, and calculation of series).
- Functions in C/C++&F90. Basic of functions, return variables, external variables, scope, static variables (trigonometry functions and computational geometry problems).
- Pointers and arrays in C/C++&F90. One-dimensional arrays vs. multidimensional arrays (vectors and matrices, spares matrix basics, conjugate-gradient methods).
- Data structures and types in C/C++&F90. Derived data structures (application to complex numbers, data structures: arrays, linked lists, binary trees, and heap data structure).
- Input/output in ASCII and binary format in C/C++&F90. File processing.
- C/C++&F90 preprocessor. Linking with other libraries (LAPACK, basic MPI).
- Debugging and profiling tools. Management of projects using make.
- Calling F90 subroutines from C/C++. Calling C/C++ subroutine from F90. Linking C/C++ and F90 modules.

Science applications:

- Computational Geometry: polygon triangulation and partitioning, search and intersection, point location, geometric data structures (quadtrees, octrees, interval trees, segment trees, multi-level trees, kd-trees, range trees), distance fields, etc.
- Computational Mathematics: system of equations (Gauss elimination, LU factorization, partial pivoting, sparse matrices), interpolation, numerical differentiation and integration (finite difference, trapezoid's rule, Simpson's rule), ordinary differential equations.

Homework:
The homework includes developing codes to solve common scientific problems in computational mathematics and computational geometry. Some of the homework will be focused on the input/output of data commonly use in computational sciences.

The challenge of the homework assignments will be different for undergraduate and graduate students.

Exams: final exam

Grades: homework and projects (70%), final exam (30%)

Class URL: http://www.cds.gmu.edu/~fcamelli/academics/csi501.html
http://cfd.gmu.edu/~fcamelli/academics/csi501.html
Blackboard

Note: Presentations in PDF format will be posted online after lectures for students.

Text Book (not required but suggested):

1. *"C Programming Language",* by B. W. Kernighan, and D. M. Ritchie.
2. *"Fortran 95/2003 Explained",* by M. Metcalf, J. Reid, and M Cohen.
3. *"The Fortran 2003 Handbook",* by J. C. Adams, W. S. Brainerd, J. T. Martin, R. A. Hendrickson, and R. E Maine.
4. *"Computational Geometry in C",* by J. O'Rourke.
5. *"Computational Geometry: Algorithms and Applications",* by M. de Berg, M. van Kreveld, M. Overmars, and O. Schwarzkopf.

Supplement Reference Books:

6. *"Algorithms in C",* by R. Sedgewick.
7. *"Memory as a Programming Concept in C and C++",* by F. Franek.
8. *"Geometric Data Structures for Computer Graphics",* by E. Langetepe, and G. Zachmann
9. *"C A Reference Manual",* by S. P. Harbison III, and G. L. Steele Jr.
10. *"Numerical Analysis",* by T. Sauer.

Honor Code:
Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work. http://academicintegrity.gmu.edu/honorcode/
Plagiarism will not be tolerated.

Academic Integrity:
GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

GMU e-mail Accounts
Students must use their Mason email accounts—either the existing "MEMO" system or a new "MASONLIVE" account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information.

Office of Disability Services
If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS. http://ods.gmu.edu

Other Useful Campus Resources:

Writing Center: A114 Robinson Hall; (703) 993-1200; http://writingcenter.gmu.edu

University Libraries "Ask a Librarian"
http://library.gmu.edu/mudge/IM/IMRef.html

University Policies
The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.