Physics 3340/8300-007 - "Computational Physics" - Fall 2016 Syllabus
Required text: "Numerical Mathematics and Computing" by E. Ward Cheney and David R. Kincaid
Thomson Brooks/Cole
Recommended edition: 7th, 2013, ISBN 1-133-10371-5
Acceptable edition: 6th, 2008, ISBN 495-11475-8

Module: Basic Skills for Command Line Computing and Numerical Analysis
Text: 1.1, 1.2, 1.3, 1.4 (6th ed. 1.1, 1.2, 2.1, 2.2)
Error terms in Taylor series approximations; limits to precision of integer and floating point binary representations
Linux command line tools, I/O redirection, pipes
C programming: Main programs and functions; char, int, double data types, arithmetic expressions; conditional and looping structures; formatted output; array and pointer data types; command line arguments
Plotting two and three dimensional data files with gnuplot
Physics problems: Response of damped harmonic oscillators, electrostatic or gravitational potential with multiple sources

Module: Visualization of Numerical Data
Physics problems: Single and double slit diffraction patterns; optical spectrum of rainbows; quantum wave packets; plotting of E&M field and potential lines

Module: Finding Roots of Functions
Text: 3.1, 3.2 (except systems), 3.3
Algorithms: Newton, Regula Falsi, Secant, Bisection
Physics problems: Kepler's equation; nonlinear electronic DC circuits; catenaries; Lagrangian orbital points

Module: Solution of Systems of Linear Equations
Text: 2.1, 2.2 (6th ed. 7.1, 7.2)
Algorithms: Gaussian elimination, scaled pivoting
C programming: Memory allocation
Physics problems: Resistive DC networks; spring-mass coupled oscillatory systems with multiple modes; static structures

Module: Solution of Systems of Nonlinear Equations
Text: Portion of 3.2
Algorithms: Newton-Raphson
C programming: Structures
Physics problems: Eigenvalues of electron in single quantum well of finite depth; Eigenvalues of electron in double quantum wells; nonlinear electronic DC networks; multiple masses on string; turbulent flow

Module: Monte Carlo Simulation
Text: 10.1, 10.2, 10.3 (6th ed. 13.1, 13.2, 13.3)
Algorithms: Linear congruential pseudorandom number generation
C programming: long long int data type
Physics problems: Radioactive decay; integration of irregular surfaces; random walk; neutron shielding; Gauss' law; Sherwood's forest and cosmology

Module: Interpolation of Sparse Data Points
Text: 4.1, 6.1, 6.2 (6th ed. 4.1, 9.1, 9.2)

Algorithms: Newton interpolation; Lagrange interpolation; spline interpolation
Physics problems: Electrostatic potential above a disc of charge; optical spectrum of prisms
C programming: Reading of data files

Module: Numerical integration
Text: 5.1, 5.2, 6.1
Algorithms: Trapezoidal, Simpson
Physics problems: Orbits and elliptical integrals; rotational inertia; center of mass; rocket thrust; Maxwell-Boltzmann distribution; Biot-Savart law; Plotting of magnetic field lines

Module: Solution of Ordinary Differential Equations in Initial Value Problems
Text: 7.1, 7.2, 7.3 (6^{th} ed. 11.1, 11.2, 11.3)
Algorithms: Euler, Runga-Kutta, Adams-Bashforth-Moulton, stability of differential equation algorithms, Runga-Kutta-Fehlberg algorithm with adaptive step size
Physics problems: Terminal velocity; large angle pendulum; spring-mass-damper resonant systems; Rutherford scattering; chaotic forced pendulum; chaotic forced van der Pol oscillator; n-body gravitational systems; Eigenvalues of electron in regular arrays of potential wells

Module: Solution of Ordinary Differential Equations in Boundary Value Problems
Text: 11.1, 11.2 (6^{th} ed. 14.1, 14.2)
Algorithms: Relaxation, Shooting
Physics problems: Eigenvalues of electron in single quantum well of finite depth

Class Grading:
Weekly assignments 30%
Two midterms 20% each
Final project 30%

Disability Accommodations: Students needing academic accommodations for a disability must first be registered with Disability Accommodations & Success Strategies (DASS). Students may call 214-768-1470 or visit http://www.smu.edu/Provost/ALEC/DASS to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

Religious Observance: Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

Excused Absences for University Extracurricular Activities: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalogue)