

Physics 3340/6361 - "Computational Physics" - Fall 2019 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

Topic 1: 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

Plotting two and three dimensional data files with gnuplot

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

Physics problems selected from: Response of damped harmonic oscillators, electrostatic or gravitational potential with multiple sources

Topic 2: Visualization of Numerical Data

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

Topic 3: Finding Roots of Functions

Text: 3.1, 3.2 (except systems), 3.3

Algorithms: Newton, Regula Falsi, Secant, Bisection

Physics problems selected from: Kepler's equation; nonlinear electronic DC circuits; catenary structures; Lagrangian orbital points

Topic 4: 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 selected from: Resistive DC networks; spring-mass coupled oscillatory systems with multiple modes; static structures

Topic 5: Solution of Systems of Nonlinear Equations

Text: Portion of 3.2

Algorithms: Newton-Raphson

C programming: Structures

Physics problems selected from: 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

Topic 6: 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 selected from: Radioactive decay; integration of irregular surfaces; random walk; neutron shielding; Gauss' law; Sherwood's forest and cosmology

Topic 7: 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 selected from: Electrostatic potential above a disc of charge; optical spectrum of prisms
C programming: Reading of data files

Topic 8: Numerical integration

Text: 5.1, 5.2, 6.1

Algorithms: Trapezoidal, Simpson

Physics problems selected from: Orbits and elliptical integrals; rotational inertia; center of mass; rocket thrust; Maxwell-Boltzmann distribution; Biot-Savart law; Plotting of magnetic field lines

Topic 9a: Solution of Ordinary Differential Equations in Initial Value Problems

Text: 7.1, 7.2, 7.3 (6th 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 selected from: 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

Topic 9b: Solution of Ordinary Differential Equations in Boundary Value Problems

Text: 11.1, 11.2 (6th ed. 14.1, 14.2)

Algorithms: Relaxation, Shooting

Physics problems selected from: Eigenvalues of electron in single quantum well of finite depth

Homework Assignments:

Although our class meetings for Physics 3340 and 6361 are common, many of the weekly homework problems assigned to Physics 6361 students are more difficult than the problems assigned to Physics 3340 students. However, students in 3340 may optionally submit a 6361 problem instead of the corresponding 3340 problem for bonus credit.

Class Grading:

Weekly assignments 30%

Two midterms 20% each

Final project 25%

Class Attendance 5%

Disability Accommodations: Students needing academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit <http://www.smu.edu/Provost/SASP/> DASS to begin the process. Once approved and registered, students will submit a DASS Accommodation Letter to faculty through the electronic portal *DASS Link* and then communicate directly with each instructor to 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 (<https://www.smu.edu/StudentAffairs/Chaplain/ReligiousHolidays>).

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. (See 2019-2020 University Undergraduate Catalogue)