PHYS-4007/5007: Computational Physics
Course Computer Project
Instruction Packet

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1 Introduction.

Your Computer Class Project will involve writing or modifying a computer code dealing with **some aspect of physics** using any of one the following areas in computational physics: **matrix solution of a set of linear equations** (say with Gaussian elimination), **solution of a set of ordinary differential equations** (using either the 4th-order Runge-Kutta technique or the Adams method), **solution of a partial differential equation** (with the dependent variable being a function of at least two independent variables, *e.g.*, solution to Schrödinger's equation), or **fitting a set of data to a linear relation using the method of least squares**. Note that if you have some other type of calculation that you wish to perform for this project, ask me for approval before writing your proposal. Note that this proposal will be your second homework assignment — you will get a separate assignment sheet with the details of how this proposal should be structured.

You are free to use any of the following programming languages: IDL, Fortran, Python (either version 2.7 or 3), or C. You are also allowed to use C++ if you like, but note that I will not be able to help you if you have troubles getting your program to work. Also note that you are not allowed to use programming languages like Mathematica, Maple, or MatLab. You are allowed to use any math functions the programming language supplies (either internally or in a library). Note that I will supply Runge-Kutta and Adams method subroutines (written in Fortran 77) on the course web pages to solve systems of ordinary differential equations. Typically when doing such a computer research project, the amount of time needed to complete a given aspect of the project is: 50% for code development, 20% for debugging the code, 20% to analyze the results, and 10% to write the manuscript.

You will then analyze and present your results. The analysis should be done via software you write (in some sort of graphics software like IDL or MatLab). Besides writing an 8 to 10 page manuscript on the results of this work, you also will be required to write a proposal to do this work for the second homework assignment. In this proposal, you need to state what problem you are taking on, how you will approach the solution, the operating system and machine type you plan on using, the programming language you plan to use, and what questions you plan on answering with this project.

This Instruction Packet contains a list of seven suggested projects (see table below). You can access the write-ups for each of these project on the Course Project web page within the next few weeks. This web page can be accessed from the course homepage:

http://faculty.etsu.edu/lutter/courses/phys4007/index.htm.

Besides these write-ups, all other help and template files you may need can be accessed from this Course Project web page. You can do any of these suggested projects or propose to do one of your own.

Those of you taking this course for honors or graduate credit must carry out the additional material in the project descriptions, or propose to do a project that is at a graduate level (and I will decide what is graduate level). Also, your research paper will need to be 10 to 15 ages in length.

Topic	**Area of Physics**	**Suggested Method of Solution**
Data Fitting to Hubble's Law	Data Analysis	Linear Least Squares
Quasi-Static Solar Coronal Loop Models	Thermodynamics	Adams Method
Polytrope Models of Stellar Interiors	Thermodynamics	4th Order Runge-Kutta
Coupled Harmonic Oscillators	Mechanics	Gaussian Elimination
Trajectories with Air Friction	Mechanics	4th Order Runge-Kutta
Quantum Mechanical Harmonic Oscillator	Quantum	PDE Solution
Quantum Mechanical Scattering	Quantum	PDE Solution

Codes should be able output data into ASCII files which can be examined by your professor and used for your analysis. The best way to display the results of your code is through a graphical plots. You will need to do this both to the terminal (*i.e.*, screen) and to a hardcopy plot such as postscript (which you can then include in your final manuscript). Besides turning in the final report, you will also be required to turn in at least one of these output files and a listing of the code itself by emailing me these items [at lutter@etsu.edu]. When writing your final manuscripts, you must use the LaTeX markup language.

2 The Course Project Website.

This site can be accessed from the course home page (printed in the last section). I have made a list of files that you will be able to download off of this page. There are instruction documents saved in PDF files (*i.e.*, files ending with '.pdf'), which describe the various suggested projects listed in the previous table. There will be sample LaTeX files which you can use for reference when writing your manuscript. In addition to these '.tex' files, there will be a sample template LaTeX file that you can use when writing your proposal for this project (as described in the second homework assignment). I will have a sample of IDL files that you can modify and use in order to generate plots for your manuscript. Finally, I will supply a few subroutines written in Fortran 77 and procedures wirtten in IDL that you can use and modify if needed.