

**PHYS 511: Computational Modeling and Simulation - Fall 2016**  
**Assignment #2, due Friday November 4, before class**

Discretization of differential operators in 1D

1. Write a Fortran (or C) program that solves the classical harmonic oscillator equation

$$q''(t) + q(t) = 0, \quad q(0) = 1, \quad q'(0) = 0,$$

by discretizing this equation on a numerical grid. Use the following parameters in the calculation:  $h = 0.01$  (grid spacing),  $N = 800$  (number of grid points).

2. You will need to figure out what would be the most suitable LAPACK subroutine for solving the system of linear equations. You can use a general one that takes dense matrices (it might be slightly easier to use). However, if you want better numerical efficiency (in particular when the number of points is very large) you may think about using a different subroutine that takes advantage of the specific structure of the matrix.
3. Make your program output the results (two columns of data,  $t$  and  $q(t)$ ) in a file called `solution.dat`.
4. Use GNU PLOT to generate a plot of your numerical solution in png format and see if it looks as expected (you may compare to the exact solution)
5. Put the source file of your program, the data file with your numerical solution, and the plot in subdirectory `as02` in your google-drive directory that is shared with the instructor. Any comments/descriptions you want to add should be written in file `report.txt`.