

# 161/2S3, Homework Problem Set.

Due: 3<sup>rd</sup> March, 2006

Note this homework requires two programs be written and submitted.

p04.c should be submitted to directory 161:4 and p05.c should be submitted to directory 161:5 using the `submit-work` command on the Maths system.

## 4.0. Source: “p04.c”, Executable: “p04”

Given the following differential equation

$$\frac{d^2x}{dt^2}(t) + 2\beta\frac{dx}{dt}(t) + \omega^2x(t) = 0,$$

with the initial conditions  $x(0) = 1$  and  $dx/dt(t=0) = 0$ , write a C program which determines  $x(t)$ .

While writing the program you can assume the following values:

$\beta = 0.1$ ,  $\omega = 1.0$  and the step-size  $h = 0.1$ . Your program should solve the two coupled first-order differential equations, resulting from the above equation, using the Euler algorithm. The program should write the values of  $t$  and  $x(t)$  to a file called *Euler.dat*, for values of  $t$  such that  $0 \leq t \leq 30$ .

*Note:* You can plot the results contained in Euler.dat to see the behaviour with time of this harmonic oscillator. Changing the values of  $\beta$  and  $\omega$  in your program should change the behaviour of the system. You can compare your plots with those at

[http://www.maths.tcd.ie/~ryan/teaching/harm\\_osc.html](http://www.maths.tcd.ie/~ryan/teaching/harm_osc.html).

(Also linked off <http://www.maths.tcd.ie/~ryan/teaching/Programs.html> where you will find a *Runge-Kutta* version of this program.

## 5.0. Source: “p05.c”, Executable: “p05”

Write a program which integrates the function

$$f(x) = \sin(x)$$

from  $a$  to  $b$  using the trapezoidal rule. As well as prompting for  $a$  and  $b$ , the program should also prompt for the number of intervals  $n$  into which  $a$  and  $b$  should be divided for the numerical integration.

Have the program print both the exact and numerical answers, and the difference between the exact and numerical answer.

### Note:

To compile p05.c, which uses the function `sin(x)` you will need to type:

```
gcc -o p05.c p05 -lm
```

The `-lm` option with `gcc` links maths libraries in the C system files where `sin(x)` is defined.