GX754

OLLSCOIL NA hÉIREANN
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SUMMER EXAMINATIONS 2000

Unit CS313 - Computational Physics

Prof. R.M. Redfern
Dr. J. Woolsey
Dr. J. Martin
Dr. M. Byrne

Time allowed: ONE AND A HALF hours.	Answer TWO questions

CS313 - Computational Physics

Q.1 Distinguish between Continuous Time Differential Equations (CT DFLE's) and Discrete Time Difference Equations (DT DE's). Give a 2nd order example of each. Briefly outline the general process whereby the solution to a DFLE is estimated numerically by computer.

Give details of the parameters and use of the Mathcad DFLE solver, ***rkfixed***. Write the Mathcad statements necessary to compute the solution of the following DFLE for $0 \le t \le 10$ sec, when the input x(t) is a step function u(t). Use 25 steps in the solution, and assume that the system is in *Zero State* at $t = 0$. Take $\zeta = 0.4$ and $\omega_n = 1$.

$$\frac{d^2y}{dt^2} + 2\cdot\zeta\cdot\omega_n\frac{dy}{dt} + \omega_n{}^2\cdot y = \omega_n{}^2\cdot x$$

Show how *both* the step response *and* the impulse response can be extracted and plotted from the solution by ***rkfixed***. Identify the nature (name) of this DFLE, and make a rough sketch of the general nature of its impulse response function, when $0 < \zeta < 1$.

Q.2 Describe briefly, and in general terms, how *Monte Carlo* techniques are used for solving scientific and mathematical problems. Illustrate your answer by describing how the area (integral) under a function f(x) between fixed limits may be estimated by Monte Carlo methods. Take $f(x) = 1 + 3x^2$, evaluated between $x = 0$ and $x = 1$, as a specific example.

The mother nucleus, N, in a radioactive process decays, with a decay constant λ, to a stable daughter product, D. Give the details of a Mathcad worksheet and program block (i.e., the general nature of the statements and code required) to estimate and plot the number of mother and daughter atoms in the radioactive sample as a function of time, using Monte Carlo methods.

p.t.o.

Q.3 Answer TWO parts only from (a), (b) and (c).

(a) Give a short account of spatial filtering (Fourier Optics) in optical systems. Define the Point Spread Function (PSF) of a 2-d optical imaging system, and explain how it is possible to sharpen a blurred image, provided that the PSF which produced it is known. Sketch out the steps required in Mathcad to perform this de-blurring process.

(b) Describe the effect of using the *Val* function in Visual Basic. Explain why it is important to define the data type (i.e. string, integer, etc.) of a variable or constant. Explain what is meant by the *scope* of a variable, and distinguish between local and module level variables. Identify which of the following are *properties* and which are *controls*: Name, Label, Text Box, Caption.

(c) Write a Visual Basic application (and sketch the form, showing the controls you would use) to convert electron energies expressed in Joules (J) to energies expressed in electronvolts (eV), and vice versa. $1eV = 1.6 \times 10^{-19}$ J.