Ollscoil na hÉireann, Gaillimh GX 2015
National University of Ireland, Galway

Semester II Examinations, 2003/2004

Exam Code(s)	3BS1, 3BS9, 3EL1, 3EL2
Exam(s)	3rd Science
Module Code(s)	CS313
Module(s)	CS313: Computational Physics
Paper No.	
Repeat Paper	Special Paper
External Examiner(s)	Professor E. Kennedy
Internal Examiner(s)	Professor S. G. Jennings
	Dr. M. Byrne
	Dr. J. Martin

Instructions: Answer TWO questions.

Duration	1½ hrs
No. of Answer Books	1
Requirements:	
Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	
No. of Pages	3
Department(s)	Experimental Physics

CS313: Computational Physics

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

Q.1 Subroutines from two separate Visual Basic programs are shown below. In each case, state what number will appear in the Textbox txtResult, after running each program, if the number initially typed into the Textbox txtNumber is 10.

[5 marks]

```
Private Sub cmd_Calculate_Click ( )
Dim iFirst As Integer
Dim iSecond As Integer
Dim iThird As Integer
iSecond = Val (txtNumber.Text)
iThird =1
For iFirst = iSecond To 1 Step –1
iThird = iThird * iFirst
Next
txtResult.Text = FormatNumber (iThird)
End Sub
```

```
Private Sub cmd_Calculate_Click ( )
Dim sFirst As Single
Dim sSecond As Single
sFirst = 0
Do While sSecond < Val (txtNumber.Text)
sFirst =sFirst + 1
sSecond = 10 ^ sFirst
Loop
txtResult.Text = FormatNumber (sFirst)
End Sub
```

Identify which of the following are Properties and which are Controls in Visual Basic: *Listbox, Caption, Label, Font.*

[2 marks]

Write a Visual Basic application (and sketch the form, showing the controls that you would use) to convert the activity of a radioactive source, expressed in Curies (Ci) to activity expressed in Becquerels (Bq), and vice versa. 1 Ci = 3.7×10^{10} Bq.

[3 marks]

Q.2 Define what is meant by the *Discretisation* of CT (Continuous Time) differential equations to DT (DT) difference equations. State the basic definitions for both the *Forward* and *Backward Euler* discretisation methods.

[3 marks]

Assume a sampling interval = T. Use the Forward Euler discretisation on the 1st order CT differential equation given below to derive the corresponding DT difference equation. Define the term *ZIR*, and write down the equation for the ZIR for this DT system.

$$\frac{dy}{dt} + 5y(t) = x(t)$$

[3 marks]

(i) Put T = 0.1 s and calculate the numerical values of the first three terms in the impulse response of the resulting DT system.
(ii) Calculate the critical value for T for which this DT system becomes unstable.
(iii) Prove that a Backward Euler discretisation on the original CT equation can never become unstable.

[4 marks]

Q.3 Answer any TWO of the following. ***[5 marks for each section]***

(a) The Logistic Equation has the form:

$$X[N+1] = 4 \cdot R \cdot X[N] \cdot (1 - X[N])$$

Explain what is meant by each of the terms in the equation, and briefly describe the context in which the equation is most commonly used. Sketch the variations in X[N] with N that you would expect for R = 0.2, R = 0.3, R = 0.8, R = 0.99 Comment on the sketched result in each case.

(b) (i) In Visual Basic programming, under what circumstances would you use a "For…Next" loop and a "Do… Until/While" loop? If one of the two loops shown below is used in a Visual Basic program, the words "Good Morning" appears in a Message Box at run time. Identify the loop that has this effect, and explain why the other loop does not.

```
;Loop 1                    ;Loop 2
 miTotal = 0                miTotal =0
 Do Until miTotal = 0       Do
 MsgBox "Good Morning"      MsgBox "Good Morning"
 Loop                       Loop Until miTotal = 0
```

[2 marks]

(ii) In the context of Visual Basic programming, explain what is meant by the term OLE. *[1 mark]*

(iii) If the variable msVelocity holds the value 15.92, write down the results of:

Round (msVelocity, 1)
FormatNumber (msVelocity) *[2 marks]*

(c) Give a full account of the parameters required in the use of the Mathcad function *rkfixed(...)*. Illustrate your answer by sketching out the main statements necessary in a Mathcad worksheet to find the (approximate numerical) solution to the following differential equation using *rkfixed*.

$$\frac{d^4y}{dt^4} + 2\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 4y = 5 \cdot \exp(-t)$$

(d) State, and briefly explain the significance of, the *Sampling Theorem*. Discuss the use and limitations of the *FFT* (Fast Fourier Transform) in estimating the frequency spectrum of (i) a non-periodic CT (Continuous Time) signal, and (ii) a periodic CT signal.