GX647

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway

Michaelmas Examinations, 2000/2001

First University Examination in Engineering

Mechanical, Biomedical & Undenominated

ENGINEERING COMPUTING I (FORTRAN)

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Attempt *Three* Questions
Time Allowed : 2 Hours

A list of Fortran 90 intrinsic procedures is attached.

1. (a) Briefly explain logical variables, logical operators and logical expressions. Use Fortran 90 statements to illustrate your answers. (5points)

   (b) Draw a flowchart and write a Fortran 90 programme to read in three numbers a, b and c, assumed to be the coefficients of the quadratic

   $$ax^2 + bx + c = 0$$

   Use the exact, analytic formula for the roots of a quadratic (*i.e.* NOT a numerical root-finding technique) to calculate the roots. Your programme should output the results and account for the three possibilities:
   (i) two different real roots
   (ii) one (double) root
   (iii) a pair of complex conjugate roots. (15 points)

2. (a) Explain the trapezoidal method and Simpson's method for estimating an integral, and derive the corresponding formulae. (5 points)

   (b) Draw a flowchart and write a Fortran 90 programme to compute the following integral

   $$\int_a^b \frac{\sqrt{y \sin y}}{y+e^y}\, dy$$

   using the trapezoidal rule (*i.e.* approximating the function by linearly varying small steps). Read in a, b and n, the number of subdivisions of the range a to b and output the value of the integral for the range 0 to $\pi/2$ using 10 and 100 subdivisions respectively. (15 points)

3. Draw a flowchart and write a Fortran 90 programme which reads in n REAL numbers (which we will call $x_1, x_2, x_3, ..., x_n$) and calculates and outputs the following statistics:

   (i) Their sum, *i.e.* $\sum_i^n x_i$, which we will call SUM
   (ii) The sum of their squares, *i.e.* $\sum_i^n x_i^2$, which we will call SUMSQ
   (iii) Their arithmetic mean, *i.e.* SUM/n
   (iv) Their standard deviation, *i.e.*

$$\sqrt{\frac{SUMSQ-(SUM^2/n)}{n-1}}$$

   (v) The largest and smallest numbers.
   (vi) The range, *i.e.* the difference between the largest and smallest numbers. (20 points)

4. (a) Briefly explain what a recurrence relation is. Use Fortran 90 statements to illustrate. (5points)

   (b) The cosine of an angle x, in radians, is the result of the summation of the infinite series:

$$1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}+\frac{x^8}{8!}+....$$

   Draw a flowchart and write a Fortran 90 programme to read in a number of angles, and for each of them to sum the first 50 terms of the series, printing out the intermediate sum after every 5 terms. At the end, compare your summations with the intrinsic procedure value COS(X). (15 points)

5. (a) Describe the possible uses of the MODULE facility in Fortran 90. Use sketches and code samples, as appropriate, to illustrate your answers. (5 points)

   (b) Derive the formulae for approximating the roots of $f(x) = 0$ by the method of (i) false position and (ii) Newton-Raphson. (5 points)

   (c) Draw a flowchart and write a Fortran 90 programme to evaluate a root of the following equation, accurate to six decimal places, using the false position method:

$$3.5x^3 = \pi(2.7e^x - 0.9\sqrt{x}\,e^{-x})$$

   Hint: Employ a FUNCTION subprogram for the task of evaluating the equation. (10 points)