Computer Science Department

Dummy Cover Sheet

B.A./B.Eng. B.Sc. B.Sc (Econ)

B400 Introductory Programming

2 hours 30 minutes

*Part A of this paper is **compulsory**. You should attempt **all of question 1** in part A and any **THREE** questions from part B. All questions carry equal credit.*

*The use of electronic calculators is **not** permitted.*

Part A

Compulsory question

Question 1

(a) Describe what is meant by a stored-program computer and explain why such machines are usually programmed in a high-level language for carrying out scientific or engineering calculations.

[8 marks]

(b) Describe briefly the processes whereby such a program written in high-level language is converted into a form that enables the computer to carry out the desired calculation, explaining how these processes enable programs and modules to be reused.

[6 marks]

(c) Draw a simple diagram to illustrate the structure of an idealised stored-program computer. Explain what each of the items you have labelled does.

[6 marks]

(d) Describe what is meant by a *variable* in a high-level language such as FORTRAN 77 and explain in detail what happens

(i) in the machine, and

(ii) from a user's point of view,

when the following fragment of FORTRAN 77 code is executed:

```
Z = X
X = Y
Y = Z
```

[5 marks]

[TURN OVER]

Part B *Attempt THREE questions from this section.*
When writing code, remember to include comments and note that more importance will be attached to the approach adopted than to detailed correctness of the syntax.

Question 2

(a) Explain what is meant by an INTEGER variable in FORTRAN 77 and decribe how it differs from a REAL variable. If N and M are integer variables and X and Y are REAL, describe what happens when the following statements are executed:

(i) X=N+M

(ii) Y=N*Y

(iii) N=N/M

[10 marks]

(b) Use the properties of integer division as in (iii) above to write a program fragment that would determine whether natural number N is prime and print an appropriate message on the screen.

[7 marks]

(c) A natural number is said to be perfect if the sum of all its factors, including one, but excluding the number itself, is equal to the number. Thus, for example, 6 with factors 1+2+3=6 and 28 with 1+2+4+7+14 = 28 are both perfect. By modifying the code you wrote in (b) above or otherwise, write a program fragment to find and print out all the perfect numbers less than 10000.

[8 marks]

[CONTINUED]

Question 3

(a) Describe how a DO-loop is constructed and explain how it works, paying particular attention to how a DO-loop is entered, how it may be left, and the meaning of the "trip count".

[10 marks]

(b) Write a short program to calculate the sum of the diagonal elements A(1,1)+A(2,2)+ ... A(N,N) of an N x N matrix A(N,N) and the sum of the squares of all its elements, and to print out the results.

[8 marks]

(c) A particular *banded* matrix B(I,J) is such that B(I,J)=B(|I-J|). Show how to modify your code in order to take advantage of the banded structure of B.

[7 marks]

You may assume that the subroutines AINPUT(X) and BINPUT(Y) when called will input values of a general matrix and of a banded matrix respectively. Note that the values of the elements of the banded matrix B depend solely on |I-J| where |.| indicates the modulus or absolute value of the enclosed expression. The elements of B are thus the same on each diagonal from top left to bottom right.

Question 4

(a) Describe what is meant by a generic function and describe how generic functions are used in FORTRAN 77. Explain what the generic functions MIN and MAX do, illustrating your answer by taking as example inputs: 2,22,13,7 and 6.0,5.6,5.3,5.7,5.9,5.8.

[10 marks]

(b) Describe how a generic function differs from a statement function and from a function subprogram.

[7marks]

[Question 4 cont. over page]

[TURN OVER]

[Question 4 cont.]

(c) In an ice skating competition, competitors are awarded marks in the range 0 to 6 in increments of 0.1 by each member of a panel of J judges. The highest and lowest marks are ignored and the remaining marks averaged to give the competitor's final score. If two or more judges award the same highest mark, one of the marks is discarded. The lowest mark is treated similarly.

Write a suitable function subprogram to calculate the final score for each competitor in the competition, given that their marks are read in turn into an array A(J).

[8 marks]

Question 5

(a) Describe the different types of variable that may be used in FORTRAN 77.

[8 marks]

(b) Explain what is meant by a FORMAT statement in FORTRAN 77 and describe how it may be used to control the input and output of data that includes both numbers and text.

[10 marks]

(c) Describe how you would read the data from the standard input to initialise the elements of an 8 x 6 array whose values are known to lie in the range -100 to +100 and to be given as decimal numbers to an accuracy of 3 decimal places. Illustrate your answer with suitable code fragments.

Describe what modifications you would require:

(i) to print the array on the standard output immediately after input for checking

(ii) to print the array on the standard output after it has been processed and the values of its elements can no longer be guaranteed to lie within known bounds.

In both cases, your output should be clearly labelled for future use. Also, indicate, in both cases, what you would expect your output to look like.

[7 marks]

[CONTINUED]

Question 6

(a) Describe how a logical variable may be used to control the execution of a program and explain how such variables may be combined using logical operators.

[10 marks]

(b) Illustrate the use of logical variables to classify characters from the Jungle Book story in which Bageera, Baloo and Sher-Kahn all growl and have claws, but only Sher-Kahn also has stripes. Of the animals, only Balloo eats honey, and only Bageera climbs trees. Mowgli, however, eats honey and climbs trees, but doesn't have claws and doesn't growl.

Define a set of logical variables to describe these attributes. Draw up a table showing the attributes of each character and use it to write down a set of rules implemented as a block-IF structure in FORTRAN 77 that will enable you to identify each character and assign a character variable NAME correctly.

[8 marks]

(c) Decribe how De Morgan's rules may be used to evaluate the converse of combinations of logical variables or expressions in an alternative way and explain why such manipulations may be advantageous.

[7 marks]

[End of paper]