

Issue date: Tuesday 28th October 2008

Deadline: Monday 3rd November 2008 (***10 am***)

Your report should include typed answers to the questions in Part 1 and program listings in Parts 2 and 3. **Program listings should be in a non-proportional font (e.g. Courier).**

Before doing any of the formal tasks it is vital that you first familiarise yourself with both the Fortran language and its implementation in the computer clusters at the University. Using either the command window or the integrated development environment, type in some of the sample programs from the notes. Compile, link and run each program. Explore the effect of small changes and the response of the compiler to deliberate errors.

Part 1 (15 marks)

Answer the following questions. (If you have any doubt about the answer, write a short Fortran program to find out. *It is not necessary to include such programs in your report.*)

- (1) Which of the following are valid (if unlikely) Fortran variable names? If not valid then explain why not.

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- (2) What are the results of the following numerical expressions in Fortran? State whether each result is of type integer or real and, if real, give the result to 2 decimal places. *Be very careful with integer division and conversion of type.*

19 / 5 - 1.8

17 / 4.0 - 6.25

56 - 5 * (56 / 5)

28 / (14 / 4)

16.0 ** (1 / 4) - 16 ** (1.0 / 4.0)

- (3) Variables I and R have been declared with INTEGER and REAL types respectively. What are the values of these variables after the following Fortran statements?

I = 3.5 * 18.0 / 5.0

R = -2 * (15 / 4)

- (4) A, B and C have been declared as logical variables. What values do they each have (.TRUE. or .FALSE.) *at the end* of the following sequence of statements?

A = "Chelsea" > "Manchester United"

B = A .OR. (16 / 3) > 5

A = A .OR. B

C = .NOT. A

A = B .OR. C

- (5) Why will the following executable line:

```
PRINT *, SQRT( -2.0 )
```

give a compiler error, but the one below compile and run correctly?

```
PRINT *, SQRT( (-2.0, 0.0) )
```

What is the output in the latter case?

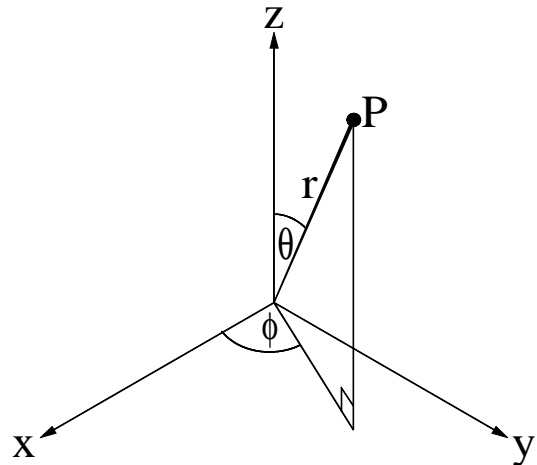
Part 2 (10 marks)

Write a short program to convert Cartesian coordinates (x, y, z) to spherical polar coordinates (r, θ, ϕ) using

$$r = \sqrt{x^2 + y^2 + z^2} ,$$

$$\theta = \cos^{-1}\left(\frac{z}{r}\right)$$

$$\phi = \tan^{-1}\left(\frac{y}{x}\right)$$



Note that:

- Both θ and ϕ should be output in *degrees* with $0 \leq \theta \leq 180^\circ$ and $0 \leq \phi < 360^\circ$.
- You may need to look at Appendix A4 of your notes to deal with \tan^{-1} correctly.

The value of θ is indeterminate at the origin, whilst ϕ is indeterminate if the point is on the z axis. For the purpose of this exercise you may ignore these problems.

Include in your report a full program listing and the output for the following (x, y, z) coordinates:

- (3.0, 4.5, -1.0)
- (-5.2, 2.5, 1.4)
- (-1.0, -1.0, 0.0)
- (0.0, 3.0, 3.0)

Part 3 (15 marks)

Write a Fortran program that will output the quantity of flow in an open channel of rectangular cross-section, given the depth of water in the channel. Assume normal flow and use Manning's equation as the basis of the flow calculation.

You should decide what the inputs and outputs are and the relevant sequence of flow calculations.

Include in your report a full program listing and the output for a trial set of data (which you can choose for yourself).