Programming for Scientists and Engineers
CSC 117

Summer 2002

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Project 5 — Due: Thursday, August 1, 2002

Total points : 40

Please email the program to the grader by midnight on the due date. You can use the command:

mail liuq@egr.unlv.edu -s "Project 5" < proj5.f90

where 'proj5.f90' is the name of the file you want to send.

Consider a cylindrical reservoir with a radius of 30.0 feet and a height of 30.0 feet that is filled and emptied by a 12-inch diameter pipe. The pipe has a 1000.0-foot-long run and discharges at an elevation 20.0 feet lower than the bottom of the reservoir. The pipe has been tested and has a roughness factor of 0.013.

Several formulas have been developed experimentally to determine the velocity at which fluids flow through such pipes. One of these, the *Manning formula*, is

$$V = \frac{1.486}{N} * R^{2/3} * S^{1/2}$$

where
- V = velocity in feet per second
- N = roughness coefficient
- R = hydraulic radius
- S = slope of the energy gradient (= $\frac{d+20}{1000}$ for this problem)

Following are some other formulas you may need to solve this problem:
- Cross-sectional area of the pipe = $\pi * pipe's\ radius^2$
- Volume of the cylinder = cross-sectional area of the cylinder $*$ the height of the cylinder
- Rate of fluid flow = Cross-sectional area of the pipe $*$ velocity

Write a program to compute the time required to empty the reservoir. Do this by assuming a constant flow rate for 5-minute segments. Ask the user to input the reservoir's height and radius, roughness coefficient, hydraulic radius, and pipe radius from the keyboard. Also Assume that initially the cylindrical reservoir is full of water. Use formatted output to print the result to the screen(Use descriptor `F` for real numbers). Your output must look like the sample output shown below.

Sample Output:

```
 Enter radius and height of reservoir:
10.0 40.0
 Enter roughness coefficient, hydraulic radius, and  pipe radius:
0.013 0.125 0.5

      Volume                 Depth          Time
 ================       ===============     ====
      12566.3594               40.0000         0
      10917.0508               34.7501         5
       9341.5508               29.7351        10
       7839.9390               24.9553        15
       6412.3057               20.4110        20
       5058.7500               16.1025        25
       3779.3838               12.0302        30
       2574.3320                8.1944        35
       1443.7363                4.5956        40
        387.7592                1.2343        45
       -593.4124               -1.8889        50
```