GX659

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway

Trinity Examinations 1998/99

Second Year Mechanical and Biomedical Engineering Examination

INTRODUCTION TO FLUID MECHANICS

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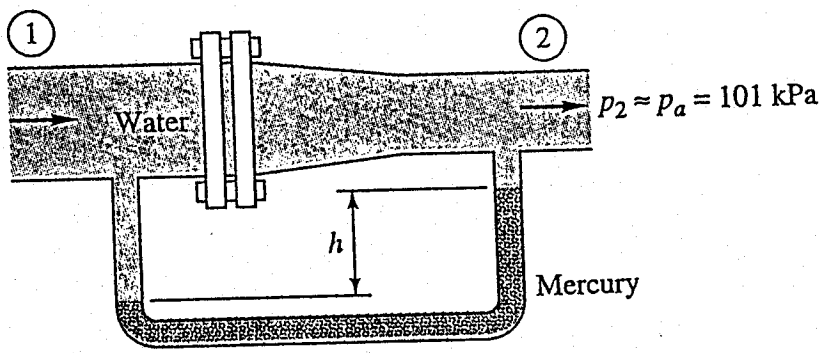
Attempt *Three* Questions
Time Allowed : 2 Hours

For every question attempted, produce at least one sketch or diagram which is clearly and accurately labelled with symbols and appropriate dimensions. State the assumptions your analyses are based upon.

Physical Properties Tables are attached.

1. For the pipe-flow reducing section of ***Figure 1***, diameters $D_1 = 80\text{mm}$, $D_2 = 50\text{mm}$, and $p_2 = 1$ atm. All fluids are at 20° C. If $V_1 = 5\ \text{ms}^{-1}$ and the manometer reading $h = 58$ cm, estimate the total horizontal force resisted by the flange bolts. (20 points)

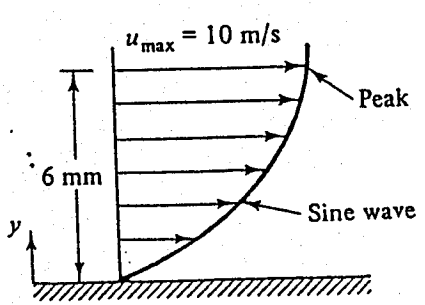
Figure 1



2. (a) Explain the influence of viscosity on fluid-mechanical behaviour, and show how its effects are related to the velocity distribution. Why is viscosity referred to as a transport property ? (8 points)

(b) Air at 20° C forms a boundary layer of sine-wave shaped velocity profile near a solid wall, as shown in ***Figure 2.*** For the given 6 mm thickness and peak velocity, compute the shear stress in the fluid at y equal to (a) 0 ; (b) 3 mm ; (c) 6 mm. (12 points)

Figure 2



3. (a) The 2-m-diameter cylinder in ***Figure 3a*** is 4 m long into the paper and rests in static equilibrium against the smooth wall at point B. Compute (a) the weight and (b) the specific gravity of the cylinder. Assume zero wall friction at point B. (10 points)

(b) The fuel gauge for a car petrol tank reads proportional to the bottom pressure gauge as in ***Figure 3b***. If the tank accidentally contains 2 cm of water plus petrol, how many centimetres "h" of air remain when the gauge reads "full" in error ? (10 points)

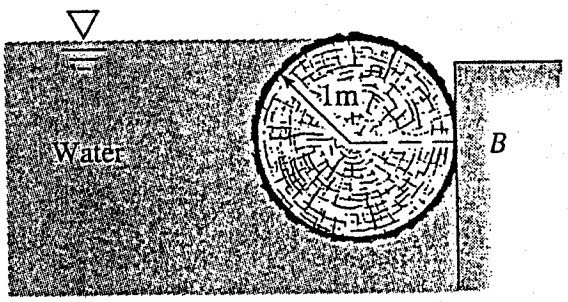


Figure 3a

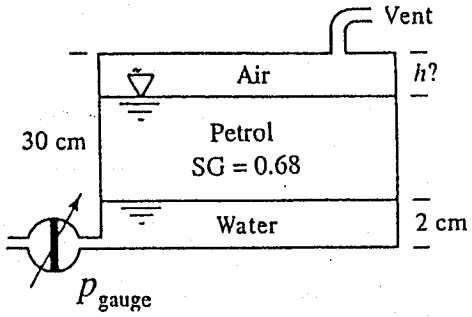
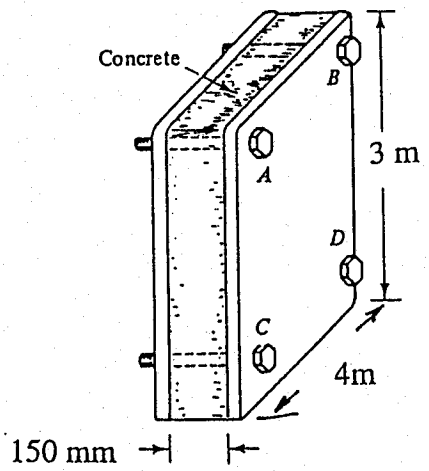


Figure 3b

4. When freshly poured between wooden forms or moulds, concrete appproximates a liquid with SG = 2.40. ***Figure 4*** shows concrete between two forms which are held together by four corner bolts A, B, C, D. Neglect end effects and calculate the force in each bolt. (20 points)

Figure 4



5. A wind tunnel draws in sea-level standard air from the surrounding room and accelerates it into a test section of 1-m by 1-m cross-section. The test section contains a model car as shown in ***Figure 5***. A pressure transducer at the test section wall measures $\Delta p = 45$ mm of water between the inside and outside. Estimate (a) the test section velocity in metre/sec, and (b) the maximum absolute pressure on the nose of the model. (20 points)

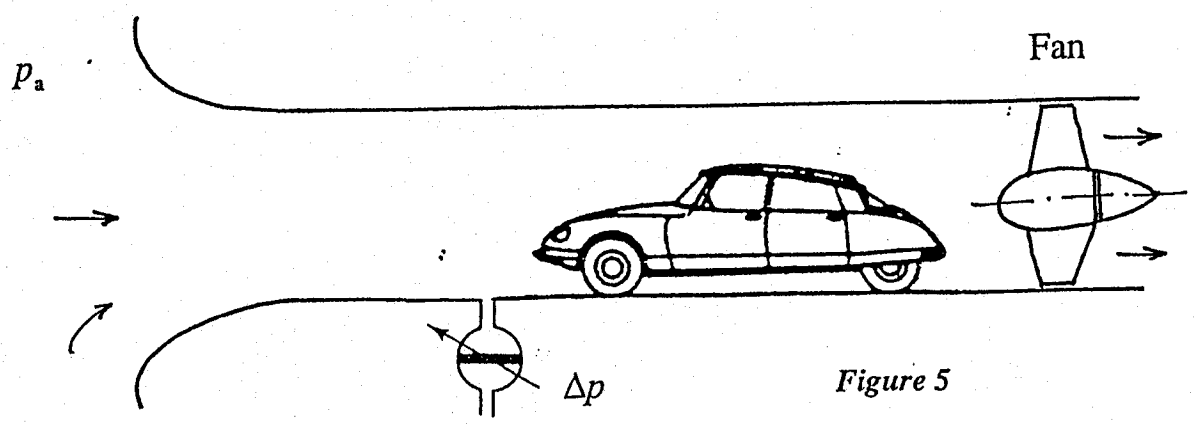


Figure 5