Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX 313

Semester II Examinations, 2002/2003

Exam Code(s)	2BM121, 2BG121
Exam(s)	2nd Year Engineering (Mechanical, Biomedical)
Module Code(s)	ME207
Module(s)	Introduction to Fluid Mechanics
Paper No.	-
Repeat Paper	- Special Paper -
External Examiner(s)	Professor P.J. Mallon
Internal Examiner(s)	Professor J.F. McNamara Dr. J.A. Eaton

Instructions:

- Answer 3 questions.
- All questions will be marked equally.
- For every question attempted, produce at least one sketch or diagram that is clearly and accurately labelled with symbols and appropriate dimensions. State the assumptions your analyses are based upon.
- Attached are the following information:
  — Equations Sheet
  — Physical Properties Tables
  — Standard Atmosphere Properties Table

Duration	2 hrs
No. of Answer books	-

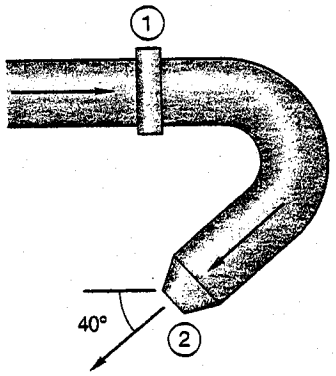
Requirements:

Handout	-
MCQ	-
Statistical Tables	Yes Log Tables
Graph Paper	-
Log Graph Paper	-
Other Material	-

No. of Pages	6
Department(s)	

1. Water at 20° C flows through the elbow in ***Figure 1*** and exits to the atmosphere. The pipe diameter $D_1 = 10$ cm, and $D_2 = 3$ cm. At a weight flow rate of 150 N/s, the pressure $p_1 = 2.3$ atm. (gauge). Neglecting the weight of water and of the elbow, estimate the horizontal force resisted on the flange bolts at Section 1. (20 points)

Figure 1



2. (a) Describe the phenomenon of cavitation. (3 points)

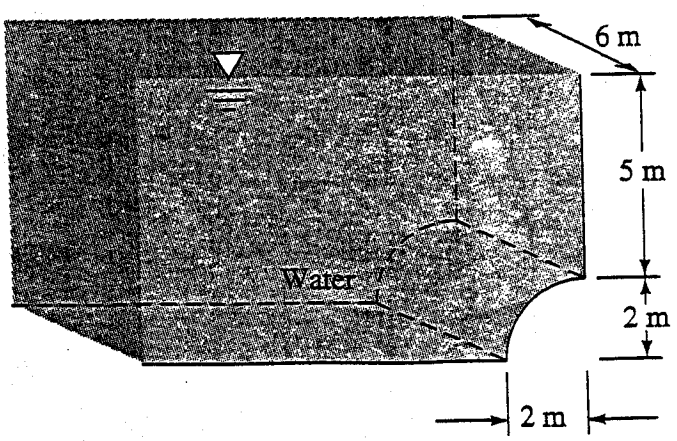
(b) A small submersible moves at velocity V in 20° C water at 2-m depth. Its critical cavitation number is $Ca = 0.25$. The free surface pressure is standard atmospheric. At what velocity will cavitation bubbles form ? Will the body cavitate if $V = 30$ m/s and the water is cold (5° C) ? *Note* : the cavitation number is defined as :

$$Ca = 2(p - p_v)/\rho V^2$$ (7 points)

(c) Due to surface tension, a solid cylindrical needle of diameter d, length L, and density ρ_n may "float" on a liquid surface. Neglect buoyancy and assume a contact angle of 0°. Calculate the maximum diameter d_{max} of needle able to float on the surface. Calculate d_{max} for a steel needle (SG = 7.84) in water at 20° C. (10 points)

3. Compute the horizontal and vertical components of the hydrostatic force on the quarter-circle panel at the bottom of the water tank in ***Figure 3***. (20 points)

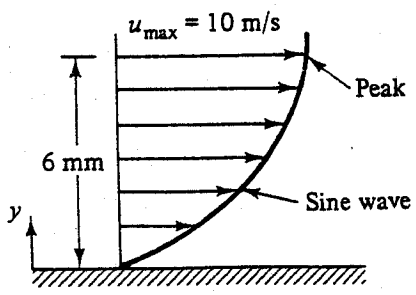
Figure 3



4. (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 p oints)

(b) Air at 20° C forms a boundary layer of sine-wave shaped velocity profile near a solid wall, as shown in ***Figure 4.*** 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 4



5. (a) The 2-m-diameter cylinder in ***Figure 5a*** 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 5b***. 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)

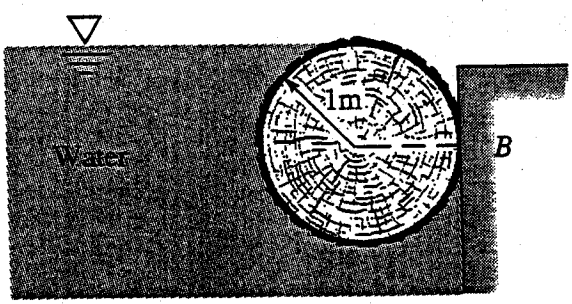


Figure 5a

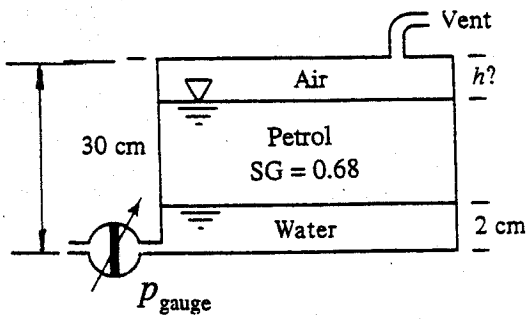


Figure 5b