Menoufiya University
Faculty of Engineering
Shebin El-Kom
Final Examination
Academic Year: 2014-2015

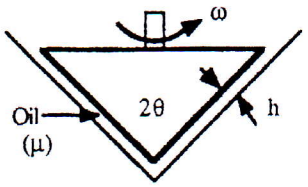
Year: First year
Department: Mechanical Power
Subject: *Fluid Mechanics (I) MPE121*
Time Allowed: 180 minutes
Date: 24.05.2015

Allowed Tables and Charts: *(None)*

Answer all the following questions (*Two Pages*) **[100 Marks for all]**

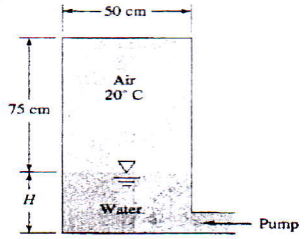
Question (1) ***(20 Marks)***

(a) A solid cone of base r_o and initial angular velocity ω_o is rotating inside a conical seat. Neglect air drag and derive a formula for the cone's angular velocity $\omega(t)$ if the applied torque is removed. **(8 Marks)**
(Hint: Angular momentum relation: $M = -\frac{3}{10} m r_o^2 \frac{d\omega}{dt}$, m= cone mass)



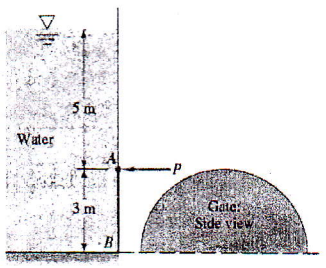
(b) Develop an expression for the rise of a liquid due to surface tension in:
(I) Tube **(2 Marks)**
(II) Two concentric tubes (the inner is solid). **(2 Marks)**

(c) A pump developing an exit pressure of 175 kPa is used to fill the cylindrical tank as shown in the Figure with 20°C water. At the instant shown, the air pressure is 110 kPa and H=35 cm. The pump stops when it can no longer raise the water pressure. Estimate "H" at that time. **(8 Marks)**



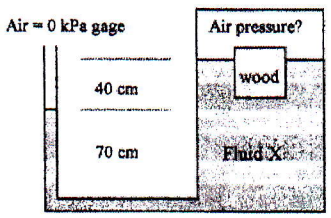
Question (2) ***(20 Marks)***

(a) Gate AB in the Figure is semicircular, hinged at B and held by a horizontal focre P at point A. Determine the required force P for equilibrium. **(6 Marks)**



(b) For stable floating bodies derive an expression for the metacentric height. **(8 Marks)**

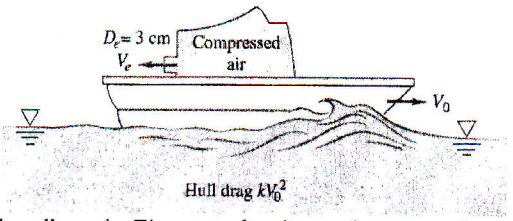
(c) A block of wood (Specific gravity=0.6) floats in fluid X as shown in Figure such that 75% of its volume is submerged in fluid X. Estimate the gage pressure of the air in the tank. **(6 Marks)**



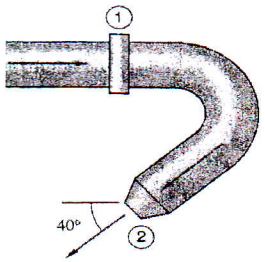
Question (3) ***(20 Marks)***

(a) Derive the general continuity equation. How do you reduce it to incompressible flow case? **(6 Marks)**

(b) The small boat is driven at steady speed V_o by compressed air issuing from 3-cm diameter hole at V_e=343 m/s and P_e=1 atm, T_e=30°C. Neglect air drag. The hull drag is kV_o^2, where k=19 N.s^2/m^2. Estimate the boat speed V_o. **(7 Marks)**



(c) Water at 20°C flows through the elbow in Figure and exits to the atmosphere. The pipe diameter is D_1=10 cm, while D_2=3 cm. At a weight flow rate of 150 N/s, the pressure P_1=2.3 atm (gage). Neglecting the weight of water and elblow, estimate the force on the flange bolts at section 1. **(7 Marks)**

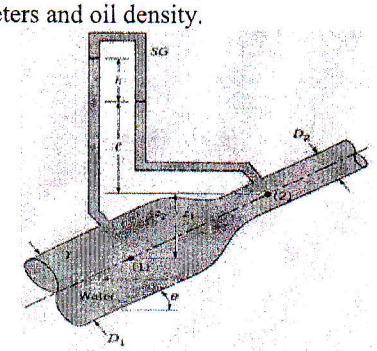


Question (4) ***(20 Marks)***

(a) Derive an expression for the discharge of water using a venture-meter in an inclined pipeline. ***(6 Marks)***

(b) From the first principles derive Euler's equation for an incompressible flow. **(6 Marks)**

(c)Water flows through a pipe reducer as shown in the Figure. The static pressures at (1) and (2) are measured by inverted U-tube manometer containing oil of specific gravity less than one. Determine the manometer reading as a function of the other geometrical parameters and oil density. **(8 Marks)**



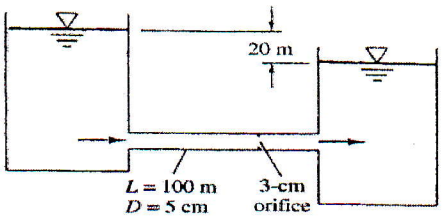
Question (5) ***(20 Marks)***

(a) Derive the equation of Darcy-Weisbach and indicate the considered assumptions. **(8 Marks)**

(b) A pipe connecting two reservoirs (20 m level difference) as shown in Figure, contains a 3 cm this-plate orifice (K_{loss}=1.5 and C_d=0.609). For water flow (ρ=998 kg/m^3 and μ=0.001 kg/m.s), estimate:

(I) the volume flow rate through the pipe and **(8 Marks)**

(II) the pressure drop across the orifice plate. ***(4 Marks)***



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Question	1	2	3	4	5	Work &oral exam. through a semester
ILOs	A8, A13,	B1, B2, C16	A8, B3 , C18	A8, B1, C1	A13, B1, B2, B3, C1	A8, A13, B1, B2, B3, C1, C16,D9

Best Wishes

Professor Dr. Eng. Wageeh A. El-Askary