UNIVERSITY OF JOHANNESBURG

PROGRAM	: BENGTECH ENGINEERING: MECHANICAL
SUBJECT	: FLUID MECHANICS II
CODE	: FLMMIA2
DATE	: JUNE MAIN EXAMINATION 29 May 2018
DURATION	: (SESSION 1) 08:30 – 11:30 AM
WEIGHT	: 60% OF FINAL MARK
TOTAL MARKS	: 101 MARKS 100 MARKS = 100%

Examiner	: MR VT. HASHE
Moderator	: MR S. SIMELANE

INSTRUCTIONS:

1. PLEASE ANSWER ALL QUESTIONS NEATLY
2. SHOW ALL CALCULATIONS
3. ANSWERS WITHOUT UNITS WILL BE PENALIZED
4. NUMBER YOUR ANSWERS STRICTLY ACCORDING TO THE QUESTIONS
5. **DRAW DIADRAMS**

NUMBER OF PAGES : **5 including cover page and 2 pages annexure**

QUESTION 1

1.1 Define the following terms in your own words:

a) Density (2)

b) Specific volume (2)

c) Specific gravity (2)

d) Dynamic viscosity (2)

e) Cavitation (2)

1.2 State Newton's Law of viscosity with expression and units (4)

1.3 Two square plates with each side 60 cm are spaced 12.5 mm apart. The lower plate is stationary and the upper plate requires a force of 100 N to keep it moving with a velocity of 2.5 m/s. The oil film between the plates has the same velocity as that of the plates at the surface of contact. Assuming a linear velocity distribution, compute:

a) the dynamic viscosity of oil in poise, and (5)

b) the kinematic viscosity of oil in stokes if the specific gravity (SG) of oil is 0.95 (3)

1.4 Define surface tension and prove that the relationship between surface tension and pressure inside a liquid droplet in excess of outside pressure is given by $p = \frac{4\sigma}{d}$ (7)

1.5 Design an experiment for fluid elevation using a capillary tube. The following details are known:
Surface tension of water, δ ranges between 72.75 – 72.76 x10 $^{-3}$ N/m at T = 20 °C
The tube diameter, d is not to exceed 4 mm (7)

[36]

QUESTION 2

2.1 The cylindrical fuel tank of a motor car, 20 cm in diameter and with its axis horizontal is filled with petrol of mass density 800 kg/m^3. A 35 mm diameter filler pipe rises from the top of the tank to a height of 50 cm.
Determine: the force on one end of the fuel tank due to the average pressure intensity on end of the tank when the filler pipe is full with petrol (9)

2.2 A differential manometer is connected at two points A and B of two pipes as shown in figure 1. If water temperature in pipe A is 50°C, mercury and paraffin oil in pipe B are at a temperature of 20°C, determine the absolute differential pressure in pipe A and B. (17)

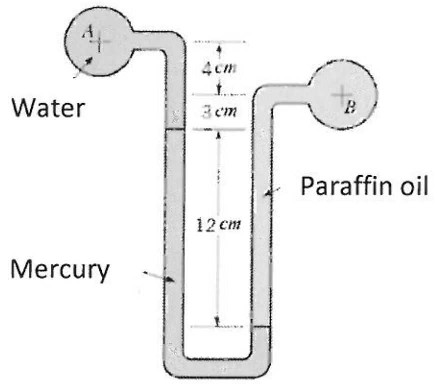

Figure 1

[26]

QUESTION 3

Figure 3 below shows an inclined rectangular sluice gate 4 m wide and 1 m depth installed to control the discharge of water. The upper end is hinged and lies at a distance of 2 m from the free surface of water. Neglecting the weight of the gate and the friction at the hinge, investigate the normal force (P in kN) to the gate applied at point B.

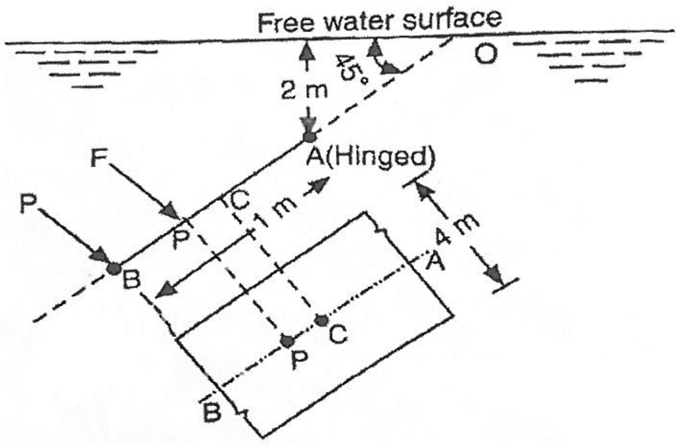

Figure 3

[13]

QUESTION 4

A pipe line is used to transfer sea water from the sea to a nearby desalination plant. The pipe gradually changes in diameter from 200 mm to 500 mm at a certain point along the pipeline. Assuming that the change in diameters in the pipeline is between point A and B and the pressure between the two points is given as 9.81 N/cm^2 and 5.886 N/cm^2 respectively, estimate the loss of head and the direction of flow. Take the discharge as 200 litres per minute if point B is 2 m higher than point A.

[10]

QUESTION 5

5.1 A fire hose has a conical nozzle at its end. In which direction the fireman will feel a force while holding the nozzle by the handle? (1)

5.2 A junior engineer is tasked to investigate what happens if a firehose diameter of 60 mm and hose ending nozzle of 20 mm is increased to the diameter of 80 mm and a nozzle of 25 mm. The supply water pressure is maintained at 700 kPa inside the pipe and investigations show that a fireman is currently experiencing a force of 1.6 kN. Do the necessary investigations and briefly report on your finding (16)

[16]

FORMULAS AND ADDITIONAL DATA

$P = F/A$

$\tau = \mu\ du/dy$

$h = 4\delta Cos\o/\rho gd$

$h = 4\delta/\rho gd$

$p = \rho gh$

$F = \rho gA\hbar$

$\hbar = (I_G Sin^2\o\ /A\hbar) + \hbar$

$P/\rho + v^2/2g + z = c$

$\dot{m} = \rho Av$

$F_x = \rho V(V_1 - V_2 Cos\ Ø) + P_1A_1 - P_2A_2 CosØ$

$F_y = \rho V(-V_2 Sin\ Ø) - P_2A_2 SinØ$

PHYSICAL PROPERTIES OF TAP WATER AT 1 ATMOSPHERE

Temperature T [°C]	Density ρ [kg.m^{-3}]	Dynamic viscosity μ [kg.m^{-1}s^{-1}]	Surface tension σ [N.m^{-1}]	Vapour pressure head $p/\rho g$ [m]	Bulk modulus of elasticity K [MN.m^{-2}]
0	999.9	1.792 x 10^{-3}	0.0762	0.06	2040
5	1000.0	1.519 x 10^{-3}	0.0754	0.09	2060
10	999.7	1.308 x 10^{-3}	0.0748	0.12	2110
15	999.1	1.14 x 10^{-3}	0.0741	0.17	2140
20	998.2	1.005 x 10^{-3}	0.0736	0.25	2200
25	997.1	0.894 x 10^{-3}	0.0726	0.33	2220
30	995.7	0.801 x 10^{-3}	0.0718	0.44	2230
35	994.1	0.723 x 10^{-3}	0.071	0.58	2240
40	992.2	0.656 x10^{-3}	0.0701	0.76	2270
45	990.2	0.599 x 10^{-3}	0.0692	0.98	2290
50	988.1	0.549 x 10^{-3}	0.0682	1.26	2300
60	983.2	0.469 x 10^{-3}	0.0668	2.03	2280
70	977.8	0.406 x 10^{-3}	0.065	3.2	2250
80	971.8	0.357 x 10^{-3}	0.063	4.86	2210
90	965.3	0.317 x 10^{-3}	0.0612	7.18	2160
100	958.4	0.284 x 10^{-3}	0.0594	10.33	2070

PHYSICAL PROPERTIES OF COMMON LIQUIDS AT 20°C AND 1 ATMOSPHERE

Liquid	Density ρ [kg.m^{-3}]	Dynamic viscosity μ [kg.m^{-1}s^{-1}]	Surface tension σ [N.m^{-1}]	Bulk modulus K [GN.m^{-2}]
Alcohol, ethyl	789	1.197 x10^{-3}	0.0223	1.32
Benzene	879	0.647 x 10^{-3}	0.0289	1.1
Carbon tetrachloride	1632	0.972 x 10^{-3}	0.0268	1.12
Glycerol	1262	620 x 10^{-3}	0.063	4.03
Mercury	13546	1.552 x 10^{-3}	0.472	26.2
Paraffin oil	800	1.900 x 10^{-3}	0.026	1.62
Water, sea	1025	1.120 x 10^{-3}	Assume same as for tap water	