First Semester Examination
2021/2022 Academic Session

February/March 2022

EAH221 – Fluid Mechanics for Civil Engineers

Duration : 3 hours

Please check that this examination paper consists of **TEN (10)** pages of printed material including appendix before you begin the examination.

Instructions : This paper contains **FIVE (5)** questions. Answer **ALL** questions.

All questions **MUST BE** answered on a new page.

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1. (a). An inverted differential manometer having a fluid of specific gravity of 0.75 is connected to two different pipes carrying water under pressure as shown in **Figure 1**. If h_1= 200 mm, h_2 = 50 mm, h = 125 mm and the pressure at Pipe A is 1.5 m of water, determine the pressure in Pipe B.

[5 marks]

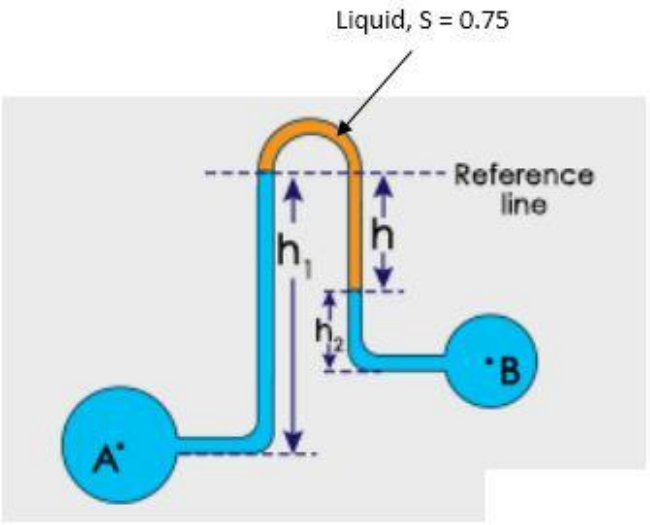

Figure 1

(b). The curved face of a dam retaining water of depth 20 m is shaped according to equation y= $\frac{x^2}{6}$ as shown in **Figure 2**. For a unit width of the dam, determine the magnitude and direction of the resultant water pressure acting on the curved surface of the dam.

[15 marks]

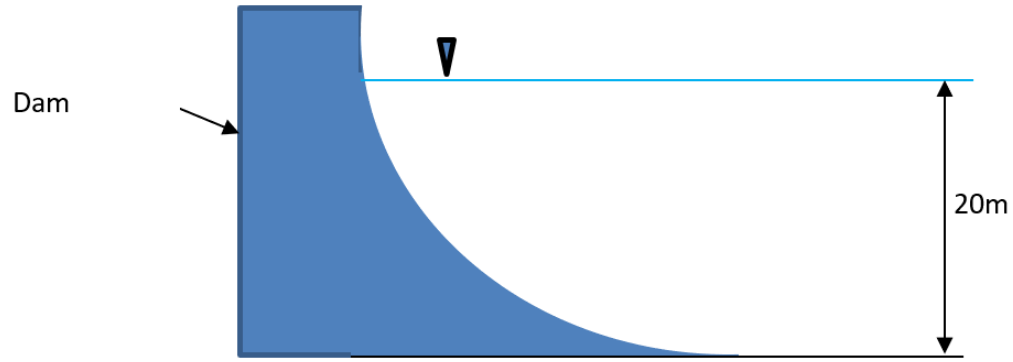

Figure 2

2. (a). A rectangular plate 2.5 m x 4.5 m is immersed in water at an angle of 30° with the water surface as shown in **Figure 3**. Determine the total pressure on one side of the plate and the position of the centre of pressure.

[5 marks]

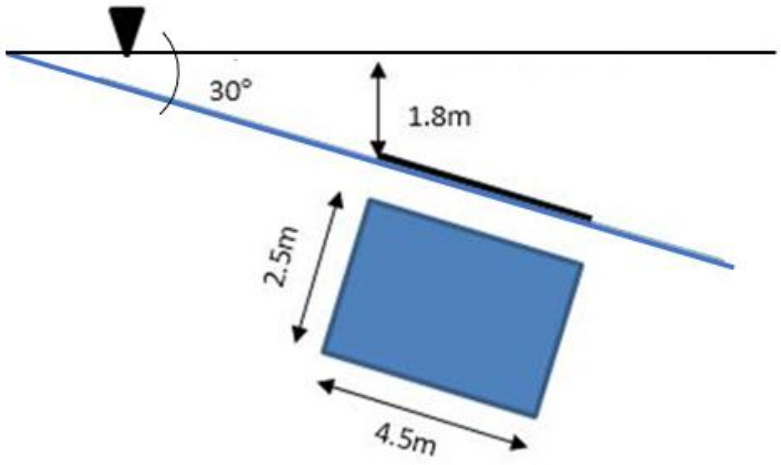

Figure 3

(b). A cylindrical buoy of weight of 22.5 kN with diameter 2.0 m and length 2.5 m is floating with its axis vertical in sea water of specific weight 10 kN/m^3. The buoy cannot float vertically. If a chain is fixed to the buoy and anchored to the sea bed, determine the minimum pull force required to ensure that the buoy floats vertically.

[15 marks]

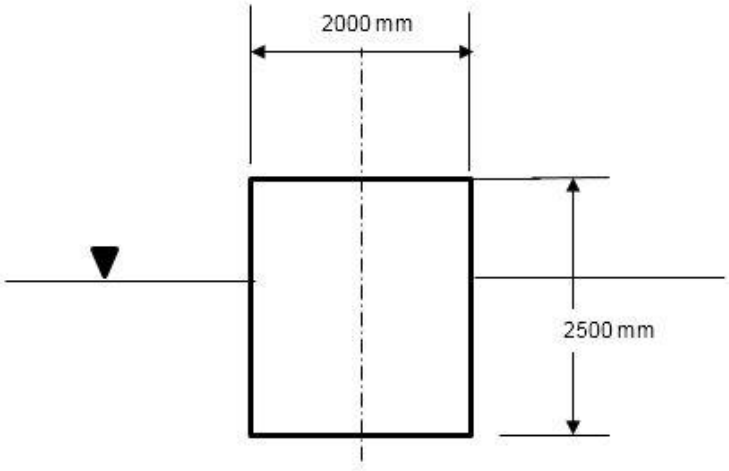

Figure 4

3. (a). Water is siphoned from a reservoir as shown in **Figure 5** with the water level of 6.5 m. The siphon consists of two pipes; d = 12 cm and D = 18 cm, calculate:

i) The minimum flowrate that can be achieved without cavitation occurring in the piping system.

ii) The maximum elevation of the highest point of the piping system to avoid cavitation.

[7 marks]

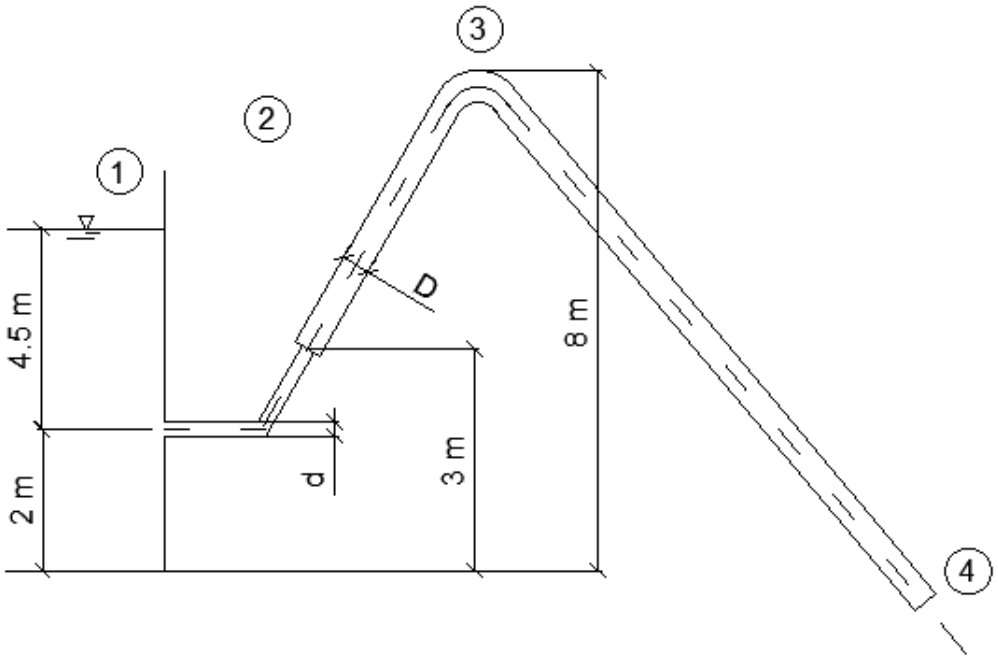

Figure 5

(b). A 40 cm diameter pipe carries water under a head of 20 m with a velocity of 2.5 m/s. If the axis of the pipe bend at angle 50^{o}, determine the magnitude and direction of the resultant force at the bend.

[6 marks]

(c). Water at 28°C flows at the rate of 1200 L/min from a reservoir as shown in **Figure 6**. Calculate the pressure at Point B (neglect all losses).

[7 marks]

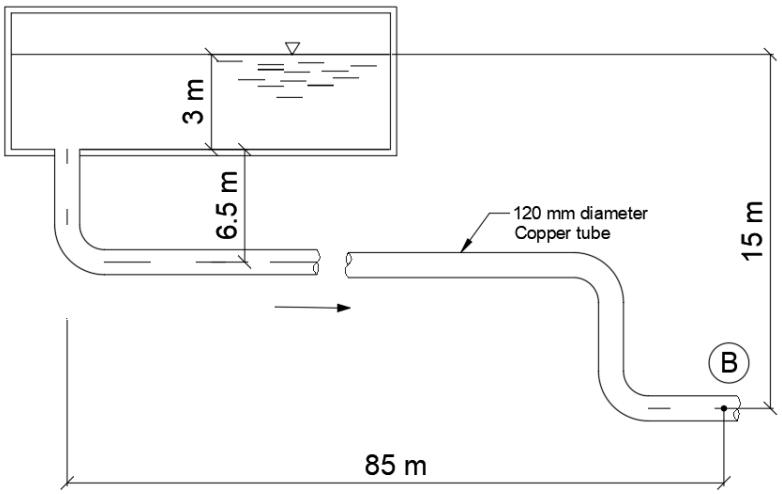

Figure 6 (Schematic drawing, not to scale)

4. (a). Water is pumped from a lake through a 25 cm pipe at a rate of 3.2 m^3/s. If viscous effects are negligible, determine the pressure in the suction pipe (the pipe between the lake and the pump) at an elevation of 1.8 m above the lake.

[7 marks]

(b). Consider a closed tank with an orifice fitted at the bottom of the tank as shown in **Figure 7**. It is given that the diameter of the orifice is 10 cm and the height of water in the tank is 1.87 m. The upper part of the tank is filled with air and is pressurised at 82 kPa above atmospheric pressure. Assume the coefficient of discharge of the orifice as 0.6. Determine the flowrate through the orifice.

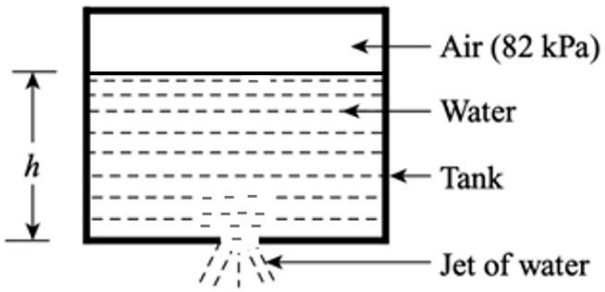

Figure 7

[10 marks]

5 (a). A converging section of a pipeline with a bend conveys water of 1.25 m^3/s as shown in **Figure 8**. The diameter of the pipe section at the inlet and outlet is 600 mm and 300 mm, respectively. The pressure at the inlet is 220 kN/m^2. It is given that the angle of the bend is 65°. Determine the magnitude and direction of the force exerted at the bend.

[15 marks]

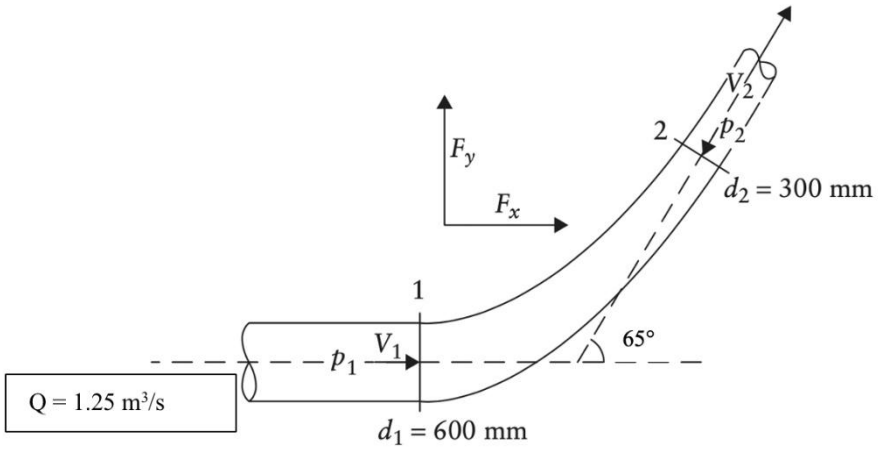

Figure 8

(b) A rectangular flume was installed with a rectangular weir at the inlet and a sharp-crested weir at the outlet to measure its flow. The water will flow initially through the rectangular weir through the flume and is discharged through the sharp-crested weir at the end of the flume. It is given that the flow of water over the rectangular weir is at a depth of 0.32 m with the width of 1.35 m. It is given that the coefficient of discharge for the rectangular and sharp-crested weir is 0.623 and 0.6, respectively. Determine the depth of water over the sharp-crested weir.

[5 marks]

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APPENDIX

Table 1 – Properties of Water

TABLE A.1 SI units [101 kPa (abs)]

Temperature (°C)	Specific Weight γ (kN/m^3)	Density ρ (kg/m^3)	Dynamic Viscosity η (Pa·s)	Kinematic Viscosity ν (m^2/s)
0	9.81	1000	1.75×10^{-3}	1.75×10^{-6}
5	9.81	1000	1.52×10^{-3}	1.52×10^{-6}
10	9.81	1000	1.30×10^{-3}	1.30×10^{-6}
15	9.81	1000	1.15×10^{-3}	1.15×10^{-6}
20	9.79	998	1.02×10^{-3}	1.02×10^{-6}
25	9.78	997	8.91×10^{-4}	8.94×10^{-7}
30	9.77	996	8.00×10^{-4}	8.03×10^{-7}
35	9.75	994	7.18×10^{-4}	7.22×10^{-7}
40	9.73	992	6.51×10^{-4}	6.56×10^{-7}
45	9.71	990	5.94×10^{-4}	6.00×10^{-7}
50	9.69	988	5.41×10^{-4}	5.48×10^{-7}
55	9.67	986	4.98×10^{-4}	5.05×10^{-7}
60	9.65	984	4.60×10^{-4}	4.67×10^{-7}
65	9.62	981	4.31×10^{-4}	4.39×10^{-7}
70	9.59	978	4.02×10^{-4}	4.11×10^{-7}
75	9.56	975	3.73×10^{-4}	3.83×10^{-7}
80	9.53	971	3.50×10^{-4}	3.60×10^{-7}
85	9.50	968	3.30×10^{-4}	3.41×10^{-7}
90	9.47	965	3.11×10^{-4}	3.22×10^{-7}
95	9.44	962	2.92×10^{-4}	3.04×10^{-7}
100	9.40	958	2.82×10^{-4}	2.94×10^{-7}

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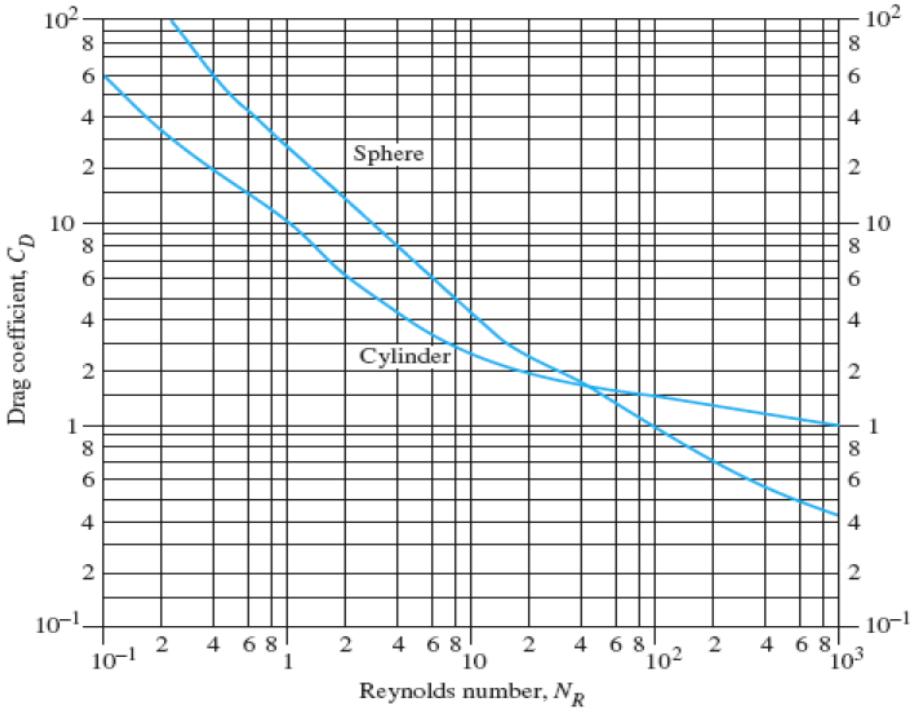
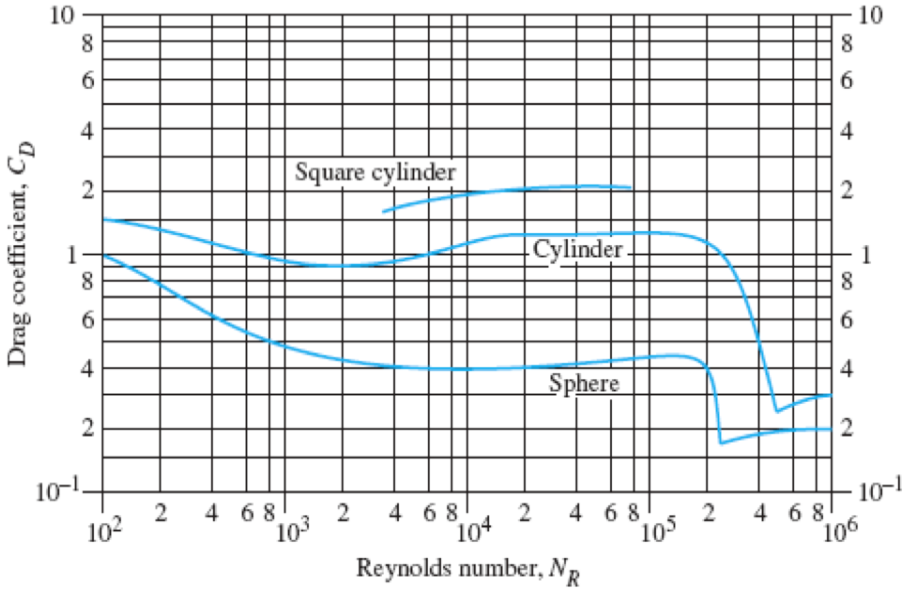


(a) C_D vs. N_R for lower values of N_R



(b) C_D vs. N_R for higher values of N_R

Figure 8 – Drag coefficients for spheres and cylinders

NOTE: 1 cP = 0.001 Ns/m^2 .

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