10

B. Sc. Engg. (CEE)/3rd Semester

Date: 5 December 2023
Time: 1:30 p.m to 4:30 p.m

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Final Semester Examination — **Winter Semester: 2022–2023**
Course Number: CEE 4361 — **Full Marks: 150**
Course Title: Fluid Mechanics — **Time: 3 Hours**

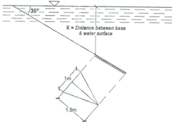
There are **6 (Six)** questions. Answer all **6 (Six)** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable data/values for any missing data/info.

1. (a) State the differences between steady and un-steady flow with examples. [CO1, PO1: 3]

(b) A certain oil of specific gravity 0.90 is flowing through a taper pipe of 225 mm diameter at section-1 and 450 mm diameter at section-2. The flow rate through the pipe is 0.25 m^3/s and pressure at section 1 and 2 are 100 kPa and 50 kPa respectively. Find the head loss and direction of flow. The difference of height between section 1 and 2 is 4.5m. [CO2, PO2: 8]

(c) A triangular plate of 1 m base and 1.5 m altitude is immersed in water as shown in the figure below. The plane of the plate is inclined at 30° with the free surface of water and the base is parallel to the water surface. Find the total force on the plate and the position of the center of pressure, when the base- [CO3, PO2: 14]

i) is at a depth of 2m from the water surface.
ii) is at a depth of 10m from the water surface.
iii) coincides with the water surface.

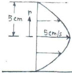


2. (a) Explain the concepts of absolute pressure and gauge pressure. [CO1, PO1: 3]

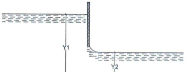
(b) The velocity distribution in a 5 cm radius pipe (as shown in the figure below) is given by- [CO2, PO2: 8]

$$u = 5\left(1 - \frac{r^2}{25}\right)\ cm/s$$

where, **r** is in cm. Find the shear stress at the pipe wall if the fluid has a viscosity of 2 centipoise. What is the resistance force per km length of pipe due to flow?



(c) The given figure shows a flow under a sluice gate. The rectangular channel width is 4.25 m. [CO3, PO2: 14]



i) If the depths upstream and downstream of the gate are 1.5 m and 0.6 m respectively, find the flow rate. Assume no head loss.

ii) If the gate opening is set such that the depth downstream is 0.7 m. Find the upstream depth under these conditions if the flow rate is 18.02 m^3/s. Assume no head loss.

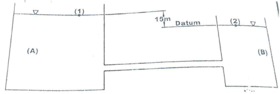
3. (a) Discuss the different kinds of similarities a model should possess and the application of model testing with real life examples. [CO1, PO1: 6]

(b) A 1:25 model of a submarine is tested in a wind tunnel. If the speed of prototype is 12 m/s, find the speed of air in wind tunnel. Find also the ratio of drag forces between the prototype and its model. The kinematic viscosities of air and sea water are 0.015×10^{-4} m^2/s and 0.012×10^{-4} m^2/s. The densities of sea water and air are 1030 kg/m^3 and 1.24 kg/m^3. Use given formulas: $R = \frac{VL}{\nu}$ and $E = \frac{F}{\rho V^2 L^2}$ [CO2, PO2: 7]

(c) The discharge Q of a centrifugal pump depends on density of water r, speed of impeller N, diameter of impeller D, pressure developed by the pump p and the viscosity of water m. Using Buckingham p-theorem show that the relationship between Q and the variables is given by, [CO3, PO2: 12]

$$Q = ND^3\varphi\left[\frac{gH}{N^2D^2}, \frac{\nu}{ND^2}\right]$$

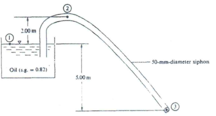
4. (a) [CO2, PO2: 8]



A certain liquid is flowing from reservoir A to reservoir B through a 60 m long and 50 mm diameter pipe. The difference of elevation between the two reservoirs is 15 m. Find the flow rate of the liquid. The kinematic viscosity of liquid is 9.30×10^{-5} m^2/s. Neglect minor losses.

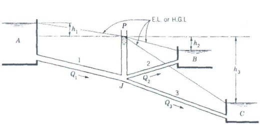
(b) Differentiate between: [CO1, PO1: 5]
(i) Laminar flow and turbulent flow
(ii) Hydraulic grade line and energy grade line

(c) A 50-mm diameter siphon is drawing oil (s.g = 0.82) from an oil reservoir, as shown in the given figure below. If the head loss from point 1 to point 2 is 1.50 m and from point 2 to point 3 is 2.40 m, Find the discharge of oil from the siphon and the oil pressure at point 2. [CO2, PO2: 7]



(d) Discuss the different types of losses in pipe flow with respective figures. [CO1, PO1: 5]

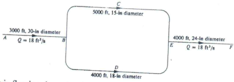
5. (a) [CO3, PO2: 12]



In the above figure, pipe 1 is 90 cm smooth concrete, 1500 m long; pipe 2 is 60 cm cast iron, 450 m long; and pipe 3 is 80 cm cast iron, 1200 m long. The elevations of water surface in reservoir A and B are 90 m and

45 m, respectively. The discharge Q_1 is 2.5 m^3/s. Find the elevation of the surface of reservoir C. Assume, for all pipes, $f = 0.028$.

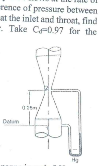
(b) A looping concrete pipe system is shown in the given figure below. The total flow rate of water is 18.0 cfs. Determine the division of flow and the loss of head from point B to point E. [CO2, PO2: 8]



(c) Water is flowing through a 1.5 km long and 75 mm diameter commercial steel pipe with a velocity of 2.2 m/s. Find the head loss and the pressure drop. Viscosity of water is 1.02×10^{-3} Ns/m^2 [CO2, PO2: 5]

6. (a) A venturimeter with a 90mm throat is installed vertically in a 180mm diameter pipeline. A certain oil of specific gravity 0.84 flows at the rate of 0.05 m^3/s in the upward direction. Find the difference of pressure between the inlet and throat. If a manometer is connected at the inlet and throat, find the deflection of mercury in the manometer. Take C_d=0.97 for the venturimeter. Use the given formula. [CO3, PO2: 10]

$$Q = \frac{A_2 C_d}{\sqrt{1-\left(\frac{d_2}{d_1}\right)^4}} \times \sqrt{2gH(\frac{S_0}{S}-1)}$$



(b) Why is it necessary to ventilate the space below the nappe in weirs? How can you identify vena-contracta when water is discharged through an orifice? [CO1, PO1: 4]

(c) Explain the phenomena of water hammer with figures. [CO1, PO1: 4]

(d) Water is flowing through the pipe system at the rate of 200 l/s. Find the total head loss over the length of the pipes. [CO2, PO2: 7]