B. Sc. Engg. (CEE)/3rd Semester — 10th October 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

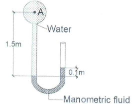
Mid Semester Examination — **Winter Semester: 2022–2023**
Course Number: CEE 4361 — **Full Marks: 75**
Course Title: Fluid Mechanics — **Time: 1.5 Hours**

There are **4 (four)** questions. Answer any **3 (three)** of them. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

1. (a) Describe Surface Tension using an example. Explain how this phenomenon is responsible for causing fluid surfaces to shrink into the minimum surface area possible. [CO1, PO1: 5.5]

(b) Explain Rotation and Vorticity with example. [CO1, PO1: 3]

(c) As shown in the following figure, originally the manometer reading (R_m) was 0.1m. The atmospheric pressure is 101.35 KN/m^2 (absolute). If the absolute pressure at A is doubled, what will be the manometer reading? [CO3, PO2: 10.5]



(d) A rigid cylinder, inside diameter of 15mm, contains a column of water 500mm in height. What will the column height be if a force of 2KN is applied to its end by a frictionless plunger? Assume no leakage. The bulk modulus of elasticity of water is 2.21 GPa. [CO3, PO2: 6]

2. (a) Explain Flow Net. Write down the equations of streamline and equipotential line and show that they are orthogonal to each other. [CO1, PO1: 4]

(b) Provide an explanation of the two primary types of molecular attraction for fluids and how they relate to a fluid's capillary action. [CO1, PO1: 4.5]

(c) The potential function for a two-dimensional flow is given by- [CO3, PO2: 16.5]

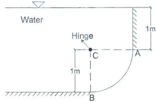
$$\varphi = \frac{3x}{x^2+y^2}$$

Find the velocity at the point P(2,5). Also verify whether the given function represents a possible cause of irrotational flow.

3. (a) State Pascal's law of fluid pressure. For a rectangular parallelopiped element of fluid at rest, prove that pressure varies only in the vertical direction. [CO1, PO1: 8.5]

(b) There is a curved gate AB located 1m beneath the water surface. If AB is the quadrant of a circular cylinder of radius 1m, answer the followings: [CO3, PO2: 16.5]

i) Determine the resultant force acting on AB, per m length.
ii) Find the angle which the resultant force makes with the horizontal.
iii) Locate the point of application of the components of resultant force.
iv) If the length of the gate is 3m, what will be the total force acting on it?



4. (a) State and derive Bernoulli's theorem of total energy of fluid. [CO1, PO1: 8.5]

(b) A pump draws water from a reservoir where the water-surface elevation is 158.5m and forces the water through a pipe 1524m long and 0.305m in diameter. This pipe then discharges the water into a reservoir with water-surface elevation of 189m. The flow rate is 0.22 cumec, and the head loss in the pipe is given by- [CO3, PO2: 16.5]

$$h_f = 0.01\left(\frac{L}{D}\right)\left(\frac{v^2}{2g}\right)$$

where L is the length of the pipe, V is the mean velocity in the pipe, and D is the diameter of the pipe. Determine the head supplied by the pump, and the power supplied to the flow. Also draw the HGL and EGL for the system. Assume that the pipe is horizontal and is 155.5m in elevation.