# Model Question Paper

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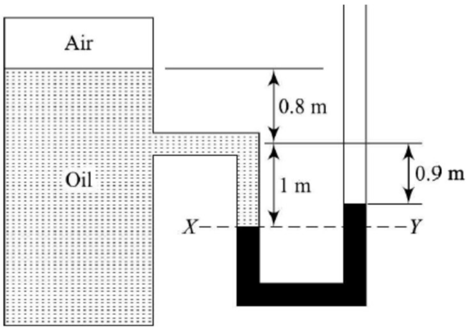
**Fourth Semester B.E. Degree Examination**
**FLUID MECHANICS AND HYDRAULICS**

**TIME: 03 Hours** **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. Appropriately assume any missing data

| | | **Module -1** | **Bloom's Taxonomy Level** | **Marks** |
|---|---|---|---|---|
| **Q.01** | **a** | Distinguish between<br>(i) Ideal and real fluids<br>(ii) Newtonian and non-Newtonian fluids<br>(iii) Adhesion and cohesion | **L2** | **06** |
| | **b** | A circular plate of diameter 4 m with a concentric circular hole of diameter 2.5 m is submerged in water in such a way that its plane makes an angle of 30° with the free surface of water. The top edge of the plate is 2 m below the free surface. Determine the total pressure force on the plate and the position of the centre of pressure. | **L3** | **08** |
| | **c** | A differential U-tube mercury manometer is used to measure the pressure difference between points A and B in a pipeline conveying water. The point A is 0.5 m lower than point B. The difference in level of manometric fluid on two limbs is 0.8 m. Calculate the pressure difference between point A and B. Take Densities of mercury & water as 13600 kg/m$^3$ and 1000 kg/m$^3$. | **L3** | **06** |
| | | OR | | |
| **Q.02** | **a** | Derive an expression for the capillary rise of a liquid in tube of diameter *D* | **L2** | **06** |
| | **b** | A cylindrical shaft of 10 cm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 60 cm and 10.5 cm internal diameter. The space between the tube and the shaft is filled by a lubricant of viscosity 2.0 poise. Determine the power required to overcome the viscous resistance when the shaft is rotated at a speed of 200 rpm | **L3** | **06** |
| | **c** | Oil of specific gravity 0.8 is stored in a closed tank up to a certain height. Air is entrapped at the top portion of the tank above oil. While one end of a U-tube mercury manometer is connected to the tank, the other end is open to the atmosphere as shown in Figure Q2c. Determine the air pressure in the tank. Assume specific weights of mercury and water as 133.28 kN/m$^3$ and 9.80 kN/m$^3$ respectively. Take atmospheric air pressure as 101 kPa.<br><br><br>**Figure: Q02c** | **L3** | **08** |
| | | **Module-2** | | |
| **Q.03** | **a** | Distinguish between<br>(i) Steady flow and Unsteady flow.<br>(ii) Uniform flow and Non-uniform flow<br>(iii) Rotational flow and Irrotational flow<br>(iv) Laminar flow and Turbulent flow | **L2** | **08** |

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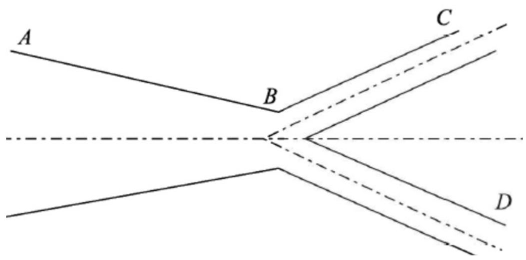
| | **b** | The water is flowing through a pipe having diameters 0.3 m and 0.5 m at the upper and bottom ends, respectively. The intensity of pressures at the upper and bottom ends are 100 kPa and 300 kPa, respectively. If the rate of flow through the pipe is 50 litres per second, then determine the difference in datum head. | **L2** | **05** |
| | **c** | A venturimeter has a diameter of 0.16 m at the enlarged end and 0.08 m diameter at the throat. It is fitted in a horizontal pipeline of diameter 0.16 m which carries an oil of specific gravity = 0.85. If the coefficient of discharge of the venturimeter is 0.98 and the difference of pressure head between the enlarged end and the throat recorded by a U-tube is 0.18 m of Hg, then determine the discharge through the pipe. Take specific gravity of mercury as 13.6. | **L3** | **07** |
| | | OR | | |
| **Q.04** | **a** | Derive Euler's equation of motion and obtain Bernoulli's equation from it. | **L2** | **06** |
| | **b** | Fluid flows through a pipeline which contracts from 45 cm diameter at A to 30 cm diameter at B and then branches into two pipes C and D as shown in **Figure Q04b**. The diameter of the pipe C is 15 cm and diameter of the pipe D is 20 cm. If the velocity at A be 1.8 m/s and that at D be 3.6 m/s. Determine velocity at *B* and discharge at C and *D*   **Figure: Q04b** | **L3** | **08** |
| | **c** | The velocity potential for a two-dimensional flow field is given by $\varphi = 3xy$. Calculate the components of velocity (1,3) and (3,3). Find also the discharge between streamlines passing through these points. | **L3** | **06** |
| | | **Module-3** | | |
| **Q.05** | **a** | Obtain an expression for discharge over a triangular notch in terms of head of water over its crest. Also mention the advantages of a triangular notch over a rectangular notch. | **L2** | **05** |
| | **b** | Derive an expression for increase in pressure in case of a rigid pipe due to sudden closure of valve.<br>Water is flowing through a pipe of diameter 30 cm and length 2500 m with a velocity of 2.0 m/s. A valve is provided at the end of the pipe. If the valve is closed in 30 seconds, find the rise in pressure. Take the velocity of pressure wave as 1800 m/s. | **L2** | **08** |
| | **c** | The water flows through a triangular right-angled weir first and then over a rectangular weir of 1 m width. If the coefficients of discharge of the triangular and rectangular weirs are 0.60 and 0.62, respectively and the depth of the triangular weir is 30 cm, then determine the depth of water over the rectangular weir. | **L3** | **07** |
| | | OR | | |
| **Q.06** | **a** | Define major and minor energy losses in pipes. Using Bernoulli's equation, obtain an expression for loss of head due to sudden expansion of pipe. | **L2** | **06** |
| | **b** | A jet of water issuing from an orifice 25 mm diameter under a constant head of 1.5 m falls 0.92 m vertically before it strikes the ground at 2.3 m measured horizontally from the vena-contracta. The discharge was found to be 102 litres per minute. Determine coefficients of velocity, discharge, and contraction of the orifice. | **L3** | **08** |

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| | **c** | The diameter of a horizontal pipe suddenly reduces from 0.5 m to 0.25 m due to which pressure changes from 135 kPa to 110 kPa. If the flow rate of water is 0.4 $m^3/s$, then find the coefficient of contraction. | **L2** | **06** |
| | | **Module-4** | | |
| **Q.07** | **a** | Differentiate between:<br>(i) Steady and unsteady flow<br>(ii) Uniform and non-uniform flow<br>(iii) Subcritical and supercritical flow | **L2** | **06** |
| | **b** | What is meant by most economical section of channel? Derive the condition for most economical section of a rectangular channel | **L3** | **07** |
| | **c** | An irrigation canal of trapezoidal section having side slope equal to 60° with the horizontal and laid on a slope of 1 in 2500 carries a discharge of 14 $m^3/s$. Determine the width at the base and depth of flow for most economical cross section. Take Manning's constant as 0.02. | **L3** | **07** |
| | | OR | | |
| **Q. 08** | **a** | Explain a specific energy curve and derive expressions for critical depth and critical velocity for rectangular channel | **L2** | **06** |
| | **b** | Derive an expression for loss of energy head in terms of conjugate depths in a hydraulic jump | **L2** | **06** |
| | **c** | Water is flowing through a rectangular channel of 3 m width at a rate of 10 $m^3/s$. If the depth of flow is 0.8 m, determine whether a hydraulic jump will occur, and if so, find its height. Also find the loss of energy and the power lost in the hydraulic jump. | **L3** | **08** |
| | | **Module-5** | | |
| **Q.09** | **a** | With help of neat sketch explain velocity triangle | **L1** | **04** |
| | **b** | A 50 mm diameter water jet having a velocity of 20 m/s impinges on a curved vane which is moving in the same direction as that of the jet with a velocity of 5 m/s. The jet leaves the vane at an angle of 150° with the direction of motion of vane. Neglecting friction find the following<br>(i) the force exerted by the jet in the direction of motion of the vane<br>(ii) the power developed by the jet<br>(iii) the efficiency of the vane. | **L3** | **08** |
| | **c** | Obtain an expression for the work done per unit time by water on the runner of a Pelton wheel. Also obtain an expression for the maximum efficiency of the Pelton wheel. | **L3** | **08** |
| | | OR | | |
| **Q.10** | **a** | Show that jet of water striking at the center of the semicircular vane, the maximum efficiency is corresponding to jet velocity of three times the vane velocity and resulting efficiency, $\eta_{max} = 0.593$ | **L2** | **07** |
| | **b** | Explain the components and working mechanism of a Francis turbine. | **L2** | **07** |
| | **c** | A centrifugal pump delivers 0.3 $m^3/s$ against a head of 30 m at 1400 rpm. The external diameter of impeller is 0.5 m and the outlet width is 0.05 m. If the manometric efficiency is 80%, find the vane angle at outlet. | **L3** | **06** |