

B. E. CONSTRUCTION ENGINEERING

SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024

HYDRAULICS

Time : 3 Hours

Full Marks : 100

Answer Question No. 1 (compulsory) and Any 4 Questions from the rest.

Answer to all parts of a Question must be presented together.

Assume any data, if not furnished, consistent with the problem.

1. (a) Explain the formation of boundary layer over a flat plate when the same is introduced in a free stream flow with the help of a neat and labelled diagram. [5]
- (b) Describe the variation of vapour pressure of a fluid with change in temperature of the fluid. [5]
- (c) Define surface tension. What is the SI unit of surface tension? What assumptions are considered for a fluid flow when deriving Bernoulli's equation? [2 + 1 + 2]
- (d) What is capillarity? Give an example of the same. Show a diagram of capillary rise with the necessary symbols. [2 + 1 + 2]
2. (a) Write short notes on any 5 (five) :- [5 X 4 = 20]
 - (i) Pascal's Law
 - (ii) Hydrostatic Law
 - (iii) U – Tube Manometer
 - (iv) Absolute, Gauge and Vacuum Pressure
 - (v) Lagrangian method of fluid motion
 - (vi) Eulerian method of fluid motion
 - (vii) Fully Developed Flow
3. (a) A fluid flow is described using the following velocity field, $\vec{V} = (t + xy^2)\hat{i} + (3 - 3z^2y)\hat{j} + (zt + 2zx)\hat{k}$. Find the acceleration vector and velocity magnitude at position coordinates (2,0,-1) and $t = 2$. [10]
- (b) A fluid flow is described using the following velocity field, $\vec{V} = (3xy)\hat{i} + (5y - zy)\hat{j} + (zx^2)\hat{k}$, at coordinates (1,1,-2). Find out (i) If the flow is compressible or incompressible? (ii) If the flow is rotational or irrotational? [5 + 5]
4. (a) Write short notes on streamlines and pathlines. [5 + 5]
- (b) Derive the Continuity Equation in its Three (3) – Dimensional Cartesian coordinate form. [Properly mention any assumptions or correlations taken during simplification] [10]

5. (a) A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30 cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$. [10]
- (b) A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. The pressure intensities in the large and smaller pipe is given as 13.734 N/cm^2 and 11.772 N/cm^2 respectively. Find the loss of head due to contraction if $C_c = 0.62$. Also determine the rate of flow of water. [10]
6. (a) A flow of water of 100 litres per second flows down in a rectangular channel of width 600 mm and having adjustable bottom slope. If Chezy's coefficient C is 56, find the bottom slope necessary for uniform flow with a depth of flow of 300 mm. [10]
- (b) Derive an expression for the actual discharge over a V – notch placed in an open channel with the help of a neat and labelled diagram. [10]
7. (a) Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity ω , speed of advance V , diameter D , dynamic viscosity μ , mass density ρ and speed of sound in the medium C . [20]