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QUESTION BANK (DESCRIPTIVE)

Subject with Code : Fluid Mechanics (16CE106) **Course & Branch**: B.Tech - CE

Year & Sem: II-B.Tech & I-Sem **Regulation:** R16

UNIT –I

FLUID PROPERTIES AND STATICS

1. a) State Pascal's law. What do you understand the terms Absolute, Gauge, atmospheric & vacuum pressure? 5M

b) What is the gauge pressure at a point 3m below the free surface of a liquid having a density 1.53 x 10^3 kg/m^3.If the atmospheric pressure is equivalent to 750mm of mercury? The Specific gravity of mercury is 13.6 and density of water = 1000 kg/m^3 5M

2. Define Manometer. Briefly explain the types of manometers in detail? 10M

3. a) A simple U – tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0.8 and having vacuum pressure is flowing. The other end of the manometer is open to atmosphere. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20 cm 5M

b) A hydraulic pipe has a ram of 30 cm diameter and a plunger of 4.5 cm diameter. Find the weight lifted by the hydraulic press when the force applied at the plunger is 500N?

4. a) An inverted U – tube manometer is connected to two horizontal pipes A and B though which water is flowing. The vertical distance between the axes of these pipes is 30cm. When an oil of specific gravity 0.8 is used as a gauge fluid, the vertical heights of water columns in the two limbs of the inverted manometer (when measured from the respective centre lines of the pipes) are found to be same and equal to 35 cm. Determine the difference of pressure between the pipes. 5M

b) Derive expression for surface tension on liquid droplet and soap bubble? 5M

5. Derive expressions for the total pressure and centre of pressure for an inclined plane surface submerge in the liquid. 10M

6. Explain how you would find the resultant pressure on a curved surface immersed in the liquid. 10M

7. Define centre of pressure and derive an expression for centre of pressure for a vertically submerged surface. 10M

8. a) Write short notes on viscosity, kinematic viscosity and Newton's law of viscosity? 5M

b) The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 2.5mm. The upper plate which moves at 2.5 m/sec requires a force of 9.81N to maintain the speed. Determine dynamic viscosity of the oil in poise and kinematic viscosity of oil if specific gravity of oil is 0.95

9. a) Explain the pressure variation in a fluid at rest? 5M

b) Define specific density and specific weight, viscosity, vapour pressure and cavitation? 5M

10.a) A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure force and position of centre of pressure, when the upper edge is 2 m below the free surface. 5M

b) Find the magnitude and direction of the resultant force due to water acting on a roller gate of cylindrical form of 4 m diameter, when the gate is placed on the dam in such a way that water is just going to spill. Take the length of the gate as 8 m. 5M

11. a) Derive expression for capillary rise? 5M

b) Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in i) water ii) mercury take surface tension 0.0725 N/m for water and 0.52 N/m for mercury in contact with air. The specific gravity of mercury is 13.6and angle of contact 130º? 5M

12. a) Derive expression for capillary fall? 5M

b) The capillary rise in the glass tube is not to exceed 0.2 mm of water. Determine its minimum size, given that surface tension for water in contact with air is equal to 0.0725 N/m. 5M

13. a) Write short notes on surface tension and derive expression for surface tension on a liquid jet?

b) The pressure outside the droplet of water of diameter 0.04 mm is 10.32 N/cm^2 (atmospheric pressure). Calculate the pressure within the droplet if surface tension is given a 0.0725 N/m of water?

14. A U-tube manometer is used to measure the pressure of water in a pipe line, which is excess of atmospheric pressure. The right limb of manometer contains mercury and is open to atmosphere. The contact between water and mercury is in the left limb. Determine the pressure of water in the main line, if the difference in the level of mercury in the limbs of U-tube is 10 cm and the free surface of mercury is in level with the center of pipe. If the pressure of water in pipe line is reduced to 9810 N/m^2, calculate the new difference in the level of mercury. Sketch the arrangements in the both cases.

15. A rectangular plane surface is 2 m wide and 3 deep. It lies in vertical plane in water. Determine the total and position of center of pressure on the plane surface when its upper edge is horizontal and
i) Coincides with water surface ii) 2.5 m below the free surface of water. 10M

16. a) Explain the working principle of Bourdon's pressure gauge? 5M

b) A hydraulic press has a ram of 20 cm diameter and plunger of 3 cm diameter. It is used for lifting a weight of 30 KN. Find the force required at the plunger? 5M

UNIT –II

FLUID KINEMATICS AND FLUID DYNAMICS

1. a) Define stream line, streak line and path line, stream tube and control volume? 5M

b) Write a brief note on continuity equation for a one- dimensional flow? 5M

2. Obtain an expression for continuity equation for a three - dimensional flow. 10M

3. a) The velocity potential function is given by Ø = 5(x2 – y2). Calculate the velocity components at the point (4, 5). 5M

b) A stream function is given by ψ = 5x – 6y. Calculate the velocity components and also magnitude and direction of the resultant velocity at any point.

4. a) If for a two – dimensional potential flow, the velocity potential is given by Ø = x(2y – 1). Determine the velocity at the point p (4, 5). Determine also the value of stream function Ψ at the point p. 5M

b) A 30 cm diameter pipe, conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the 30 cm diameter pipe is 2.5 m/s. Find the discharge in the pipe. Also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s. 5M

5. a) What is Euler's equation of motion? How do you obtain Bernoulli's equation from it? Name the different forces present in a fluid flow 5M

b) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive the expression for Bernoulli's theorem from first principle and state the assumption made for such a derivation. 5M

6. a) What is flowing through a pipe of 5 cm diameter under a pressure of 29.43N/cm^3 (gauge) and with mean velocity of 2.0 m/s. Find the total head or total energy per unit weight of the water at a cross section which is 5 m above the datum line. 5M

b) Water is flowing through a pipe has diameter 300 mm and 200 mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 24.525 N/cm^2 and the pressure at the upper end is 9.81 N/cm^2. Determine the difference in datum head if the rate of flow through pipe is 40 lit/s.

7. a) Write a short notes on velocity and acceleration function and also define local and convective acceleration 5M

b) The following case represent the two velocity components, determine the third velocity component such the they satisfy the continuity equation i) u= $x^2+y^2+z^2$, v= xy^2-yz^2+xy and ii) v=$2y^2$, w=2xyz 5M

8. a) What is the relation between stream function and velocity potential function? 5M

b) Write a short notes on the following i) Equipotential line ii) Line of constant stream function iii) Flow net 5M

9. a) Define hydraulic gradient line and total energy line. 5M

b) Explain briefly the analysis of free liquid jets. 5M

10. a) Define compressible and incompressible flows.

b) Define laminar and turbulent flows.

c) Define uniform and non uniform flow.

d) Distinguish between rotational and irrotational flow.

e) Distinguish between steady and unsteady flow 10M

10. The velocity vector in a fluid flow V= $4x^3i-10x^2yj+2tk$, find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t=1. 10M

UNIT –III

FLOW THROUGH PIPES

1. Derive the expression for head loss in pipes due to friction by Darcy - Weisbach equation and chezy's formula 10M

2. a) Derive the expression for flow through pipes in series. 5M

b) Derive the expression for flow through parallel pipes. 5M

3. Derive the expression for head loss in pipes due to sudden enlargement and sudden contraction formula 10M

4. The rate of flow of water through a horizontal pipe is $0.25 m^3/s$. The diameter of the pipe which is 200 mm is suddenly enlarged to 400mm. The pressure intensity in the smaller pipe is $1.772 N/cm^2$. Determine the i) Head loss due to sudden enlargement ii) Pressure intensity in the large pipe iii) Power lost due to enlargement 10M

5. A horizontal pipe of diameter 500mm is suddenly contracted to a diameter of 250mm. The pressure intensity in the larger and smaller pipe is given as 13.734 N/cm^2 and 11.772 N/cm^2 respectively. Find the head lost due to contraction if C_C is 0.63. Also determine the rate of flow of water? 10M

6. A Siphon of diameter 200 mm connects two reservoirs having a difference in elevation of 20 m. The length of the siphon is 500 m and the summit is 3.0 m above the water level in the upper reservoir. The length of the pipe from upper reservoir to the summit is 100 m. Determine the discharge through the siphon and also pressure at the summit. Neglect minor losses. The co efficient of friction is 0.005. 10M

7. A horizontal pipe line 40m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25m of its length from the tank, the pipe is 150mm diameter and its diameter is suddenly enlarged to 300mm. the height of water level in the tank is 8m above the centre of the pipe line. Considering all losses of head which occur and determine the rate of flow take f=0.01 for both sections of pipe. 10M

8. The difference in water surface levels in two tanks which are connected by three pipes in series of lengths 300m, 170m and 210m and diameters of 300mm, 200mm and 400mm respectively is 4m. Determine the rate of flow of water if coefficients of friction are 0.005, 0.0052, 0.0048 respectively, considering i) minor losses ii) neglecting minor losses 10M

9. A pipe line of 0.6 m diameter is 1.5 km long. To increase the discharge, another line of same diameter is introduced parallel to the first in the second half of the length .Neglecting minor losses, find the increase in discharge if 4f = 0.04. The head at inlet is 300 mm. 10

10. a) Find the head lost due to friction in a pipe of diameter 300 mm and the length 50 m, through which water is flowing at velocity of 3 m/s using i) Darcy formula ii) Chezy's formula for which C=60 and kinematic viscosity 0.01 stokes? 5M

b) Find the loss of head when a pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. The rate of flow of water through the pipe is 250 lit/s. 5M

UNIT –IV

FLOW MEASUREMENTS

1. a) Explain Pitot tube with neat sketch ? 10M

b) A sub-marine moves horizontally on a sea and has its axis 15m below the surface of water. A pitot tube properly placed just in front of a sub-marine and along its axis is connected to two limbs of a u – tube containing mercury. The difference of mercury level is found to be 170mm find the speed of the sub-marine knowing that the specific gravity of mercury is 13.6 and that of sea water is 1.026 with respect of fresh water.

2. What is a notch and a weir? Explain about Classifications of notch and a weir? 10M

3. a) Find the expression for the Discharge over a Rectangular notch or weir 10M
b) Determine the height of a rectangular weir of length 6m to be built across a rectangular channel. The maximum depth of water on the upstream side of the weir is 1.8m and discharge is 2000 lit/sec. Take C_d=0.6 and neglect end contractions?
4. a) A horizontal venture meter with 30cm diameter inlet and 10cm throat is used for measuring the flow of water through a pipeline. If pressure in pipe is 1.5kpa and the vacuum pressure at the throat is 40cm of mercury, calculate the rate of flow. It may be presumed that 5% of differential head is lost between the pipe main and the throat section. Also make calculations for the discharge co-efficient take specific weight of water = 10kN/m^3 5M
b) In a 100mm diameter horizontal pipe a venture meter of 0.5 contraction ratio has been fixed. The head of water on the meter when there is no flow in 3m (gauge). Find the rate of flow for which the throat pressure will be 2m of water is 0.97 take atmospheric pressure head = 10.3m of water. 5M
5. a) A board-crest weir of 50m length, has 50cm Height of water above its crest. Find the maximum discharge take Cd=0.60 neglect velocity approach (ii) If the velocity approach is to be taken in to the consideration, find the maximum discharge when the channel has a cross sectional area is 50m^2 on a upstream side. 5M
b) An Ogee weir 5m long has a head of 40cm of water. If Cd=0.6.find the discharge over the weir5M
6. Explain the principle of venturimeter with neat sketch? Also derive the expression of rate of flow of Fluid through on it 10M
7. An external cylindrical mouth piece of diameter 150 mm is discharging water under a constant head of 6 m. Determine the discharge and absolute pressure head of water at B vena – contracta. Take $C_d = 0.855$ and C_c for vena contracta = 0.62 and atmospheric pressure head = 10.3 of water.10M
8. a) Water flows over a rectangular weir 1m wide at a depth of 150mm and afterwards passes through a triangular right-angled weir. Taking C_d for the rectangular and triangular weir as 0.62 and 0.59 respectively .find the depth over a triangular weir 5M
b) Find the discharge over a triangular notch of angle 60 when the head over the V-Notch is 0.3M assume C_d is 0.6
9. What is a Mouth Piece? What are the advantages are providing the Mouth Piece? How the Mouth Piece are classified? 10M
10. a) What are the advantages of V-Notch over a rectangular notch?
b) Differentiate between sharp-crested weir and Board-crested weir?

UNIT –V

LAMINAR FLOWAND BOUNDARY LAYER THEORY

1. Derive Hagen Poiseuille equation? 10M
2. An oil of viscosity 0.1 Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50mm and length 300 m. The rate of flow of fluid through a circular pipe is 3.5 lit/sec. Find the pressure drop in a length of 300m and also the shear stress at the pipe wall? 10M
3. Derive the equation for the flow of viscous fluid between two parallel plates? 10M
4. Calculate: i) Pressure gradient along the flow, ii) The average velocity and iii) The discharge for an oil of viscosity 0.02 Ns/m^2 flowing between two stationary plates 1 m wide maintained 10 mm apart. The velocity midway between the plates is 2 m/s? 10M
5. a) Explain the Reynolds's experiment with neat sketch 5m
b) Define Reynolds's number and derive the expression for Reynolds's number?
6. A velocity profile for a turbulent boundary layer $\frac{u}{v} = \left(\frac{y}{\delta}\right)^{\frac{1}{7}}$ obtain expression for boundary layer thickness, shear stress, drab force on one side of the plate and co efficient of drag in terms of Reynold number. Given the

shear stress (τ_0) for boundary layer as $\tau_0 = 0.0225\,\rho U^2 \left(\frac{\mu}{\rho U \delta}\right)^{\frac{1}{4}}$

7. For the following velocity profiles, determine whether the flow has separated or on the verge of separation or will watch with the surface

i) $\frac{u}{U} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$ ii) $\frac{u}{U} = 2\left(\frac{y}{\delta}\right)^2 - \left(\frac{y}{\delta}\right)^3$ iii) $\frac{u}{U} = -2\left(\frac{y}{\delta}\right) + \left(\frac{y}{\delta}\right)^2$

8. a) Define Boundary layer and derive the expression for energy thickness

b) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at a distance y from the plate and u=U where δ= Boundary layer thickness. Also calculate the value of δ^*/θ

9. Explain boundary layer thickness, displacement thickness, momentum thickness and energy thickness?

10. Explain the separation of Boundary layer?

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