CBCS SCHEME

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18MT42

Fourth Semester B.E. Degree Examination, June/July 2024
Fluid Mechanics and Machines

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following terms with SI units,
(i) Kinematic viscosity
(ii) Weight density
(iii) Surface tension **(06 Marks)**

b. The dynamic viscosity of an oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft diameter is 0.4 m and rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of an oil film is 1.5 mm. **(06 Marks)**

c. Define Pascal's law and prove it. **(08 Marks)**

OR

2 a. Derive the expression for centre of pressure of vertical plane surface submerged in a liquid. **(08 Marks)**

b. A circular plate 3 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of centre of pressure. Also if the circular plate has a hole d diameter 1.5 m concentrically. Then calculate the total pressure and position of the centre of pressure on one face of the plate. **(08 Marks)**

c. Explain the terms : Vapour pressure and Cavitation. **(04 Marks)**

Module-2

3 a. Explain the different types of fluid flows. **(08 Marks)**

b. Derive continuity equation for the 3D incompressible flow in Cartesian coordinates. **(08 Marks)**

c. A fluid flow field is given by, $V = x^2 yi + y^2 zj - (2xyz + yz^2)K$. Calculate the velocity at point (2, 1, 3). Prove that, it is a case of possible steady incompressible flow. **(04 Marks)**

OR

4 a. Derive an expression for Euler's equation of motion along a stream line and deduce it to Bernoulli's equation. **(08 Marks)**

b. Mention the assumptions and applications of Bernoulli's equation. **(04 Marks)**

c. A non-uniform part of a pipe line 5 m (metres) long is laid at a slope of 2 in 5. Two pressure gauges each fitted at upper and lower ends read 20 N/cm^2 and 12.5 N/cm^2. If the diameters at the upper and lower ends are 15 cm and 10 cm respectively, determine the quantity of water flowing per second. **(08 Marks)**

Module-3

5 a. What is dimensional homogeneity? Explain with examples. **(04 Marks)**

b. Describe the different types of similarity between model and prototype. **(06 Marks)**

c. The rate of discharge Q of a centrifugal pump is dependent upon density of fluid ρ, pump speed N in rpm, diameter of the impeller D and pressure P and viscosity of the fluid μ, using Buckingham's π-theorem, show that

$$Q = ND^3.\phi\left[\frac{P}{\rho N^2 D^2}, \frac{\mu}{\rho N D^2}\right]$$ **(10 Marks)**

OR

6 a. Derive the expression for rate of flow through a venturimeter. **(08 Marks)**

b. Water flows over a rectangular weir 1 m wide at a depth of 150 mm and afterwords 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 and the triangular weir. **(06 Marks)**

c. An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. C_d = 0.6. Find the discharge of water through pipe. **(06 Marks)**

Module-4

7 a. Define Turbo-machine. With a neat sketch, explain the parts of Turbo-machine. **(08 Marks)**

b. Differentiate between positive displacement machine and turbo-machine. **(08 Marks)**

c. Classify Turbo machines. **(04 Marks)**

OR

8 a. Define Degree of reaction. Obtain the expression for general relationship between degree of reaction and utilization factor. **(06 Marks)**

b. With necessary velocity triangles, derive an expression of alternative form of Euler's turbine equation and explain each component. **(08 Marks)**

c. Derive an expression for effect of blade discharge angle on energy transfer. **(06 Marks)**

Module-5

9 a. Explain with a neat diagram, the Francis turbine. **(06 Marks)**

b. A propeller turbine runner has an outer diameter 4.5 m and inner diameter of 2 m. It develops 28,000 HP (20,580 kW) when running at 137 rpm, under a head of 20 m. The hydraulic efficiency is 94% and the overall efficiency is 94% and the overall efficiency is 88%. Find the discharge through the turbine and the guide blade angle at inlets and outlet. Also find the inlet velocity absolute and entry angle. **(08 Marks)**

c. What is draft tube? What is the necessary of draft tube, explain its types. **(06 Marks)**

OR

10 a. Derive an expression for maximum blade efficiency of a 50% reaction, Reaction turbine. **(10 Marks)**

b. Steam issuing from a nozzle to a De-laval turbine with a velocity of 1000 ms^{-1}. The nozzle is 20°, the mean blade speed is 400 ms^{-1}. The blades are symmetrical, the mass flow rate = 1000 kg/hr, friction factor = 0.8, nozzle efficiency = 0.95. Calculate

(i) The blade angles (ii) Axial thrust (iii) Tangential force

(iv) Work done per kg of steam (v) Power developed (vi) Blade efficiency

(vii) Speed ratio (viii) Stage efficiency. **(10 Marks)**

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