CBCS SCHEME

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21MR43

Fourth Semester B.E. Degree Examination, June/July 2023
Fluid Mechanics and Machinery

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Derive an expression for the depth of center of pressure from free surface of liquid of inclined plane surface submerged in the liquid. **(06 Marks)**

b. With usual notation derive expression for metacentric height for a floating body in liquid. **(08 Marks)**

c. The differential mercury manometer is connected between pipe A and Pipe B. Pipe 'A' is 500mm above pipe 'B' and deflection in mercury manometer is 200mm. The pressure intensity in pipe 'A' its greater than pipe B. Both the pipes carry the fluid of specific gravity 0.9, determine the pressure difference between two pipes. **(06 Marks)**

OR

2 a. Derive an expression for continuity equation for a three dimensional steady incompressible flow. **(08 Marks)**

b. Explain the following with respect to fluid flow
   i) Steady and unsteady flow
   ii) Uniform and Non-uniform flow
   iii) Laminar and turbulent flow **(06 Marks)**

c. A block of wood specific gravity 0.7 floats in water. Determine the metacentric height of the block if its size is 2m × 1m × 0.8m. State whether the equilibrium is stable or unstable. **(06 Marks)**

Module-2

3 a. What is Euler's equation of motion? Derive an expression of Bernoulli's equation of motion. Also state assumptions made for derivation. **(10 Marks)**

b. A pipe line carrying oil of specific gravity 0.87, changes in diameter from 200mm at a position 'A' to 500mm diameter at a position 'B' which is 4 meters at a higher level. If the pressure at 'A' and 'B' are 9.81N/cm^2 and 5.886N/cm^2 respectively and the discharge is 200 liters/s. Determine the loss of head and direction of flow. **(10 Marks)**

OR

4 a. Derive an expression for rate of flow through the orifice meter. **(10 Marks)**

b. Water flows over a rectangular Notch 1m wide at a depth of 150mm and afterwards passes through a triangular right-angled Notch. Taking Cd for the rectangular and triangular Notch as 0.62 and 0.59 respectively, find the depth over the triangular Notch. **(10 Marks)**

Module-3

5 a. Derive the Hagen-Poisencille equation for head loss in a circular pipe carrying fluid which is laminar. **(10 Marks)**

b. An oil of viscosity 0.1N-s/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50mm and of length 300m. The rate of flow of fluid through the pipe is 3.5 liters/second. Find the pressure drop in a length of 300m and also shear stress in the pipe wall. **(10 Marks)**

OR

6 a. Derive an expression of Darcy Weisbach equation for loss of head due to friction. Also derive Chezy's equation for loss of head due to friction. **(12 Marks)**

b. Find the head lost due to friction in a pipe of diameter 300mm and length 50m, through which water is flowing at a velocity of 3m/s using i) Darcy formula ii) Chezy's formula for which e = 60 and kinematic viscosity of 0.01 stoke. **(08 Marks)**

Module-4

7 a. Derive an expression of Euler's turbine equation it terms of velocity components. **(08 Marks)**

b. If a stage of an impulse turbine the mean blade dia is 0.75m, its rotational speed being 3500rpm. The absolute velocity of fluid discharging from a nozzle inclined at 20° to the plane of the wheel is 275m/s. If the utilization factor is 0.9 and the relative velocity at the rotor exit is 0.9 times that at the inlet, find the inlet and exit rotor angle. Also find the power output from the stage for a mass flow rate of 2Kg/s and axial thrust on the shaft. **(12 Marks)**

OR

8 a. Show that the maximum blade efficiency of a Pelton wheel turbine is $\eta_{max} = \frac{1+C_b \cos\beta_2}{2}$ where $C_b = \frac{Vr_2}{Vr_1}$. **(12 Marks)**

b. In a Franci's turbine, the discharge is radial the blade speed at inlet is 25m/s. At the inlet tangent component of velocity is 18m/s the radial velocity of flow is constant and equal to 2.5m/s, water flows at a rate of $0.8m^3/s$. The utilization factor is 0.82. Find i) Euler's head ii) Power developed iii) Inlet blade angles iv) Degree of reaction (R). Draw velocity triangle. **(08 Marks)**

Module-5

9 a. Explain the following with respect to centrifugal pump i) pumps in series ii) pumps in parallel iii) cavitation **(10 Marks)**

b. A centrifugal pump has an impeller diameter of 25cm and width of 7.5cm at exit. It delivers 120 lit/s of water against a head of 24m at 1440 rpm. Assuming the vane blocks the area of flow by 5% and a hydraulic efficiency of 0.85. Estimate the vane angle at exit. Also calculate the torque exerted on the driving shaft if the mechanical efficiency is 95%. **(10 Marks)**

OR

10 a. Explain the following with respect to pump.
- i) Manometric efficiency
- ii) Mechanical efficiency
- iii) Volumetric efficiency
- iv) Overall efficiency. **(08 Marks)**

b. What is minimum starting speed? Obtain an expression for minimum starting speed for centrifugal pump. **(08 Marks)**

c. Explain the following i) Priming ii) Net positive suction head. **(04 Marks)**

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