# INSTITUTE OF AERONAUTICAL ENGINEERING 

(Autonomous)
Dundigal-500043, Hyderabad
B.Tech IV SEMESTER END EXAMINATIONS (REGULAR) - JULY 2022

Regulation:UG20
HYDRAULICS AND HYDRAULIC MACHINERY
Time: 3 Hours
(CIVIL ENGINEERING)
Max Marks: 70
Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
(NOTE: Provision is given to answer TWO questions from among one of the Modules III / IV / V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

## MODULE - I

1. (a) Obtain an expression for the depth after the hydraulic jump and the loss of head due to the jump. Write the assumptions made [BL: Remember| CO: 1|Marks: 7]
(b) Determine the economical cross-section for an open channel of trapezoidal section with side slopes of 1 vertical to 2 horizontal, to carry $10 \mathrm{~m}^{3} / \mathrm{s}$, the bed slope being $1 / 2000$. Assume Manning coefficient as 0.022 .
[BL: Understand| CO: 1|Marks: 7]

## MODULE - II

2. (a) What is a boundary layer ?Explain the fundamental causes of its existence. Discuss the various methods of controlling the boundary layer.
[BL: Understand| CO: 2|Marks: 7]
(b) A free stream of water has a velocity of $4 \mathrm{~m} / \mathrm{s}$ and a smooth flat plate with a sharp leading is placed in it. Find the distance from the leading edge where the boundary layer transition from laminar to turbulent flow occurs. Find also the thickness of the boundary layer at that point. The density and viscosity of water are $1000 \mathrm{~kg} / \mathrm{m}^{3}$ and 1 centipoise, respectively.
[BL:Understand | CO: $2 \mid$ Marks: 7$]$

## MODULE - III

3. (a) Derive the expression for normal force exerted by a jet when it strikes an inclined flat plate which is moving in the same direction as the jet
[BL: Understand| CO: 3|Marks: 7]
(b) A jet of water 50 mm in diameter and moving with a velocity of $26 \mathrm{~m} / \mathrm{s}$ is impinging normally on a plate. Determine the pressure on the plate when it is fixed and when it is moving with a velocity of $10 \mathrm{~m} / \mathrm{s}$ in the direction of the jet. Also determine the work done per second by the jet.
[BL: Understand| CO: 3|Marks: 7]
4. (a) What do you mean by gross head, net head and efficiency of turbine. Explain the different types of efficiencies of a turbine
[BL: Understand| CO: 4|Marks: 7]
(b) The mean bucket speed of a pelton turbine is $15 \mathrm{~m} / \mathrm{s}$. The rate of flow of water supplied by a jet under under a head of $1 \mathrm{~m}^{3} / \mathrm{s}$ If the jet is deflected by the buckets at an angle of $165^{0}$ Find the power and efficiency of turbine. Take coefficient of velocity $C_{v}=0.985$
[BL: Understand| CO: 4|Marks: 7]
MODULE - IV
5. (a) Explain net positive suction head and required net positive suction head, and explain how these two quantities are used to ensure that cavitation does not occur in a pump.
[BL: Understand| CO: $5 \mid$ Marks: 7$]$
(b) A centrifugal pump delivers water against a net head of 14.5 m and design speed of 1000 rpm . The vanes are curved back to an angle of $30^{\circ}$ with periphery. The impeller diameter is 300 mm and outlet width 50 mm . Determine the discharge of the pump if the manometric efficiency is $95 \%$
[BL: Understand| CO: 5|Marks: 7]
6. (a) Differentiate between
i) Reciprocating pumps and centrifugal pumps.
ii) Single stage and multistage centrifugal pump
[BL: Understand| CO: 5|Marks: 7]
(b) The internal and external diameter of the impeller of a centrifugal pump are 300 mm and 600 mm respectively. The pump is running at 1000 rpm . The vane angles of the impeller at inlet and outlet are $20^{\circ}$ and $30^{\circ}$ respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by impeller per unit weight of water. Sketch the velocity triangle.
[BL: Apply| CO: 5|Marks: 7]

## MODULE - V

7. (a) Explain geometric, kinematic and dynamic similarities? Are these similarities truly attainable? If not why?
[BL: Understand| CO: 6|Marks: 7]
(b) A prototype spillway has a characteristic velocity of $3 \mathrm{~m} / \mathrm{s}$ and a characteristic length of 10 m . A small model is constructed by using Froude scaling. What is the minimum scale ratio of the model that will ensure that its minimum Weber number is 100 ? Both flows use water at $20^{\circ} \mathrm{C}$.
[BL: Apply| CO: 6|Marks: 7]
8. (a) State Buckingham $\pi$ theorem. What do you mean by repeating variables? How are the repeating cariables selected in dimenssional analysis.
[BL: Understand| CO: 6|Marks: 7]
(b) The power input $\mathbf{P}$ to a centrifugal pump is a function of the volume flow $\mathbf{Q}$, impeller diameter $\mathbf{D}$, rotational rate $\Omega$, density $\rho$ and viscosity $\mu$ of the fluid.

$$
P=f(\Omega, \rho, Q, D, \mu)
$$

Rewrite this as a dimensionless relationship. Hint: Use $\Omega, \rho$, and D as repeating variables.
[BL: Understand| CO: 6|Marks: 7]
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