MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

ME-505B

APPLIED FLUID MECHANICS

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. $10 \times 1 = 10$

(i) Hydraulic jump occurs in a channel when

(A) Downstream Froude number is greater than unity
(B) Upstream Froude number is greater than unity
(C) Downstream Froude number is less than unity
D) Upstream Froude number is less than unity

(ii) The relation $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$, for an irrotational flow is known as which one of the following?

(A) Navier - Stokes equation (B) Laplace equation
(C) Reynolds equation (D) Euler's equation

(iii) Cavitation will take place if the pressure of the flowing fluid at any point is

(A) more than vapor pressure of the fluid
(B) equal to vapor pressure of the fluid
(C) is less than vapor pressure of the fluid
(D) none of the above

(iv) The area velocity relationship for compressible fluid is

(A) $\frac{dA}{A} = \frac{dV}{A}\left(1 - M^2\right)$ (B) $\frac{dA}{A} = \frac{dV}{V}\left(M^2 - 1\right)$

(C) $\frac{dA}{A} = \frac{dV}{V}\left(1 - V^2\right)$ (D) $\frac{dA}{A} = \frac{dV}{V}\left(C^2 - 1\right)$

(v) Dynamic similarity between the model and prototype is the

(A) similarity of motion (B) similarity of length
(C) similarity of forces (D) similarity of discharge

(vi) Choking of a nozzle fitted to a pressure tank containing gas implies

(A) Sonic velocity at the throat (B) Increase of the mass flow rate
(C) Obstruction of flow (D) All of these

(vii) At critical pressure ratio, the velocity at the throat of a nozzle is

(A) equal to sonic speed (B) less than sonic speed
(C) more than sonic speed (D) none of these

(viii) The stagnation pressure and temperature are

(A) less than their ambient counterparts
(B) more than their ambient counterparts
(C) same as in ambient flow
(D) none of these

(ix) Governing of a turbine means

(A) The head is kept constant under all condition of work
(B) The head is kept constant under all condition
(C) The discharge is kept constant under all condition
(D) None of these

(x) Model analysis of pipe flow are based on

(A) Reynolds Number (B) Froude Number

(C) Mach Number (D) Euler's Number

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Explain the function and performance of a Hydraulic coupling. 5

3. A hydraulic jump forms at the downstream end of spillway carrying 18 m/s discharge. If the depth before jump is determine the depth after the jump and energy loss. 5

4. Explain head-discharge curve for centrifugal pump. 5

5. Define Cavitation. What are the effects of Cavitation? Give the precautions against Cavitation. 5

6. Define Mach number. What is Mach cone? What is zone of silence? Find the value of Mach angle in terms of Mach number. 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. A closed cylindrical vessel of diameter 30 cm and height 100 cm contains water upto a depth of 80 cm. The air above the water surface is at a pressure of 5.886 N/cm^2. The vessel is rotaed at a speed of 250 r.p.m about its vertical axis. Find the pressure head at the bottom of the vessel: (a) at the centre (b) at the edge. 10+5

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8. (a) Prove that for a convergent-divergent duct, the maximum discharge occurs at the throat for M = 1. Also find out the maximum value of the discharge. 9

(b) Air flows steadily and adiabatically from a large tank through a convergent nozzle connected to a constant area duct. The nozzle itself may be connected frictionless. Air in the tank is at p = 1.00 Mpa (abs), T = 125 °C. The absolute pressure at the nozzle exit (the duct inlet) is 784 kPa. Determine the pressure at the end of the duct length L, if the temperature there is 65 °C, and the entropy increases. 6

9. (a) Define specific speed of a centrifugal pump and derive an equation for the same. 1+3

(b) What are the characteristics curves of a centrifugal pump? Draw the operating characteristics of an ordinary centrifugal pump. What is the purpose of Muschel curves? 5

(c) To predict the performance of a large centrifugal pump, its model having the following parameters was constructed: 6
H = 8 m, N = 925 rpm, P = 17.64 kW.
Diameter of the model pump is 9 times smaller than that of the prototype. The prototype has to work against a head of 30 m. Find its working speed and the power required to drive it. Determine the rate of flow for both the pumps.

10. For an incompressible flow turbo machine by using Buckingham-π theorem obtain different π terms. Hence, explain how the different terms head coefficient, capacity coefficient, power coefficient, Reynolds number ,and specific speed are coming from those π terms. 15

11.(a) A sluice gate discharges water into a horizontal rectangular channel with a velocity of 6 m/s and a depth of flow is 0.4 m. The width of the channel is 8 m. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water. 7

(b) Define the terms: (i) Impact of jets and (ii) jet propulsion. 2

(c) A jet of water of diameter 50 mm strikes a curved vane with a velocity of 20 m/s. the vane is moving with a velocity of 10 m/s in the direction of the jet. The jets leave the vane at an angle of 60° to the direction of motion of vane outlet. Find (i) the force exerted by the jet on the vane in the direction of the motion, (ii) work done by the jet on the vane per second. 6

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