

INDIAN MARITIME UNIVERSITY
Time Bound Assignment
B Tech (ME) Arrear Examinations
September/October 2020
UG11T3504
Fluid Mechanics-II

Date: 14/09/2020
Duration: 3 Hrs

Max Marks: 70
Pass Marks: 35

Part – A (compulsory)

Answer the following (10x2=20 Marks)

1. Define Static head and Manometric head of a centrifugal pump.
2. Define specific speed of a centrifugal pump.
3. Draw the operating characteristics curve of a centrifugal pump.
4. Define Co-efficient of discharge and slip of a reciprocating pump.
5. Show the effect of acceleration and friction in suction and delivery pipe of a reciprocating pump on indicator diagram.
6. What do you mean by Negative slip of a reciprocating pump?
7. Write down the advantages and disadvantages of a Francis turbine over a Pelton wheel.
8. Define unit speed and unit discharge of a turbine.
9. Define degree of reaction of a turbine.
10. Discuss three types of similarities between model and prototype.

Part – B

Answer any 5 out of 7 questions (5 x 10= 50 marks)

11. i. Derive the Euler Momentum equation of a centrifugal pump.

(4 Marks)
- ii. A centrifugal pump running at 800 r.p.m. is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and outlet width 60 mm. If the vanes angle at outlet is 40° and Manometric efficiency is 70 percent, determine:
 - (a) Flow velocity at outlet,
 - (b) Absolute velocity of water leaving the vane,
 - (c) Angle made by the absolute velocity at outlet with the direction of motion at outlet, and
 - (d) Rate of flow through the pump

(6 Marks)

12. A centrifugal pump, in which water enters radially, delivers water to a height of 165 mm. The impeller has a diameter of 360 mm and width 180 mm at inlet and the corresponding dimensions at the outlet are 720 mm and 90 mm respectively; its rotational speed is 1200 r.p.m. The blades are curved backward at 30° to the tangent at exit and the discharge is $0.389 \text{ m}^3/\text{s}$. Determine:
- (a) Theoretical head developed,
 - (b) Manometric efficiency
 - (c) The vane angle at inlet, and
 - (d) Power required to drive the pump assuming an overall efficiency of 70%.
 - (e) What would be corresponding mechanical efficiency?
- (10 Marks)**
13. i. Determine the required power to drive a double acting reciprocating pump. **(5 Marks)**
- ii. A single-acting reciprocating pump has a diameter (piston) of 100 mm and stroke length 200 mm. The length and diameter of the suction pipe are 6.5 m and 50 mm respectively. If the suction lift of the pump is 3.2 m and separation occur when pressure in the pump falls below 2.5 m of water absolute and the manometer reads 763 mm of mercury, find the maximum speed at which pump can be run without separation in the suction pipe. **(5 Marks)**
14. Proof that the hydraulic efficiency of a Pelton wheel is maximum when the velocity of the wheel is half the velocity of jet of water at inlet. Determine the maximum hydraulic efficiency of the Pelton wheel also. **(10 Marks)**
15. i. A reaction turbine works at 450 r.p.m. under a head of 120 m. Its diameter at inlet is 1.2 m and the flow area is 0.4 m^2 . The angles made by absolute and relative velocities at inlet are 20° and 60° respectively with the tangential velocity. Determine:
- (a) The volume flow rate,
 - (b) The power developed, and
 - (c) The hydraulic efficiency.
- (6 Marks)**

ii. Determine the overall efficiency of a Kaplan turbine developing 2850 kW under a head of 5.2 m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.8 m above the tail race level. A vacuum gauge connected to the draft tube indicates a reading of 5.2 m of water. Assume draft tube efficiency as 75 percent. Neglect head loss in draft tube. **(4 Marks)**

16. i. Define the following dimensionless numbers: a. Froude Number, b. Euler's Number, c. Weber's Number, d. Mach Number.

(4 Marks)

ii. A test was made on a pipe model 15 mm in diameter and 3 m long with water flowing through it at the corresponding speed for frictional resistance. The head loss was found by measurement to be 7 m of water. The prototype pipe is 300 mm in diameter and 240 m long through which air is flowing at 3.6 m/s. Density of water and air are 1000 kg/m^3 and 1.22 kg/m^3 respectively and co-efficient of viscosity of water and air are 0.01 and 1.8×10^{-4} poise respectively.

Find:

(a) The corresponding speed of water in the model pipe for dynamic similarity;

(b) Pressure drop in prototype pipe. Neglect change of density of the air. **(6 Marks)**

17. i. Water turbine delivering 10 MW power is to be tested with the help of a geometrically similar 1:8 model, which runs at the same speed as the prototype.

(a) Find the power developed by the model assuming the efficiencies of the model and the prototype are equal.

(b) Find the ratio of the heads and the ratio of mass flow rates between the prototype and the model. **(5 Marks)**

ii. 3 m^3 of water per second is lifted to a height of 30 m with an efficiency of 75 percent by single - stage centrifugal pump. The impeller diameter is 300 mm and it is rotating at 2000 r.p.m. Find the number of stages and diameter of each impeller of a similar multi-stage pump to lift 5 m^3 of water per second to a height of 200 m when rotating at 1500 r.p.m. **(5 Marks)**

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