Indian Maritime University

(A Central University, Govt of India)

Mar/Apr'26 SE

Programme Name: B Tech (ME)

Semester: V

Subject Code: UG11T3504

Subject Name: Fluid Mechanics - II

Date: 17.03.2026	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in respective section.
(iii) Assume the density of water as 1000 kg/m^3 and gravity as 9.81 m/s^2 wherever needed.

Section A

Choose the correct answer as applicable. (10x1=10)

1. Euler's equation of turbo-machinery is a conservation of which of the following quantities?
(a) Kinetic energy
(b) Linear Momentum
(c) Angular momentum
(d) None of these

2. In a Francis turbine, how should the blade height change from inlet of the runner to the outlet so as to keep the flow velocity at a constant level?

(a) It should increase from inlet to outlet
(b) It should decrease from inlet to outlet
(c) It should remain unchanged along the length of the blade passage
(d) It should change depending on the inlet blade angle

3. Considering the direction of flow of water in a Pelton turbine, it may be categorized as
(a) radial flow machine
(b) axial flow machine
(c) tangential flow machine
(d) mixed flow machine

4. In a reaction turbine, which of the following locations is most likely to be affected by cavitation?

(a) runner inlet
(b) draft tube exit
(c) runner exit
(d) volute casing

5. In the centrifugal pump, the desired value of whirl velocity at the inlet to the impeller blade is
(a) half of the jet velocity
(b) zero
(c) equal to jet velocity
(d) equal to the outlet whirl velocity

6. The dimensionless flow coefficient in rotodynamic machines is given by:
(a) Q/ND^3
(b) $Q/\rho ND^3$
(c) $Q/\rho ND^2$
(d) Q/ND^2

7. Reciprocating pumps are suitable for _____ pressures and _____ flow rates
(a) high, low
(b) low, high
(c) high, high
(d) low, low

8. Which of the following blade types are preferred for centrifugal pumps?
(a) forward curved
(b) backward curved
(c) radial
(d) none of the above

9. The main function of the draft tube in a reaction turbine is?
(a) to guide the flow properly towards the tail water
(b) to convert the pressure head at runner exit to kinetic head
(c) to convert the kinetic head at runner exit to pressure head
(d) to provide a decreasing flow area in the flow direction in the turbine

10. The phenomenon of slip in centrifugal pump occurs due to
(a) friction on blade surface
(b) curvature of blade
(c) wear and tear of the blade
(d) all of these

Section B

Answer all the questions. (5x2=10)

11. What is priming of a pump? Which component helps to successfully prime a centrifugal pump?

12. Explain the difference between the (i) hydraulic efficiency of turbines and pumps, and (ii) overall efficiency of turbines and pumps.

13. Write a mathematical expression to explain the meaning of degree of reaction in turbines.

14. What is the meaning of specific speed of a pump? How is it different from unit speed of turbine?

15. What is NPSH? How is it related to cavitation?

Section C

Answer any 05 questions (5x10=50).

16. (a) Starting from the velocity triangles at inlet and outlet for a Pelton wheel turbine, show that the wheel efficiency is maximum when the bucket speed is half of the jet velocity. (6)
(b) A Pelton wheel has a mean bucket speed of 10 m/s with the jet of water coming out of the nozzle having a flow rate of 700 litres per second. If the wheel is working under a head of 30 m, and the bucket deflects the jet through 160°, calculate the power delivered to the wheel by the water and the efficiency of the wheel. Assume the bucket to be frictionless and the coefficient of velocity at the nozzle as 0.97. (2+2)

17. The impeller of a centrifugal pump rotating at 900 RPM has an eye radius of 51 mm and an outside diameter of 406 mm. The inlet and outlet blade angles measured from the radial flow direction are 75° and 83° respectively, while the depth of the blade is 64 mm. Assuming zero inlet whirl, zero slip and a hydraulic efficiency of 89%, calculate:
(i) discharge through the impeller
(ii) stagnation and static pressure rise across the impeller
(iii) power transferred to the fluid and input power to impeller (3+4+3)

18. (a) For a given centrifugal pump impeller (outer diameter D_2) running at a constant specified speed (N) with zero whirl at inlet and backward curved blades, develop an expression relating the theoretical head developed ($H_{theoretical}$) and discharge (Q). (6)
(b) What are the various losses that lead to the actual head developed by the centrifugal pump to be different from the theoretical head developed? (4)

19. A Francis turbine has an inlet diameter of 1.4 m and rotates at 430 RPM. Water enters the runner with a flow velocity of 9.5 m/s and leaves the runner without whirl with an absolute velocity of 7 m/s. The difference between the sum of the static and potential heads at the entrance and exit of the runner is 62 m. The turbine develops a power output of 12.25 MW at flow rate of 12 m^3/s. Find:
(i) absolute velocity at runner inlet
(ii) inlet guide vane angle and inlet blade angle
(iii) loss of head in the runner (3+3+4)

20. (a) A single acting reciprocating pump having a cylinder diameter of 150 mm and a stroke of 300 mm is used to raise water through a height of 20 m. If the crank rotates at 120 RPM, calculate the theoretical power required to run the pump and the theoretical discharge through the pump. If the actual discharge is 10 litres/s, find the percentage slip. (4+1)
(b) A reciprocating pump has a suction head of 6 m and a delivery head of 15 m. It has a bore of 150 mm and a stroke of 250 mm, and the piston makes 60 double strokes per minute. Find the force required to drive the piston during the suction and delivery strokes. Also find the power required to drive the pump. (3+2)

21. (a) A centrifugal pump has to handle liquid whose kinematic viscosity is 3 times that of water. The dimensionless specific speed of the pump is 0.183 and it has to discharge $2m^3/s$ of liquid against a head of 15 m. Determine the speed, test head and flow rate for a one-quarter scale model investigation of the full size pump. Assume that the model uses water. The specific speed of pump is given by the relation $K_{sp} = \frac{NQ^{1/2}}{(gH)^{3/4}}$. (3+2+2)
(b) Classify hydraulic turbines on the basis of (i) type of action, (ii) flow direction and (iii) specific speed. Give one example for each type. (3)

22. (a) Calculate the least diameter of the impeller of a centrifugal pump to just start delivering water to a height of 30 m, if the inside diameter of the impeller is half of the outside diameter. The pump runs at 1000 RPM and has a manometric efficiency of 0.8. (5)
(b) Show that when the runner blade angle at the inlet of a Francis turbine is 90° and velocity of flow is constant through the machine, the hydraulic efficiency is given by $\frac{2}{2+tan^2\alpha}$, where α is the inlet guide vane angle. (5)