Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations– June 2023

Programme Name: B Tech (ME)

Semester: V

Subject Code: _UG11T3504

Subject Name: FLUID MECHANICS II

Date: 16.06.2023	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.

QP setters to specify the following as applicable:-

(iii) Tables (Steam/Log/Nautical Almanac etc) that can be used.
(iv) Chart Work Booklets to be used.
(v) Any other tables/charts to be used.

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1. Centrifugal pumps transfer energy from-
(a) Rotor to fluid
(b) Fluid to rotor
(c) Draft to rotor
(d) Rotor to draft

2. 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

3. Which of the following blade types are preferred for centrifugal pumps?
(a) forward curved
(b) Backward curved

(c) radial
(d) None of the above

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

5. Reciprocating pumps are also called as
(a) Force pumps
(b) Mass Pumps
(c) Heat pumps
(d) Speed pumps

6. 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

7. Which of the following efficiencies for Francis Turbine is defined as the ratio between the power available at the shaft to the power supplied by water at the inlet-
(a) Hydraulic efficiency
(b) Volumetric efficiency
(c) Mechanical efficiency
(d) Overall efficiency

8. 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

9. Which of the following quantities has the dimensions $[M^0\ L^0\ T^0]$
(a). Density
(b). Stress
(c). Strain
(d). Strain Rate

10. 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

Section B

Five Questions of 02 Marks each
11. What is priming of a pump? Which component helps to successfully prime a centrifugal pump?

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

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

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

15. Explain the types of similarities with example?

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

16. 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)

17. The outer diameter of an impeller of a centrifugal pump is 400 mm and outlet width is 50 mm. the pump is running at 800 rpm and is working against a total head of 15 m. The vanes angle at outlet is 40° and Manometric efficiency is 75% .Determine-
(i) Velocity of flow at outlet
(ii) Velocity of water leaving the vanes
(iii) Angle made by the absolute velocity at outlet with the direction of the motion.
(iv) Discharge. (2.5+2.5+2.5+2.5)

18.(a) What is use of air vessel in reciprocating pump? (5)

(b) A double acting reciprocating pump, running at 40 rpm is discharging 1 m^3 of water per min. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20m and 5m respectively. Find the slip of the pump and power required to derive the pump. (5)

19. (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)

20. (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)

21. 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)

22. Using Buckingham's π- theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\emptyset(\frac{D}{H}, \frac{\mu}{\rho VH})$ where H is the head causing flow,D is the diameter of the orifice, μ is co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. (10)