72568974

Indian Maritime University

(A Central University, Govt of India)

Sep/Oct'25 SE

Programme Name: B Tech (ME)

Semester: Fourth

Subject Code: UG11T4402

Subject Name: - MARINE TURBO MACHINERY

Date: 26.09.2025	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) Steam tables can be used.

Section A

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

1. If the angle of the inlet absolute velocity (α_1) equals the angle of the outlet relative velocity (β_2) in a steam turbine's moving blade, the turbine is known as:

(a) De Laval turbine
(b) Curtis turbine
(c) Rateau turbine
(d) Parson turbine

2. For an impulse steam turbine with perfectly smooth and symmetrical blades, the maximum diagram efficiency is:
(a) $\cos^2 \alpha_1$
(b) $\cos^2 (\alpha_1 + \beta_2)$
(c) $\cos \alpha_1$
(d) $(2 \cos^2 \alpha_1) / (1 + \cos^2 \alpha_1)$

3. In a gas turbine, ______ design of combustion chamber (combustor) is the most efficient design.
(a) Can combustor
(b) Can-annular combustor
(c) Multi-can combustor
(d) Annular combustor

4. The recommended A/F (air to fuel ratio) for efficient working of gas turbine is ________.

(a) 10
(b) 100
(c) 14.7
(d) 5

5. What is the primary function of a diaphragm in a steam turbine?

(a) To hold the nozzles and seal the stages
(b) To regulate the speed of the turbine shaft
(c) To cool down the steam before entering the next stage
(d) To reduce vibrations in the turbine casing

6. Which of the following physical quantity is dimensionless?
(a) Strain
(b) Angle
(c) Specific gravity
(d) All of the above

7. For the compact design of turbine, the type of turbine preferred is _____
(a) Single spool design
(b) Double/Twin spool design
(c) Triple spool design
(d) All of the above

8. Carryover efficiency can be improved by using _______
(a) Using a steam dryer
(b) Operating the boiler at a higher pressure
(c) Using a chemical water treatment program
(d) All of the above

9. A turbocharger is used in an internal combustion (IC) engine _____
(a) To increase the engine's fuel consumption
(b) To improve the engine's thermal efficiency by reducing heat loss
(c) To force more air into the combustion chamber for better power output
(d) To cool down the engine by circulating compressed air

10. What does Net Positive Suction Head (NPSH) primarily indicate in a pumping system?
(a) The total pressure available at the pump discharge
(b) The velocity of the fluid in the suction pipe
(c) The available pressure at the suction side to prevent cavitation
(d) The efficiency of the pump

Section B

Five Questions of 02 Marks each

11. With a simple sketch, explain the function of Labyrinth seal.
12. What are lacing wires and shrouded blades in steam turbine? Briefly state their purposes.
13. With the help of a Pressure-Volume (PV) diagram, explain the working principle of a turbocharger.
14. What is specific speed and specific diameter of a pump?
15. With the help of a schematic diagram, define the stagger and camber angles for a typical reaction turbine blade.

Section C

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

16. (a) Explain with suitable diagrams, working principle of a pressure-velocity compounded impulse steam turbine showing variations of pressure and velocity of steam as it passes through the turbine.
(b) Justify the purpose of warming up a steam turbine before running it.
(7 + 3 marks)

17. (a) State Buckingham's Pi theorem. Using this theorem for a control volume of pump, combine speed(Ω), fluid density(ρ) and impeller diameter (D) with pressure head (gH) and power (P), derive the relationship for non-dimensional numbers head coefficient and power coefficient. Note: g – Gravitational constant.
(b) A radial flow hydraulic turbine produces 42 kW under a head of 16m and running at 100 rpm. A geometrically similar model producing 32 W and a head of 6 m is to be tested under geometrically similar conditions. If model efficiency is assumed to be 92%, find the diameter ratio between the model and prototype, the volume flow rate through the model, and speed of the model. (5 + 5 marks)

18. (a) With the help of a schematic diagram, explain pulse converter Turbo charging system and list out its advantages.
(b) Explain the difference between constant pressure turbocharging and pulse turbocharging with neat sketch. (4 + 6 marks)

19. (a) Draw the velocity triangles for 0 % and 100 % reaction axial flow turbines. Label all vectors in these triangles.
(b) A single stage gas turbine operates at its design condition with an axial absolute flow at entry and exit from the stage. The absolute flow angle at the nozzle exit is 70 deg. At stage entry, the total pressure and temperature are 311 kPa and 850°C respectively. The exhaust static pressure is 100 kPa, the total to static efficiency is 0.87 and mean blade speed is 500 m/s. Assuming constant axial velocity through the stage, determine (a) the specific work done (b) the axial velocity. Use absolute zero temp = 273 K, C_p = 1148 J/kg *K, γ= 1.33.

(4 + 6 marks)

20. Draw the typical Marine gas turbine propulsion plant (Twin spool arrangement with free turbine). Label all the important components.
(b) Derive the relationship between the degree of reaction and the stage loading coefficient for a general zero-swirl turbine. (6 + 4 marks)

21. (a) Briefly describe any two devices used for starting a gas turbine.
(b) In reference to the apportioning the airflow in a flame tube of a gas turbine, explain the division of airflow in zones, with their function.
(c) Briefly describe with a schematic diagram, a typical lubrication system used in gas turbine. (2 + 4 + 4 marks)

22. The following particulars apply to a two-row velocity compounded impulse stage of a turbine: nozzle angle 17°; blade speed 125 m/s; exit angles of the first row of moving blades, fixed blades and the second row of moving blades, 22°, 26° and 30° respectively. Take the blade velocity coefficient for each row of blades as 0.9, and assume that the absolute velocity of the leaving the stages is in the axial direction. (i) Draw the velocity diagram for both stages with a suitable scale and (ii) Calculate the absolute velocity of the steam leaving the velocity stage.