

**Indian Maritime University**  
**(A Central University, Govt of India)**  
**End Semester Examinations– June 2024**  
**Programme Name: B Tech (ME)**

**Semester: Fourth**

**Subject Code: UG11T4402**

**Subject Name: - MARINE TURBO MACHINERY**

---

Date: 30.05.2024

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. Curtis turbine is:

- (a) velocity compounded turbine
- (b) pressure compounded turbine
- (c) pressure-velocity compounded turbine
- (d) reaction turbine

2. The steam turbines are compounded to

- (a) Increase efficiency
- (b) Decrease turbine speed
- (c) Increase blade speed ratio
- (d) Decrease axial thrust

3. The stage loading is defined as the ratio of the stagnation enthalpy change through a stage to the square of \_\_\_\_\_

- (a) Inlet absolute velocity
- (b) Exit absolute velocity
- (c) Mean blade speed
- (d) Axial velocity

4. 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
5. Which of the following is not satisfied as a starter for marine gas turbines,
- (a) A small diesel engine
  - (b) Another small compact gas turbine.
  - (c) A hydraulic motor
  - (d) A pneumatic starter
6. Internal gear box in a marine steam turbine is used because
- (a) It becomes difficult to bring the drive shaft outwards as it may disturb the gas flow.
  - (b) The gas turbine never equipped with external gearbox
  - (c) Internal gear box is stronger than external gear box.
  - (d) Gear box is only used for running a fuel pump for the turbine.
7. A \_\_\_\_\_ drawn from the head of turbine blade to tail is called as chord.
- (a) curved axis
  - (b) straight line
  - (c) linear axis
  - (d) None of the above
8. Mean radius in a mean line design is equal to
- (a) Half of the mean of sum of all blade tip diameters of turbine.
  - (b) Mean radius of the rotor shaft
  - (c) Half of the mean diameter of the turbine casing
  - (d) Half of the distance between hub radius and tip radius of a blade
9. According to the compressor performance map, it is recommended not to operate the compressor near
- (a) Operating line
  - (b) Design point
  - (c) Stall line
  - (d) None of the above
10. Pulse type turbocharging when installed in a small two stroke diesel engines, then it results
- (a) less effective and insufficient scavenging in part load condition.
  - (b) Very effective and substantial scavenging in part load condition.
  - (c) Similar effect like constant pressure turbocharging.
  - (d) A high-level disaster, so this combination never used.

## Section B

Five Questions of 02 Marks each

11. Indicate and label important angle and velocity terms in velocity diagrams of moving blade in 50% reaction turbine.
12. How the slip is generated in a centrifugal flow compressor?
13. Explain impingement cooling of blades of a gas turbine
14. What is Cordier diagram?
15. What are the advantages and disadvantages of pulse turbocharging?

## Section C

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

16. (a) In reference to the Marine steam turbine blades, illustrate five different type of blade fastening arrangements normally used. (5 marks)
- (b) A 4 stage combination turbine has a two row Curtis wheel as the first stage followed by three stages of Rateau. The 3<sup>rd</sup> and 4<sup>th</sup> stage have slightly higher mean blade radius than the 2<sup>nd</sup> stage. Show how absolute steam pressure and velocity vary in the turbine. Considering the facts that have been mentioned. (5 Marks)
- 17a. Write a short note on steam turbine diaphragms. Bring out the method of fixing and expansion arrangement for impulse turbine diaphragms. (5 marks)
- (b) A parson stage steam turbine receives steam from fixed blades at 90 m/s. The mean blade height is 40 mm, and moving blade exit angle is 20°. Axial velocity is considered as  $\frac{3}{4}$  of blade velocity at mean radius. Steam supply is at rate 9000 kg/h at a specific volume 0.669 m<sup>3</sup>/kg and the effect of blade tip thickness at annulus area can be neglected. Calculate :
  - a) rotational speed (revolutions per second) of the wheel
  - b) the diagram power
  - c) Enthalpy drop in a stage(5 marks)

18(a). A model centrifugal pump with an efficiency of 88% is tested at a rotational speed of 3000 rpm and delivers 0.12 m<sup>3</sup> /s of water against a head of 30m. Using the similarity rules given above, determine the rotational speed, volume flow rate, and power requirement of a geometrically similar prototype at eight times the scale of the model and working against a head of 50m.

(6marks)

- (b) Sketch and describe velocity diagrams of centrifugal flow compressor (4 marks)

19.(a) In reference to Axial flow type turbo-compressors,

Define 'degree of reaction' and 'flow coefficient'.

Draw the velocity triangles at the entry and exit of moving blades.

Deduce the relationship between the 'Degree of reaction', flow coefficient and blade angles. How the relation is applied for 50% reaction? (7 marks)

b) Draw a typical Performance characteristics curves for high speed axial compressor (3Marks)

20(a). 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. (6 marks)

(b) In reference to gas turbine used for ship propulsion, name the components found in the air intake path with a simple sketch. (4 marks)

21.(a) Draw the schematic diagram, demonstrate a Gas turbine closed recuperative cycle with reheat and intercooling. (3 marks)

(b) With the help of a neat sketch explain the concept of blade cooling in gas turbines. (4 Marks)

(c) List out the various advantages and disadvantages of gas turbine over diesel and steam as propulsion plant options. (3marks)

22.(a) In reference to the marine turbochargers used with marine diesel engines, neatly draw the compressor performance curves and the turbine performance curves with mapping. Specify the salient points. (6 marks)

(b) Why an auxiliary blower is required with constant pressure turbocharging? (4 marks)