

Indian Maritime University
(A Central University, Govt of India)
End Semester Examinations – June 2026
Programme Name: B Tech (Marine Engineering)
Semester: VI
Subject Code: UG11T4602
Subject Name: Marine Machinery Systems & Design

Date: 03.06.2026

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) Use of necessary design data book is allowed.
- (iv) Assume suitable data wherever necessary.

Section A

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

1. The types of standards used in design office are

- (a) standards prepared by Bureau of Indian Standards (BIS)
- (b) standards prepared by International Standards Organization (ISO)
- (c) standards prepared by professional bodies like American Gear Manufacturing Association (AGMA)
- (d) all the three

2. Steels used for helical springs are

- (a) medium carbon steel (b) mild steel
- (c) high carbon steel (d) alloy steel

3. When the length of the journal is equal to the diameter of the journal, then the bearing is said to be a _____ bearing.

- a) short, b) long, c) medium, d) square.

4. Hydrodynamic lubrication in sliding bearings occurs when

- a) metal surfaces touch

- b) a full oil film separates surfaces
- c) no lubricant is used
- d) pressure is zero

5. For a four stroke IC engine, at the top dead centre firing position the crankshaft is subjected to _____
a) Maximum bending moment, b) Maximum torsional moment, c) Both a & b, d) None of these.

6. The main function of a flywheel in an internal combustion engine is to
a) increase fuel supply
b) store rotational energy and reduce speed fluctuation
c) cool the engine
d) increase lubrication

7. The most suitable fire extinguisher for electrical fires is
a) water
b) foam
c) CO₂
d) sand

8. The Emergency fire pump is not located in _____
a) Engine room, b) Steering gear room, c) Bow thruster room, d) Shaft tunnel.

9. As per SOLAS, the main steering gear should be capable of moving the rudder from 35° on one side to 35° on the other side at maximum service speed within

- a) 10 seconds
- b) 20 seconds
- c) 28 seconds
- d) 60 seconds

10. The propulsion shaft system of a cargo vessel is subject to complex stress conditions, ----- enduring bending, shear, and corrosion-related fatigue.
a) Thrust shaft, b) Intermediate shaft, c) Tail-end shaft, d) None of these.

Section B

Five Questions of 02 Marks each

11. Define the term machine.

12. Explain: 'design synthesis' in marine machinery design process.

13. Define the term mechanical advantage.

14. Explain: 'whipping stress' in connecting rod for I.C. engine.

15. Explain in brief the design considerations for determining the compressed air system requirement for starting a main engine

Section C

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

16. Design a helical compression spring for the exhaust valve of a medium-speed marine diesel engine. The spring is required to withstand cyclic loading during valve operation. The spring has to support a maximum valve load of 900 N. Due to space limitations in the cylinder head assembly. The outer diameter of the spring should not exceed 60 mm. The solid length should not exceed 75 mm. The free length of the spring should not exceed 160 mm. The allowable shear stress for the spring material (alloy steel valve spring wire) is 600 MPa, and the modulus of rigidity $G = 80000 \text{ N/mm}^2$. Assume Spring index is 6. Determine a) Wire diameter b) Mean coil diameter c) No of active coils d) Stiffness e) Check the design for the safety against shear stress. (10 marks)

17. A machine is driven by a motor, which exerts a constant torque. The resisting torque of the machine increases uniformly from 500 N-m to 1500 N-m through a 360° rotation of the driving shaft and drops suddenly to 500 N-m again at the beginning of the next revolution. The mean angular velocity of the machine is 30 rad/s and the coefficient of speed fluctuations is 0.2. A solid circular steel disk, 25 mm thick, is used as flywheel. The mass density of steel is 7800 kg/m^3 , while Poisson's ratio is 0.3. Calculate the outer radius of the flywheel disk and the maximum stresses induced in it. (10 marks)

18. The load on the journal bearing is 150 kN due to propeller shaft of 300 mm diameter running at 1800 r.p.m.

Evaluate: A.] Length of the bearing if the allowable bearing pressure is 1.6 N/mm^2 , and B.] Amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C , viscosity of the oil at 60°C is 0.02 kg/m-s and the bearing clearance is 0.25 mm. (Take $k=0.002$) (10 marks)

19. a) Explain about bulk CO_2 system with neat sketch. (5 marks)

b) A CO_2 cylinder used in a marine fire-fighting system has an internal diameter of 250 mm and is subjected to an internal pressure of 6 MPa. The permissible tensile stress for the cylinder material is 120 MPa. Determine: The required thickness of the cylinder wall using Lame's equation. The

maximum hoop stress in the cylinder. Assume the cylinder is closed at both ends. (5 marks)

20. A 15,000 GRT general cargo vessel is fitted with a main engine developing a brake power of 15 MW at 110 RPM, directly coupled to the propeller shaft through a thrust block and intermediate shaft. The given design data are as follows: Allowable shear stress: 25 MN/m², Ship speed: 15.5 knots, Wake speed: 5 knots, Transmission efficiency: 0.95, Propeller efficiency: 0.60, Number of thrust pads: 6, Angle subtended by each pad: 40°, Clearance between pads: 18 mm, Allowable bearing pressure: 2.35 MN/m². Using the given data, determine the following design parameters for the propulsion shafting system:

- a) Diameter of the thrust shaft. (4 Marks)
 - b) Total surface area of each thrust pad (3 Marks)
 - c) Outer diameter of the thrust pad (3 Marks)
21. (A) Draw a neatly labelled schematic circuit diagram of Hydraulic circuit for four-ram electro-hydraulic steering gear. (4 Marks)
- (B) Explain the function and operation of the fuel injection pump in diesel engines operating on the dual combustion cycle. Additionally, discuss the common problems associated with fuel injection and suggest suitable remedial measures to overcome them. (6 Marks)

22. State and explain the main steps involved in the Finite Element Method (FEM) for analysing a static structural problem using commercial software like ANSYS to determine stress and deformation due to applied load. (10 marks)

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