**Indian Maritime University**

**(A Central Univ6ersity, Govt of India)**

**End Semester Examinations – June 2025**

**Programme Name: B Tech (Marine Engineering)**

**Semester: SIXTH**

**Subject Code: UG11T4602**

**Subject Name: MARINE MACHINERY SYSTEMS AND DESIGN**

Date: 02.06.2025 Max Marks: 70

Duration: 03 Hrs Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.

(ii) Design data Handbook is allowed for the examination

## Section A

**Ten MCQs of 01 Mark each – Choose the correct answer as applicable.**
**10x1=10**

1. Which type of spring is used in marine safety valves to regulate pressure and prevent overloading?
(A) Leaf spring (B) Helical compression spring (C) Belleville spring
(D) Helical torsion spring

2. In thrust bearings, the load acts
(A) Along the axis of rotation (B) parallel to the axis of rotation
(C) Perpendicular to the axis of rotation (D) in any direction

3.Two shafts A and B are made of same material. The diameter of shaft A and B are $d_A$ and $d_B$ respectively. The ratio of torque transmitted by the shaft A to that of shaft B will be

(A) $\left[\frac{d_A}{d_B}\right]^1$ (B) $\left[\frac{d_A}{d_B}\right]^2$ (C) $\left[\frac{d_A}{d_B}\right]^3$ (D) $\left[\frac{d_A}{d_B}\right]^4$

4. If the inner diameter of the air bottle is 25 times of the thickness, then the thickness of air bottle cylinder is determined on the basis of,
(A) radial stress (B) circumferential stress (C) longitudinal stress (D) principal shear stress

5. What is the main reason $CO_2$ is effective in extinguishing fires?
A) It cools down the fire B) It displaces oxygen and smothers the fire

C) It absorbs moisture from the air D) It creates a protective layer over the fire

6. Which of the following is NOT a type of fire extinguisher used on ships?
A) Dry chemical powder B) Foam C) Water mist D) Ammonia-based

7. In an electro-hydraulic steering gear system, the primary power source is:
A) Compressed air B) Electricity C) Diesel fuel D) Steam

8.For a 4Stroke engine, at the top dead canter position ( firing TDC), the crankshaft is subjected to,
(A) maximum bending moment (B) maximum torque
(C) maximum torsional and bending moment (D) none of these

9. Preferred sizes in design are chosen based on:
A) Manufacturing feasibility and material availability
B) Designer's personal preference
C) Random selection
D) Theoretical calculations only

10. If the LO pump discharges 250 $M^3$/hr of oil at 6 bar pressure with a mechanical and hydraulic efficiency of 90% and 80 % respectively, then what is the motor power available for the pump
(A) 41.6 kW (B) 57.5 kW (C) 108 kW (D) 30 kW

## Section B

**Five short Questions of 02 Marks each** **5x2=10**

11. Distinguish between hydrostatic and hydrodynamic lubricated journal bearings.
12. State any four factors affecting the design of a flywheel?
13. What is the role of a rudder stock in an electro-hydraulic steering gear system?
14. What is throughput of a lube oil purifier. When high and low throughput is used?
15. What are the advantages of using a hollow shaft in transmission shafting system.

## Section C

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

16. A helical valve spring of circular wire is to be designed for an operating load range of approximately 90 to 135 N. The deflection of the spring for the load range is 7.5 mm. Assume a spring index of 10. Permissible shear stress for the material of the spring = 480 MPa and its modulus of rigidity = 80 GPa. Use the Wahl's stress factor as $K=\{(4C-1)/(4C-4)+(0.615/C)\}$. Assume square and ground end coils. Design the spring and determine (i) wire diameter; (ii) mean coil diameter;

(iii) number of active coils & Total number of coils; (iv) free length of spring; and (v) pitch. (10 Marks)

17. The cast-iron piston for a single-acting four-stroke I.C. engine has the following specifications:
Cylinder bore= 100 mm; Stroke length= 120 mm; Maximum gas pressure= 6 MPa Brake mean effective pressure= 0.7 MPa; Fuel consumption= 0.24 kg/kW-hr; Speed= 2200 rpm; Allowable tensile strength of piston material = 40MPa; HCV for diesel = $44 \times 10^3$ KJ/kg; thermal conductivity factor= $46.6 \times 10^{-3}$ kW/m/$^0$C; temperature difference ($T_c$-$T_e$) = 220$^0$C. Calculate the thickness of the piston the (i) piston head, (ii) ribs, (iii) rings (assume total rings = 5; allowable bending stress of ring material = 100 MPa; and contact pressure = 0.035 MPa), and (iv) barrel. (10 Marks)

18. A 150 mm diameter shaft supporting a load of 10 kN has a speed of 1500 r.p.m. The shaft runs in a bearing whose length is 1.5 times the shaft diameter. If the diametral clearance of the bearing is 0.15 mm and the absolute viscosity of the oil at the operating temperature is 0.011 kg/m-s, find the power wasted in friction. (10 Marks)

19. (a) Sketch a low-pressure bulk $CO_2$ system suitable for Cargo Space.
(b) For a ship's engine room $CO_2$ system is to be installed. Machinery space without casing having a volume of 15000 $M^3$. A 5% extra quantity planned to be kept to compensate losses. Take, Specific volume of $CO_2$ is 0.56 $M^3$/kg, Assume Density of $CO_2$ liquid 1100 kg/$M^3$.
(i) Find the dimension of the cylinder if $CO_2$ is kept as bulk up to 85% by volume. The cylinder length is 2.5 times of radius. The end plates are ellipsoidal with minor axis 0.55 of major axis.
(ii) Find the number of cylinders, if gang release system is used, if each cylinder is filled with 45 kgs of $CO_2$.
5+5 =10

20. A thrust block is installed on a ship's main engine to absorb the axial thrust. Given the following data, determine the necessary design parameters:
a) Determine the required diameter of the thrust shaft. (4 Marks)
b) Compute the total surface area of each thrust pad. (3 Marks)
c) Find the outer diameter of the thrust pad. (3 Marks)
The given parameters are as follows: Power of the engine: 18 MW Rotational speed of shaft: 140 rpm Allowable shear stress: 28 MN/m$^2$ Angle subtended by thrust pads at the center: 50° Ship velocity: 18.5 knots Wake velocity: 5.5 knots Transmission efficiency: 0.96 Propeller efficiency: 0.68 Total number of thrust pads: 5 Clearance between inner edge of pads and thrust shaft: 22 mm Allowable pressure on thrust pads: 2.55 MN/m$^2$

21. (a) Discuss the function of air receivers in a marine diesel engine air-starting system. (5 Marks)

(b) Explain the working of a fuel injection pump (Bosch type) in a marine diesel engine with a suitable sketch.

(5 Marks)

22. Describe and explain the steps involved in the finite element method with suitable sketches. (10 Marks)