FDTY5216

Indian Maritime University

(A Central University, Govt of India)

Sep/Oct'25 SE

Programme Name: B TECH (ME)

Semester: VI

Subject Code: UG11T4602

Subject Name: MARINE MACHINERY SYSTEM AND DESIGN

Date: 18.10.2025	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.

Section A

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

1. What is the primary objective of the design process in mechanical engineering?
   a) To create the cheapest design
   b) To follow the steps of an established procedure
   c) To maximize energy consumption
   d) To avoid using standards in design

2. Which of the following is not a component typically found in marine machinery design?
   a) Crank shaft
   b) Connecting rod
   c) Torsion Spring
   d) Electric motor

3. Which software is commonly used for 3D modeling in computer-aided design (CAD)?
   a) Microsoft Word
   b) AutoCAD
   c) Adobe Photoshop
   d) MATLAB

4. What is the role of a flywheel in marine machinery?
   a) To regulate the flow of fuel
   b) To store energy and smooth power delivery
   c) To filter exhaust gases
   d) To circulate lubricating oil

5. Which of the following is a key component in the design of a marine diesel engine fuel system?
   a) Turbocharger
   b) Fuel pump
   c) Water pump
   d) Exhaust manifold

6. In the design of marine systems, the electro-hydraulic steering gear includes which of the following components?
   a) Compressor
   b) Rudder stock
   c) Heat exchanger
   d) Fuel injector

7. Which of the following tools is used for finite element analysis (FEA) in stress and strain calculations?
   a) SolidWorks
   b) ANSYS
   c) AutoCAD
   d) NX

8. In the design of a bulk CO2 system, which factor is crucial in deciding whether to use a low or high-pressure system?
   a) Cost of the CO2
   b) Efficiency of the CO2 storage
   c) Pressure at which CO2 is stored and transported
   d) The size of the system's pipes

9. Which type of bearing is specifically designed to handle axial loads in marine machinery?
   a) Journal bearing
   b) Thrust bearing
   c) Roller bearing
   d) Radial bearing

10. When designing a marine system's firefighting system, what is the main consideration for the emergency fire pump?
   a) The colour of the pump
   b) The noise level of the pump
   c) The pump's ability to maintain pressure under emergency conditions

d) The pump's size and shape

Section B

Five Questions of 02 Marks each

11. What is the purpose of design synthesis in the mechanical design process? (2M)
12. Define the term "piston" and its role in marine machinery components. (2M)
13. What is the function of a bulk CO2 system in marine systems? (2M)
14. What is the role of computer-aided design (CAD) in modern mechanical design? (2M)
15. At what pressure is CO2 typically stored in a high-pressure CO2 system, and at what pressure is it tested? (2M)

Section C

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

16. Calculate internal radius of low-pressure CO2 system, given volume of machinery space 7000 m3, content of CO2 in bottle is 90%, a=R, b=0.556a, L= 2.575 R(10M)

17. Calculate the motor power required to drive the compressor and following data is given no. of stages is 2, compression index is 1.3, suction pressure is 1.035 bar, discharge pressure is 30 bar, volume of air compressed per second is 300/3600 m^3/s. mechanical efficiency of compressor is 85%. For energy efficient operation of electric motor, motor should run at 85% MCR. (10M)

18. A helical torsion spring is made of a circular wire of diameter 6 mm and has a mean coil diameter of 50 mm. The spring has 12 active coils and is subjected to an angular moment of 5 Nm. The modulus of rigidity (shear modulus) for the material is 80 GPa.

Determine:

1. The maximum shear stress induced in the spring wire. (5M)
2. The angular deflection of the spring in degrees.
   Assume standard torsion spring theory. (5M)

19. A thrust block is fitted on main engine.

a) Calculate thrust shaft diameter (4M)

b) Calculate area of each thrust pad (4M)

c) Calculate outside diameter of thrust pad (3M)

Given: Brake Power= 20 MW, N= 120 rpm, Allowable shear Stress= 30MN/m 2. Angle subtended by pads at the centre =45 degree,

Velocity of ship= 17.1 Knots
Velocity of wake= 5.13 knots, Transmission efficiency= 0.98, Propeller efficiency= 0.65, Total number of pads= 6, Clearance between inner edge of pads and thrust shaft= 20 mm, Total number of thrust pads :6, Allowable pressure on thrust pads :22.414MN/mt (10M)

20.Design the piston head (crown) of a cast iron piston for a single-acting four-stroke engine using the following specifications:
Cylinder Bore = 110 mm
Stroke Length = 140 mm
Maximum Gas Pressure = 6 N/mm^2
Indicated Mean Effective Pressure (IMEP) = 0.85 N/mm^2
Mechanical Efficiency = 82%
Fuel Consumption = 0.18 kg per brake power per hour
Higher Calorific Value (HCV) of Fuel = 44,000 kJ/kg
Engine Speed = 2200 rpm
Determine:

1. The thickness of the piston head using Grashof's formula. (5M)
2. The heat dissipation requirement of the piston head. (5M)

21.A crankshaft is subjected to a completely reversed bending moment of 2000 Nm and a steady torsional moment of 1500 Nm. The material of the crankshaft has an ultimate tensile strength (UTS) of 600 MPa and a yield strength of 400 MPa. The factor of safety is 3, and the load correction factors for bending and torsion are 0.8 and 0.6, respectively. (10M)

Determine:

1. The equivalent bending moment using the modified Goodman equation. (5M)
2. The required diameter of the crankshaft using the ASME code formula. (5M)

22. (a) How does CAD software facilitate stress analysis in mechanical components and explain the difference between static and dynamic stress analysis in CAD? (5M)
(b) What are the primary factors that influence stress distribution in a mechanical structure and how to interpret stress analysis results obtained from CAD simulations. Discuss the importance of stress concentration analysis in CAD For identifying potential failure points? (5M)