

Enrollment No.....



Faculty of Engineering / Science
End Sem Examination May-2024
EN3ES18 / BC3ES05 / BC3ES06
Basic Mechanical Engineering

Programme: B.Tech./ B.Sc

Branch/Specialisation: All

Duration: 3 Hrs.**Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

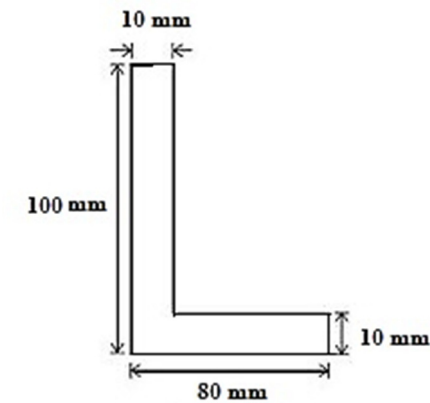
- Q.1 i. Which of the following attributes explain why pure metals are not frequently used in engineering applications? **1**
 (a) Highly ductile (b) Hardness
 (c) Brittleness (d) High tensile strength
- ii. Which one of the following is the resistance of a material to plastic deformation by indentation? **1**
 (a) Toughness (b) Hardness
 (c) Brittleness (d) Fatigue
- iii. Which one of the following law is used to understand the conservation of energy? **1**
 (a) Zeroth law (b) First law
 (c) Second law (d) All of these
- iv. The value of workdone is zero for which process- **1**
 (a) Isothermal (b) Reversible adiabatic
 (c) Isobaric (d) Isochoric
- v. Scavenging process is associated with which one of the following engine- **1**
 (a) Four stroke petrol engine
 (b) Four stroke diesel engine
 (c) Two stroke petrol engine
 (d) None of these
- vi. The volume occupied by piston between TDC and BDC is known as- **1**
 (a) Dead volume (b) Compression ratio
 (c) Clearance volume (d) Swept volume

[2]


- vii. The economiser is used in boiler to- **1**
 (a) Increase the steam pressure
 (b) Increase flue gas temperature
 (c) Economise the fuel
 (d) Increase the thermal efficiency
- viii. Value of dryness fraction for dry and saturated steam is- **1**
 (a) Zero (b) Zero to one (c) One (d) One to Two
- ix. The point at which the total area of a plane figure is assumed to be concentrated is called- **1**
 (a) Centroid (b) Centre of gravity
 (c) Central point (d) All of these
- x. The axis about which moment of area is taken is known as- **1**
 (a) Axis of area (b) Axis of moment
 (c) Axis of reference (d) Axis of rotation
- Q.2 i. Define toughness and hardness with example. **2**
 ii. Explain the stress strain diagram for gray cast iron. **3**
 iii. Define malleable cast iron, its important mechanical properties and applications. **5**
- OR iv. Define ductile cast iron, its important mechanical properties and applications. **5**
- Q.3 i. Define thermodynamic system and its types with suitable examples. **3**
 ii. Enlist limitations of first law of thermodynamics. Explain two important statement of second law with suitable diagram. **7**
- OR iii. A domestic food freezer maintains a temperature of -15°C . The ambient air is at 30°C . If the heat leaks into the freezer at a continuous rate of 1.75 KJ/s , what is the least power necessary to pump the heat out continuously? **7**
- Q.4 i. Explain the working of four stroke diesel engine with suitable diagram. **4**
 ii. Air is supplied at 1 bar, and 300 K in diesel cycle with compression ratio is 14. Find the pressure and temperature at the end of compression. **6**
- OR iii. Derive an expression for efficiency of Otto cycle with suitable pressure volume diagram. **6**

[3]

- Q.5 i. Explain any two important boiler performance parameters with formula. **4**
 ii. Find the enthalpy, internal energy and entropy of steam when the pressure is 2 MPa and specific volume is $0.09 \text{ m}^3/\text{kg}$. **6**
- OR iii. Explain the construction and working of Cochran boiler. **6**
- Q.6 i. Differentiate between centre of gravity and centroid. **3**
 ii. Derive an expression for moment of inertia of rectangular lamina about both axes passing through its centroid. **7**
- OR iii. Find the moment of inertia of given L section about an axis passing through its centroid and parallel to its base. **7**



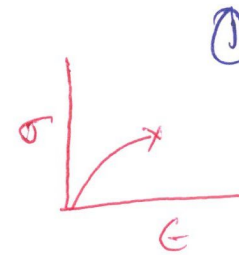
Scheme of Marking

| | | | |
|---|--|--|--|
|  | Faculty of Engineering End Sem Examination May-2024 Basic Mechanical Engineering (T) - EN3ES18 (T) Programme: B.Tech. Branch/Specialisation: | | |
|---|--|--|--|

Note: The Paper Setter should provide the answer wise splitting of the marks in the scheme below.

| | | | | |
|-----|-------|--|-----|------|
| Q.1 | i) | a) Highly ductile | ✓ | 1 |
| | ii) | b) Hardness | ✓ | 1 |
| | iii) | b) First law | ✓ | 1 |
| | iv) | d) Isochoric | ✓ | 1 |
| | v) | c) Two stroke petrol engine | ✓ | 1 |
| | vi) | d) Swept volume | ✓ | 1 |
| | vii) | d) Increase the thermal efficiency | ✓ | 1 |
| | viii) | c) One | ✓ | 1 |
| | ix) | a) Centroid | ✓ | 1 |
| | x) | c) Axis of reference | ✓ | 1 |
| Q.2 | i. | Definition of toughness with example | | 1 |
| | | Definition of hardness with example. | | 1 |
| | ii. | Stress strain diagram for gray cast iron. | | 1 |
| | | Explanation of the stress strain diagram. | | 2 |
| | iii. | Introduction of malleable cast iron | | 1 |
| | | Mechanical properties | - 2 | 2 |
| | | Applications. | - 2 | 2 |
| | iv. | Introduction of ductile cast iron | | 1 |
| | | Mechanical properties | | 2 |
| | | Applications. | | 2 |
| Q.3 | i. | Definition of thermodynamic system | | 1 |
| | | Its types and examples. | | 2 |
| | ii. | limitations of first law of thermodynamics | | 1 |
| | | Each statement and diagram 3 Marks *2 | | 6 |
| OR | iii. | Final COP = 5.73 least power necessary = 0.3 kW | | 3, 4 |

| | | | |
|-----|------|--|--------|
| Q.4 | i. | 1 Mark for explanation of each stroke | 4 |
| | ii. | Final pressure = 40.23 bar | 3 |
| | | Final temperature = 862.13 K | 3 |
| OR | iii. | Pressure volume diagram Derivation | 1 5 |
| Q.5 | i. | Equivalent evaporation | 2 |
| | | Boiler efficiency | 2 |
| | ii. | Enthalpy = 2610.43 kJ/kg | 2 |
| | | Internal energy = 2430.91 kJ/kg | 2 |
| | | Entropy = 5.95 kJ/kg | 2 |
| OR | iii. | Construction of boiler Working of boiler | 3 3 |
| Q.6 | i. | 1 Mark for each difference | 3 |
| | ii. | Moment of inertia about x - axis | 3.5 |
| | | Moment of inertia about y - axis | 3.5 |
| | iii. | Locate centroid of lamina $\bar{x} = 21.47 \text{ mm}$ | 3 |
| | | Calculate MOI $\bar{y} = 31.47 \text{ mm}$ | 4 |



$$I_{xx} = 1.176 \times 10^6 + 0.496 \times 10^6$$

$$I_{xx} = 1.672 \times 10^6 \text{ mm}^4$$

$$I_{yy} = 0.28 \times 10^6 + 0.673 \times 10^6$$

$$I_{yy} = 0.953 \times 10^6 \text{ mm}^4$$

Verified

2(11)

$$0.09 = 0.00117 + x(0.0996 - 0.00117)$$

$$x = 0.948$$

$$\boxed{x = 0.9}$$

h =

$$\boxed{2610.43}$$

3(111)

$$COP = \frac{T_L}{T_H - T_L} = \frac{258}{303 - 258} = 5.73$$

$$5.73 = \frac{Q_L}{W} \Rightarrow W = 0.3 \text{ kJ/sec}$$

$$4f = 906.4$$

$$4g = 2600.2$$

$$4h = 908.8$$

$$4j = 2799.5$$

$$2.447 = 5f$$

$$6.34j = 5g$$

4

5

$$\boxed{2430.91}$$

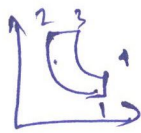
$$\boxed{5.9516}$$

4(11)

$$P_1 = 1 \text{ bar}$$

$$T_1 = 300 \text{ K}$$

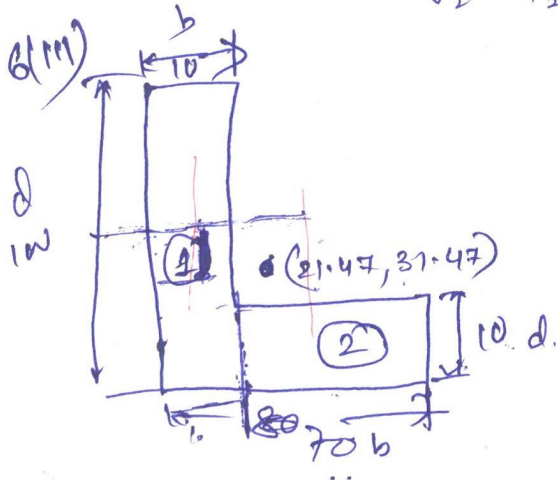
$$\gamma = 1.4$$



$$P_2 = P_1 (r)^{\gamma} = 1 \times (14)^{\gamma} = 50.23 \text{ bar} \quad (3)$$

$$T_2 = T_1 (r)^{\gamma-1} = 300 \times (14)^{0.4} = 862.13 \text{ K} \quad (3)$$

$$Q_s = C_v (T_3 - T_2) \quad r = \frac{V_3}{V_2} = \frac{T_3}{T_2}$$



$$A_1 = 10 \times 100 = 1000 \text{ mm}^2$$

$$A_2 = 70 \times 10 = 700 \text{ mm}^2$$

$$x_1 = 5 \quad y_1 = 50 \text{ mm}$$

$$x_2 = 45 \quad y_2 = 5 \text{ mm}$$

$$\bar{x} = \frac{1000 \times 5 + 700 \times 45}{1700} = 21.47$$

$$\bar{y} = \frac{50 \times 1000 + 700 \times 5}{1700} = 31.47$$

$$I_{xx} = I_{xx1} + I_{xx2}$$

$$= \frac{bd^3}{12} + A(y_1 - \bar{y})^2$$

$$I_{xx1} = \frac{10 \times 100^3}{12} + 1000(50 - 31.47)^2$$

$$= 1.176 \times 10^6 \text{ mm}^4$$

$$I_{xx2} = \frac{70 \times 10^3}{12} + 700(5 - 31.47)^2$$

$$= 583333$$

$$= 0.496 \times 10^6 \text{ mm}^4$$

$$I_{xx} = 1.672 \times 10^6 \text{ mm}^4$$

$$I_{yy} =$$

$$I_{yy} = I_{yy_1} + I_{yy_2}$$

$$I_{yy} = \frac{100 \times 10^3}{12} + 1000(5 - 21.47)^2 + \frac{10 \times 70^3}{12} + 700(45 - 21.47)^2$$

$$= 0.28 \times 10^6 + 0.673 \times 10^6$$

$$= 0.953 \times 10^6 \text{ mm}^4$$