

**PART C**  
**General Engineering**  
**(MECHANICAL)**

1. (a) Define the following : 15  
 (i) Reversible and Irreversible process  
 (ii) External and Internal irreversibility  
 (iii) Intensive and Extensive properties
- (b) Describe the following : 15  
 (i) Clausius Statement  
 (ii) Kelvin-Planck Statement  
 (iii) Perpetual motion machine of the second kind
- (c) Volume of  $0.1 \text{ m}^3$  of an ideal gas at  $300 \text{ K}$  and  $1 \text{ bar}$  is compressed adiabatically to  $8 \text{ bar}$ . It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Determine : 15  
 (i) Pressure at the end of constant volume cooling  
 (ii) Change in internal energy during constant volume process  
 (iii) Net work done and heat transferred during the cycle.  
 Take  $c_p = 14.3 \text{ kJ/kg K}$  and  $c_v = 10.2 \text{ kJ/kg K}$ .
- (d) A reversible heat engine operates between two reservoirs at temperatures  $700^\circ\text{C}$  and  $50^\circ\text{C}$ . The engine drives a reversible refrigerator which operates between reservoirs at temperatures of  $50^\circ\text{C}$  and  $-25^\circ\text{C}$ . The heat transfer to the engine is  $2500 \text{ kJ}$  and the net work output of the combined engine refrigerator plant is  $400 \text{ kJ}$ . 15  
 (i) Calculate the heat transfer to the refrigerant and the net heat transfer to the reservoir at  $50^\circ\text{C}$ ;  
 (ii) Reconsider (i) given that the efficiency of the heat engine and the C.O.P. of the refrigerator are each 45 percent of their maximum possible values.

2. (a) Give the comparisons between Otto cycle, Diesel cycle and Dual cycle. 15
- (b) An air standard Otto cycle is to be designed according to the following specifications. Pressure at the start of the compression process = 101 kPa; Temperature at the start of the compression process = 300 K; Compression ratio = 8; Maximum pressure in the cycle = 8.0 MPa. Find
- (i) the net work output per unit mass of air
  - (ii) cycle efficiency
  - (iii) MEP 15
- (c) Explain the effect of Superheating and Sub-cooling on vapour compression refrigeration cycle. 15
- (d) An air standard Brayton cycle has air entering the compressor at 100 kPa and 27°C. The pressure ratio is 10 and the maximum allowable temperature in the cycle is 1350 K. Determine 15
- (i) temperatures at salient points of the cycle
  - (ii) compressor and turbine work per unit mass of air
  - (iii) net work output and work ratio
  - (iv) thermal efficiency of the cycle
  - (v) specific air consumption in kg/kWh
  - (vi) improvement in the thermal efficiency of the cycle if a regenerator with 100% effectiveness is incorporated in the cycle

3. (a) Define density, specific volume, weight density, specific gravity and Bulk Modulus. 15
- (b) A ship weighing 4000 tons and having an area of  $465 \text{ m}^2$  at water line submerging to a depth of 4.5 m in sea water with a density of  $1024 \text{ kg/m}^3$  moves to fresh water. Determine the depth of submergence in fresh water. Assume that the sides are vertical at the water line. 15
- (c) What is cavitation ? How does it affect the performance of hydraulic machines ? 15
- (d) The following details refer to a centrifugal pump :  
 Outer diameter : 30 cm, Eye diameter : 15 cm, Blade angle at inlet :  $30^\circ$ , Blade angle at outlet :  $25^\circ$ , Speed 1450 rpm. The flow velocity remains constant. The whirl at inlet is zero.  
 Determine the work done per kg. If the manometric efficiency is 82%, determine the working head. If width at outlet is 2 m, determine the power  $\eta_0 = 76\%$ . 15
4. (a) Write short notes on the following : 15
- (i) Stainless steel
- (ii) High speed steel
- (iii) High carbon steel
- (b) With the help of figure, describe the Shielded Metal Arc Welding process. 15
- (c) Explain the different operations performed in grinding machine. 15
- (d) Mention the differences between shaper and planer machine tools. 15

5. (a) Give the classification of kinematic pairs. 15
- (b) An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Calculate the speed of the dynamo shaft, when (i) there is no slip, and (ii) there is a slip of 2% at each drive. 15
- (c) Mention the comparison between involute and cycloidal gears. 15
- (d) Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor.
6. (a) Three forces of  $2P$ ,  $3P$  and  $4P$  act along the three sides of an equilateral triangle of side 100 mm taken in order. Find the magnitude and position of the resultant force. 15
- (b) A body of weight 300 N is lying on a rough horizontal plane having a coefficient of friction as 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of  $25^\circ$  with the horizontal. 15
- (c) Derive the expression for the shear stress in a circular shaft subjected to torsion. 15
- (d) Derive the expression for circumferential stress in a thin cylindrical vessel. 15