

Question Paper 2015

Mechanical Engineering (Paper II)

1. (a) Derive the thermal efficiency and mean effective pressure expressions for air standard diesel engine. (15)
 - (b) Describe the processes involved in a simple Rankine cycle with relevant diagrams. Also, explain the effect of pressure and temperature on simple Rankine cycle. (15)
 - (c) A single-acting two-stage reciprocating air compressor with complete intercooling delivers 6 kg/min at 15 bar pressure. Assume an intake condition of 1 bar and 15°C. The compression and expansion processes are assumed polytropic with $n = 1.3$.
Determine (15)
 - (i) the power required
 - (ii) isothermal efficiency
 - (d) In a stage of reaction turbine, the mean diameter of the rotor is 1.4 m. The speed ratio is 0.7. Determine the blade inlet angle, if the blade outlet angle is 20°. The rotor speed is 3000 rpm. Also find the diagram efficiency and work done per kg of steam. (15)
2. (a) Draw the Phase diagram on p-v coordinates for a substance which shrinks in volume on melting. Explain the relevant constant property lines. (15)
 - (b) Prove that a system which violates the kelvin-Planck statement of second law also violates the Clausius statement of the second law. (15)
 - (c) A centrifugal pump delivers 2730 kg/min water by increasing the pressure from 0.8 bar to 2.8 bar. The suction is 2 m below the centre of the pump and delivery is 5 m above the centre of the pump. The suction and delivery pipe diameters are 15 cm and 10 cm respectively. Find the power required to run the pump. (15)
 - (d) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between the reservoirs at temperatures of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and net work output of the combined engine refrigerator plant is 360 kJ. (15)
 - (i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.
 - (ii) Also determine the same parameters as given in (i) when the efficiency of the heat engine and COP of the refrigerator are each 40% of their maximum possible.
3. (a) Explain the performance characteristics of centrifugal pumps with the help of figures. (15)
 - (b) Deduce an expression for the specific speed of a hydrodynamic machine and point out how the classification of turbines is based on specific speed. (15)
 - (c) A 2 m long pipeline tapers uniformly from 10 cm diameter to 20 cm diameter at its upper end. The pipe centre line slopes upwards at an angle of 30° to the horizontal and the flow direction is from smaller to bigger cross-section. If the pressure gauges installed at the lower and upper ends of the pipeline read 200 kPa and 230 kPa respectively, assume that no energy loss occurs. Calculate the flow rate and the fluid pressure at the mid-length of the pipeline. (15)
 - (d) An inclined rectangular sluice gate, 4 m wide \times 1 m deep, has been installed to control the discharge of water. The upper end A is hinged and lies at a distance of 2 m from the free surface of water. What force normal to the gate should be applied at the lower end B to open it? (15)
4. (a) Differentiate between up-milling and down-milling. Also explain their applications. (15)

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- (b) Describe with figure the constructional features of a twist drill and label the features. (15)
- (c) Explain the different types of mild steel. Give two applications for each. (15)
- (d) Explain the TIG welding process. Mention the applications. (15)
5. (a) Derive an expression for all minimum number of teeth required on the pinion in order to avoid interference in involute gear teeth when it meshes with the wheel. (15)
- (b) Determine the width of a 9.75 mm thick belt required to transmit 15 kW from a motor running at 900 rpm. The diameter of the driving pulley of the motor is 300 mm. The driven pulley runs at 300 rpm and the distance between the centre of the two pulleys is 3 metres. The density of the belt material is 1000 kg/m^3 . The maximum allowable stress in the leather is 2.5 MPa. The coefficient of friction between the leather and the pulley is 0.3. Assume open belt drive and neglect the sag and slip of the belt. (15)
- (c) Define and explain the following terms relating to governors. (15)
- (i) Sensitiveness
- (ii) Stability
- (iii) Isochronism
- (iv) Hunting
- (d) Define the terms coefficient of fluctuation of energy and speed in the case of flywheels.
6. (a) A metallic bar, 300 mm \times 100 mm \times 40 mm, is subjected to a force of 5 kN, 6 kN and 4 kN (all are tensile) along x, y and z directions respectively. Determine the change in the volume of the block. Take $E = 2 \times 10^5 \text{ N/mm}^2$ and Poisson's ratio = 0.25. (15)
- (b) Derive the bending moment equation of a beam with the usual notations. (15)
- (c) Define the term Polar modulus. Find the expression for polar modulus for a solid shaft and for a hollow shaft. Also give the expression for torsional rigidity of a shaft. (15)
- (d) A simply supported beam AB of length 6 m is hinged at A and B. It is subjected to a clockwise couple of 24 kNm at a distance of 2 m from the left end A. Draw the shear force and bending moment diagrams. (15)