Total Pages—6

B.Tech-5
DME

Set-2

Full Marks : 70

Time : 3 hours

Answer **Q. No. 1** and any **five** from the rest

The figures in the right-hand margin indicate marks

Assume suitable data if necessary but justify the same

1. Answer *all* questions : 2 × 10

   (i) State at least five important mechanical properties of materials in machine design.

   (ii) Write briefly the steps to be followed by a designer.

   (iii) Iterative nature of design activity improves the design, comment.

   (iv) What are the merits and demerits of straight and curved arms of pulley ?

   (v) What are the assumptions made to derive the equation for critical frequency ? Why critical frequency is important in shaft design ?

(*Turn Over*)

(vi) A foot-step bearing of 100 mm radius, supports a load of 3 kN. The shaft runs at $600/\pi$ r.p.m., and the co-efficient of friction is 0·1. What is the frictional power in watts, according to uniform pressure theory ?

(vii) A plate 50 mm wide and 12·5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld. Assume allowable shear strength to be 56 MPa.

(viii) What does the term "uniform strength" in the context of leaf spring mean ?

(ix) What is meant by whipping of connecting rod and what is its effect ?

(x) What are the correction factors used to modify belt maximum stress ?

2. Three pulleys, *A*, *B* and *C* are mounted on a simply supported shaft of 3 m span ; at distances of 1 m, 1·5 m, and 2 m respectively from the left bearing. The diameters of the pulleys *A*, *B* and *C* are 500 mm, 700 mm, and 350 mm respectively. An electric motor supplies 15 kW power to the

shaft at *A*, and the machines take 9 kW power from *B*, and 6 kW power from *C*. A horizontal belt drive is arranged for *A*, the drive from *B* is vertically downwards, and the drive from *C* is at 45° to the drive *A*, and in a downward direction. The speed of the shaft is 240 rpm and the allowable shear stress of the shaft materials is 45 MPa. Co-efficient of friction between the belt and pulleys is 0·3. Determine the shaft diameter according to the ASME code if $C_{bm} = 2{\cdot}0$ and $C_t = 1{\cdot}5$. 10

3. An automotive engine develops maximum torque at a speed of 1000 r.p.m. At this speed, the power developed by the engine is 25 kW. The engine is equipped with a single plate clutch having two pairs of friction surfaces. The mean diameter of the friction disk is 190 mm and the coefficient of friction is 0·35. Six helical springs, with spring index of 6, provide the necessary axial force. The number of active coils is 5. The spring is made of patented and cold-drawn steel wires of Grade 2 ($\sigma_{ult} = 1570$ N/mm², $G = 81370$ N/mm²). Determine (*i*) the wire diameter (*ii*) the mean coil diameter (*iii*) the solid length of the spring and (*iv*) the stiffness of the spring. $2\frac{1}{2} \times 4$

4. A pump is driven by an electric motor through a open type flat belt drive. The following data is given for this drive. Motor pulley diameter (d_s) = 300 mm, pump pulley diameter (d_L) = 600 mm, co-efficient of friction (μ_s) for motor pulley = 0·25, coefficient of friction (μ_L) for pump pulley = 0·20, center distance between the pulleys = 1000 mm, Rotational speed of the motor = 1440 rpm, power transmission = 20 kW, Density of the belt material (ρ) = 1000 kg/m³, Design stress for the belt material (σ_{des}) = 2 MPa, thickness of the belt = 5 mm, service factor (C_{ser}) = 1·2 calculate : (*i*) the diameters of pulleys (*ii*) the belt tensions (*iii*) optimal velocity of the belt for maximum power transmission and (*iv*) the length and width of the belt. $2\frac{1}{2} \times 4$

5. A cone clutch is used to connect an electric motor running at 1440 r.p.m. with a machine which is stationary. The machine is equivalent to a rotor of mass 150 kg and radius of gyration as 250 mm. The machine has to be brought to the full speed of 1440 r.p.m. from stationary condition in 40 S. The semi cone angle is 12·5°. The mean radius of the clutch is twice the face

width. The co-efficient of friction is 0·2 and normal intensity of pressure between the contracting surfaces should not exceed 0·1 N/mm². Assuming the uniform wear criterion, calculate : (*i*) the inner and outer diameter (*ii*) the face width of the friction lining (*iii*) the force required to engage the clutch, and (*iv*) the amount of heat generated during each engagement of clutch. $2\frac{1}{2} \times 4$

6. The following data is given for the connecting rod of a diesel engine :

Cylinder bore = 85 mm, length of connecting rod = 350 mm, maximum gas pressure = 3 MPa, Factor of safety against buckling failure = 5, (l/d) ratio for the piston pin bearing = 1·5, (l/d) ratio for crank pin bearing = 1·25, Allowable bearing pressure for piston pin bearing = 13 MPa, Allowable bearing pressure for crank pin bearing = 11 MPa, length of stroke = 140 mm, Mass of reciprocating parts = 1·5 kg, Engine speed = 2000 rpm, Thickness of bearing bush = 3 mm, Material of cap = steel 40 C8, yield strength of the cap material = 380 N/mm², Factor of safety for cap = 4, Material of bolts = Chromium molybdenum steel yield strength of

bolt material = 450 N/mm^2, Factor of safety for bolts = 5, Density of connecting rod = 7800 kg/m^3, calculate : (*i*) dimensions of the cross -section of connecting rod (*ii*) nominal diameter of bolts for the cap (*iii*) thickness of the cap, and (*iv*) magnitude of whipping stress. $2\frac{1}{2} \times 4$

7. The end of a cylindrical air receiver is closed by a lap joint. The maximum pressure in the receiver is 1 N/mm^2. The axial length of the receiver is limited to 2 m, while its storage capacity is 2 m^3. Design and sketch the joint. The permissible stresses in shear and crushing of rivets may be taken as 60 and 90 MPa respectively. The permissible tensile stress for the plate material is 80 MPa. 10

8. Design a cotter joint of socket and spigot type, which may be subjected to a pull or push of 30 kN. All the parts of the joint are made of the same material with the permissible stresses, 55 MPa in tension, 70 MPa in compression, and 40 MPa in shear. 10