Reg. No. : | | | | | | | | | | | | |

Question Paper Code : X20843

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020 AND APRIL/MAY 2021

Fourth/Fifth/Sixth Semester

Mechanical Engineering

ME 6503 – DESIGN OF MACHINE ELEMENTS

(Common to Mechanical Engineering (Sandwich) Automobile Engineering, Industrial Engineering, Mechanical and Automation Engineering, Mechanical Engineering)

(Regulations 2013)

(Also Common to PTME 6503 – Design of Machine Elements for B.E. (Part-Time) – Fourth Semester – Mechanical Engineering – Regulations 2014)

Time : Three Hours | Maximum : 100 Marks

Use of Approved Design Data Book is permitted.

Any required design data can be suitably assumed.

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. How the machine design may be classified ?
2. What is an S-N Curve ?
3. List the different types of sunk keys and draw any one.
4. Differentiate rigid and flexible couplings.
5. What are the stresses act on screw fastenings due to static loading ?
6. What are the two types of fillet weld ?
7. Sketch the stresses induced in the cross section of a helical spring, considering Wahl's effect.
8. What are the forces acting on connecting rod ?
9. What is meant by square journal bearing ?
10. Give an example for anti-friction bearing.

PART – B **(5×13=65 Marks)**

11. a) A circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar at given by ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.

(OR)

b) A hollow circular column of external diameter 250 mm and internal diameter 200 mm carries a projecting bracket on which a load of 20 kN rests, as shown in Fig. The centre of the load from the centre of the column is 500 mm. Find the stresses at the sides of the column. All dimensions in mm.

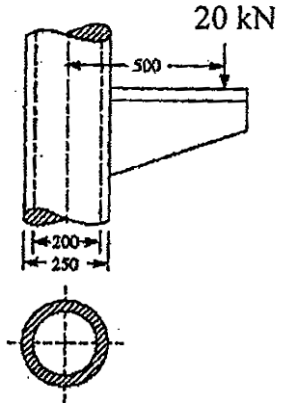

Fig. Q. 11(b)

12. a) A helical compression spring of the exhaust valve mechanism is initially compressed with a preload of 375 N. When the spring is further compressed and the valve is fully opened, the torsional shear stress in the spring wire should not exceed 750 N/mm^2. Due to space limitations, the outer diameter of the spring should not exceed 42 mm. The spring is to be designed for minimum weight. Calculate the wire diameter and the mean coil diameter of the spring.

(OR)

b) A punching machine carries out punching 10 holes per minute. Each hole of 36 mm diameter in 16 mm thick plate requires 7 N-m of energy/mm^2 of the sheared area. The punch has a stroke of 90 mm. Determine the power of the motor required to operate the machine.

If the total fluctuation of speed is not to exceed 2.5% of the mean speed; determine the mass of the flywheel. The mean speed of the flywheel is 15 m/s.

13. a) A steam engine cylinder of 300 mm effective diameter, is subjected to a steam pressure of 1.5 MPa. The cylinder head is connected by means of 8 bolts having yield strength of 30 MPa and endurance limit of 240 MPa. The bolts are tightened with an initial preload of 1.5 times that of steam load. A soft copper gasket is used to make the joint leak proof assuming a fatigue stress concentration factor of 1.4, and factor of safety of 2; determine the size of the bolts required.

(OR)

b) Design a knuckle joint to withstand a load of 100 kN. All the parts of the joint are made of the same material with $\sigma_{ut} = \sigma_{uc} = 480$ MPa, and $\tau_u = 360$ MPa. Use factor of safety of 6 on ultimate strength.

14. a) A safety valve of 60 mm diameter is to blow off at a pressure of 1.2 N/mm^2. It is held on its seat by a close coiled helical spring. The maximum lift of the valve is 10 mm. Design a suitable compression spring of spring index 5 and providing an initial compression of 35 mm. The maximum shear stress in the material of the wire is limited to 500 MPa. The modulus of rigidity for the spring material is 80 kN/mm^2.

Calculate : 1) Diameter of the spring wire, 2) Mean coil diameter, 3) Number of active turns and 4) Pitch of the coil.

(OR)

b) A punching press pierces 35 holes per minute in a plate using 10kN-m of energy per hole during each revolution. Each piercing takes 40 per cent of the time needed to make one revolution. The punch receives power through a gear reduction unit which in turn is fed by a motor driven belt pulley 800 mm diameter and turning at 210 r.p.m. Find the power of the electric motor if overall efficiency of the transmission unit is 80 percent. Design a cast iron flywheel to be used with the punching machine for a coefficient of steadiness of 5, if the space considerations limit the maximum diameter to 1.3 m.

Allowable shear stress in the shaft material = 50 MPa,

Allowable tensile stress of cast iron = 4 MPa,

Density of cast iron = 7200 kg/m^3.

15. a) A spring loaded safety valve for a boiler is required to blow off at a pressure of 0.8 MPa. The diameter of the valve sear is 90 mm and maximum lift of valve is 10 mm. Design a suitable spring for the valve assuming the spring index as 7. Provide an initial compression of 30 mm. Take allowable shear stress as 420 MPa.

(OR)

b) A punching machine makes 25 working strokes per minute and is capable of punching 25 mm diameter holes in 18 mm thick steel plates having an ultimate shear strength of 3000 kg/cm^2. The punching operation takes place during 1/10th of a revolution of the crank shaft. Estimate the horse power needed for the driving motor, assuming a mechanical efficiency of 95%. Determine suitable dimensions for the rim cross section of the flywheel, which is to revolve at 9 times the speed of crankshaft. The permissible fluctuation of speed is 0.1. The flywheel is to be made of cast iron having a working stress (tensile) of 60 kg/cm^2 and weighing 7.25 gm/cu. cm. The diameter of the flywheel must not exceed 140 cm owing to space restrictions. The hub and spokes may be assumed to provide 5% of the rotational inertia of the wheel. Check for the centrifugal stress induced in the rim.

PART – C **(1×15=15 Marks)**

16. a) A shaft is supported by two bearing placed 1100 mm apart A pulley of diameter 620 mm is keyed at 400 mm to the right of the left hand bearing and this drives a pulley directly below it with a maximum tension of 2.75 kN. Another pulley of diameter 400 mm is placed 200 mm to the left of the right hand bearing and is driven with a motor placed horizontally to the right. the angle of contact of the pulleys is 180^o and the coefficient of friction between the belt and the pulleys is 0.3. Find the diameter of the shaft. Assume $K_b = 3$, $K_t = 2.5$, $S_{yt} = 190$ MPa, $S_{uy} = 300$ MPa.

(OR)

b) A solid circular shaft of diameter 45 mm is loaded by bending moment 650 Nm. torque 900 Nm and an axial tensile force of 30 kN. The shaft material is ductile with yield strength of 280 MPa. Determine the factor of safety according to maximum principal stress, Tresca and Von misses theories of failure .

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