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Question Paper Code : X10703

B.E./B.Tech. DEGREE EXAMINATIONS, NOV/DEC 2020 AND APRIL/MAY 2021
Fifth/Sixth Semester
Automobile Engineering
ME 8593 – DESIGN OF MACHINE ELEMENTS
(Common to Industrial Engineering/Mechanical Engineering/Mechanical Engineering
(Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering)
(Regulations 2017)

Time : Three Hours

Maximum : 100 Marks

Answer ALL questions

PART – A

(10×2=20 Marks)

1. A component is loaded with normal and shear stresses as $\sigma_x = 15$ MPa ; $\sigma_y = 5$ MPa ; and $\tau_{xy} = 10$ MPa. Find the maximum shear stress developed in the component.
2. Which theory of failure is suitable for the design of cast iron component subjected to steady state loading ?
3. Define equivalent bending moment.
4. Differentiate between rigid and flexible couplings.
5. What is meant by set screw ?
6. Differentiate between butt and fillet welded joints.
7. Name the common types of mechanical springs.
8. A flywheel connected to a punching machine has to supply energy of 400 N-m while running at a mean angular speed of 20 rad/s. If the total fluctuation of speed is not to exceed $\pm 2\%$, what is the mass moment of inertia of the flywheel ?
9. What is meant by static load carrying capacity of a bearing ?
10. Classify the bearings depending upon type of rolling element.



11. a) A cantilever beam of rectangular cross-section is used to support a pulley as shown in Fig. 11a. The tension in the wire rope is 10 kN. The beam is made of cast iron whose ultimate strength $\sigma_{ut} = 240$ MPa and the factor of safety is 3. The ratio of depth to width of cross-section is 2. Determine the dimensions of the cross-section of the beam.

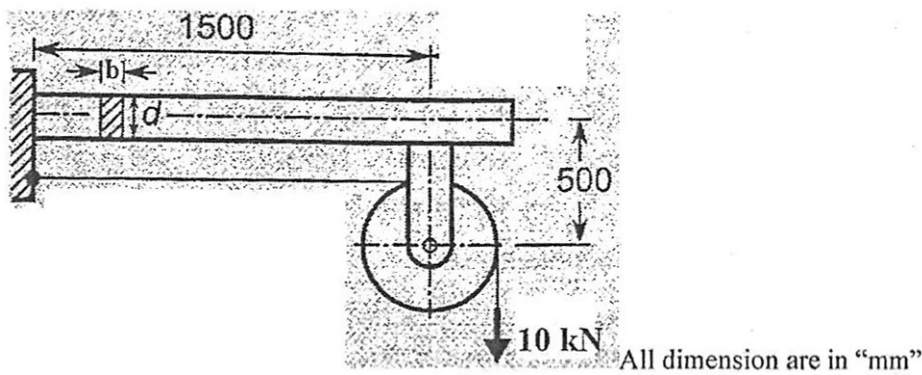


Fig. 11a

(OR)

- b) A component machined from a plate made of 45C8 ($\sigma_u = 650$ MPa) as shown in Fig. 11b. It is subjected to a completely reversed axial force of 100 kN. The reliability factor, $k_c = 0.897$; factor of safety = 2. The size factor, $k_b = 0.8$, surface finish factor, $k_a = 0.76$. determine the thickness of the plate, for infinite life, if the notch sensitivity factor, $q = 0.8$.

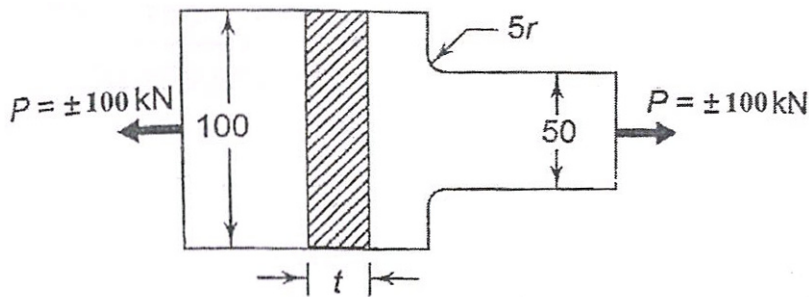
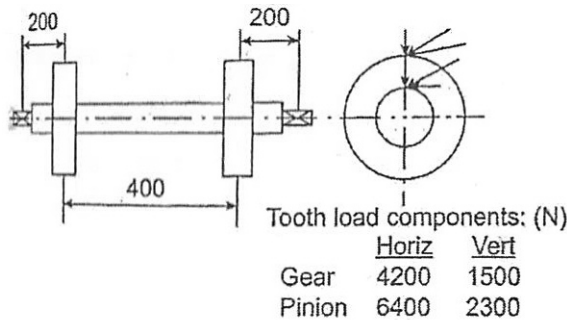


Fig. 11b



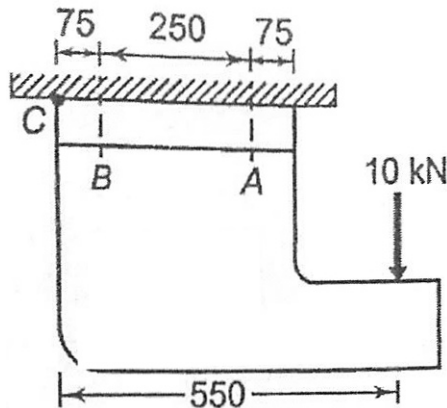
12. a) The intermediate shaft in a multi-stage gear box carries a pinion and a gear as show in fig. 12a. The dimensions and the tooth loads are given in figure. The material of the shaft is plain carbon steel whose yield strength is 380 MPa. The factor of safety is specified as 3. The power flowing through the shaft is approximately 38 kW at a speed of approximately 200 rpm. Determine the size of the shaft on the basis of strength.



All dimension are in "mm"

Fig. 12a
(OR)

- b) A split muff coupling is used to connect two shafts for transmitting 40 kW at 200 rpm. Plain carbon steel is used as material for the shafts whose yield strength is 380 MPa. The number of clamping bolts is 8 and the factor of safety for shafts, bolts and key is 4. The coefficient of friction between the coupling halves is given as 0.3. Calculate (a) diameter of the shafts (b) draw a line sketch of the coupling halves and mark the dimensions, bore diameter, OD, and hub length. (c) Assuming that power is transmitted by friction between the two halves of the coupling, determine the diameter of the clamping bolt.
13. a) A cast iron bracket, as shown in fig. 13a, supports a load of 10 kN. It is fixed to the horizontal channel by means of four identical bolts, two at A and two at B. The bolts are made of steel 30C8 whose yield strength is 400 MPa and the factor of safety is 6. Determine the major diameter of the bolts if $d_c = 0.8d$.

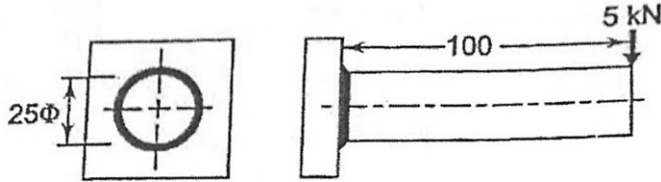


All dimension are in "mm"

Fig. 13a
(OR)



- b) A solid circular beam, 25 mm in diameter, is welded to a support by means of a fillet weld as shown in Fig. 13b. Determine the leg dimensions of the weld, if the permissible shear stress is 95 MPa.



All dimension are in "mm"

Fig. 13b

14. a) A safety valve, 40 mm in diameter, is to blow off at a pressure of 1.2 MPa. It is held on its seat by means of a helical compression spring, with initial compression of 20 mm. The maximum lift of the valve is 12 mm. The spring index is 6. The spring is made of cold-drawn steel wire with ultimate tensile strength of 1400 MPa. The permissible shear stress can be taken as 50% of this strength. $G = 81.37$ GPa. Calculate (i) wire diameter, (ii) mean coil diameter and (iii) number of active coils.

(OR)

- b) A semi-elliptic leaf spring used for automobile suspension consists of three extra full-length leaves and 15 graduated-length leaves, including the master leaf. The centre-to-centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9 : 1. The modulus of elasticity of the leaf material is 207 GPa. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 MPa. Determine (i) the width and thickness of the leaf : (ii) the initial nip and (iii) the initial pre-load required to close the gap C between extra full-length leaves and graduated length leaves.

15. a) A single-row deep groove ball bearing is subjected to a radial force of 8 kN and thrust force of 3 kN. The values of X and Y factors are 0.56 and 1.5 respectively. The shaft rotates at 1200 rpm. The diameter of the shaft is 75 mm and bearing No. 6315 (Dynamic load carrying capacity, $C = 112\ 000$ N) is selected for the application.

- i) Estimate the life of this bearing with 90% reliability
- ii) Estimate the reliability for 20,000 hr life

(OR)



b) Following data is given for a 360° hydrodynamic bearing :

Radial load = 3.2 kN

Journal speed = 1490 rpm

l/d ratio = 1

Unit bearing pressure = 1.3 MPa

Radial clearance = 0.05 mm

Viscosity of the lubricant = 25 cP

Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate (i) Journal diameter and bearing length, (ii) coefficient of friction, (iii) power lost in friction and (iv) minimum oil film thickness.

PART – C

(1×15=15 Marks)

16. a) A rimmed flywheel made of grey cast iron FG 200 whose density is 7100 kg/m^3 is required to keep down fluctuations in speed from 200 to 220 rpm. The cyclic fluctuations in energy is 30,000 N-m, while the maximum torque during the cycle is 75,000 N-m. The outside diameter of the flywheel should not exceed 2 m. It can be assumed that there are six spokes and the rim contributes 90% of the required moment of inertia. The cross-section of the rim is rectangular and the ratio of width to thickness is 2. Determine the dimensions of the rim. Assuming suitable cross-section for spokes, calculate the stresses in the rim and spokes.

(OR)

b) Determine the dimensions of cross-section of the connecting rod for diesel engine with following data :

Cylinder bore = 100 mm

Length of connecting rod = 350 mm

Maximum gas pressure = 4 MPa

Factor of safety = 6.
