15. (a) A journal bearing is proposed for a steam engine. The load on the journal is 5 kN. diameter 50 mm. length 75 mm speed 1600 rpm, diametral clearance 0.001 mm. ambient temperature 15.5 °C. Oil SAE 10 is used and the film temperature is 60°C. Determine the heat generated and heat dissipated. Take absolute viscosity of SAE10 at 60°C = 0.014 kg/m-s.

Or

(b) A ball bearing operates on the following work cycle :

Element no	Radial load N	Speed, rpm	Element time, %
1	3000	720	30
2	7000	1440	50
3	5000	900	20

The dynamic load capacity of the bearing is 16.6 kN. Calculate

(i) The average speed of rotation (4)

(ii) The equivalent radial load (3)

(iii) The bearing life and (4)

(iv) The bearing life at 95% reliability (2)

PART C — (1 × 15 = 15 marks)

16. (a) Calculate the stresses on the element at A as shown in the figure. 3

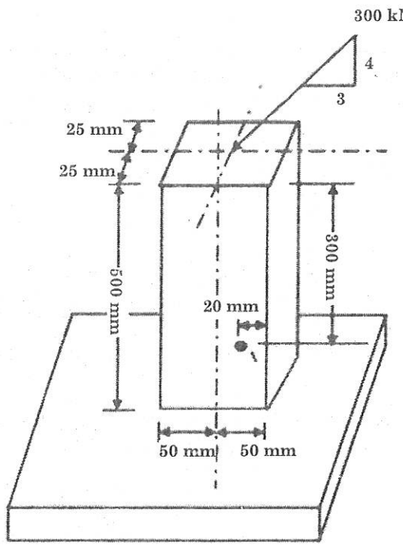

Figure 3

Or

(b) Select a bearing for a 40 mm diameter shaft which rotates at 400 r.p.m. Due to a bevel gear mounted on the shaft, the bearing will have to withstand at 5000 N radial load and a 3000 N thrust load. The life of the bearing is expected to be at least 1000 hrs.

1516 AN

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

Question Paper Code : 50880

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fifth/Sixth Semester

Mechanical Engineering

ME 8593 — DESIGN OF MACHINE ELEMENTS

(Common to : Automobile Engineering/Industrial 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. State St. Venant theory of failure.

2. What are the methods to reduce stress concentration?

3. List the various failures that occurs in keys.

4. A hollow circular shaft of inner radius 15 mm, outer radius 30 mm and length 1 m is to be used as a torsional spring. If the shear modulus of the material of the shaft is 250 GPa, the torsional stiffness of the shaft (in kN-m/rad) is?

5. How is a bolt designated? Mention with an example.

6. Why are riveted joints replaced by welded joints?

7. What are the applications of spring?

8. What is nipping in a leaf spring? List the material commonly used for the manufacture of the leaf spring.

9. What is known as self-acting bearing?

10. What is meant by the life of anti-friction bearings?

PART B — (5 × 13 = 65 marks)

11. (a) A hot rolled steel shaft is subjected to a torsional moment that varies from 350 Nm clockwise to 120 Nm counter clockwise and an applied bending moment at a critical section varies from 450 Nm to – 210 Nm. The shaft is of uniform cross-section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MN/m² and a yield strength of 420 MN/m². Take the endurance limit as half the ultimate strength, factor of safety of 2, size factor of 0.85 and a surface finish factor of 0.62.

Or

(b) A bracket, made of steel FeF 250 (S_{yt} = 250 N/mm²) and subjected to a force of 5 kN acting at an angle of 30° to the vertical, is shown in Figure 1. The factor of safety is 3. Determine the dimensions of the cross-section of the bracket.

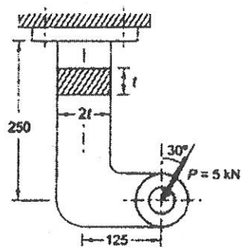

Figure 1

12. (a) A shaft is supported by two bearings placed 1 m apart. A 600mm diameter pulley is mounted at a distance of 300 mm to the right of left-hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right-hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and μ = 0.24. Determine the suitable diameter for a solid shaft, allowing working stress of 75 N/mm² in tension and 42 N/mm² in shear for the material of the shaft. Assume that the torque on one pulley is equal to that on the other pulley.

Or

(b) Design and draw a protective type of cast iron flange coupling for a steel shaft transmitting 25 kW at 250 rpm and having allowable shear stress of 50 N/mm². The working stress in the bolts should not exceed 40 N/mm². Assume that the same material is used for shaft and key and that the crushing stress is twice the value of its shear stress. The maximum torque is 25% greater than the full load torque. The shear stress for cast iron is 16 N/mm².

13. (a) A locomotive semi-elliptical laminated spring has an overall length of 1 m and sustains a load of 80 kN at its center. The spring has 3 full-length leaves and 15 graduated leaves with a central band of 100 mm width. All the leaves are to be stressed to 400 N/mm² when fully loaded. The ratio of the total spring depth to that of width is 2. Let E = 0.2 × 10⁶ N/mm². Determine:
(i) The thickness and width of the leaves. (5)
(ii) The initial gap that should be provided between the full length and graduated leaves before the band load is applied. (4)
(iii) The load exerted on the band after the spring is assembled. (4)

Or

(b) Design a valve spring of a petrol engine for the following operating conditions. Spring load when the valve is open 400 N, spring load when the valve is closed 250N. Maximum inside diameter of spring 25 mm. Length of the spring when the valve is open 40 mm. Length of the spring when the valve is closed 50 mm. Maximum permissible stress 400 Mpa.

14. (a) A welded connection of the steel plate is shown in Figure. 2. It is subjected to an eccentric force of 50 kN. Determine the size of the weld, if the permissible shear stress in the weld is not to exceed 70 N/mm².

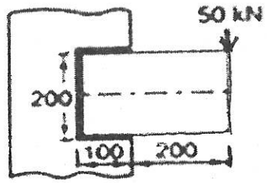

Figure 2

Or

(b) Two tie-bar plates of a bridge structure, 250 mm wide and 20 mm thick, are to be connected by double-strap butt joint. The rivets and the plates are made of steel. The permissible stresses in tension, shear and compression are 80, 60 and 120 N/mm² respectively.
(i) Determine the diameter of the rivet by using the following *empirical* relationship. $d = 6\sqrt{t}$, where '*t*' plate thickness. (4)
(ii) Determine the number of rivets by equating the strength of the plate with the strength of the rivets. Assume that shear resistance of one rivet in double shear is 1.875 times its resistance in single shear. (4)
(iii) Show the arrangement of rivets (2)
(iv) Determine the efficiency of the joint. (3)
Assume the following relationship, Margin (m) = 1.5 d, Transverse pitch (p) = 2d, Thickness of the strap = 0.625 t.