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Question Paper Code : 70902

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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.   Distinguish between machine and mechanism.

2.   List the causes for stress concentration.

3.   Name the materials used for making transmission shaft.

4.   Why couplings are located as near as possible to the bearing?

5.   Mention any three advantages of cap screw with heads engaged from the end.

6.   State any four disadvantages of welded joints.

7.   What is nipping of a leaf spring?

8.   Define spring index.

9.   State any two advantages of partial bearing over full bearing.

10.   Classify the sealing devices.

PART B — (5 × 13 = 65 marks)

11. (a) (i) A shaft as shown in figure 11(a)(i) is subjected to a bending load of 3kN, pure torque of 1000 N–m and axial pulling of 15 kN, calculate the stresses at A and B. (8)
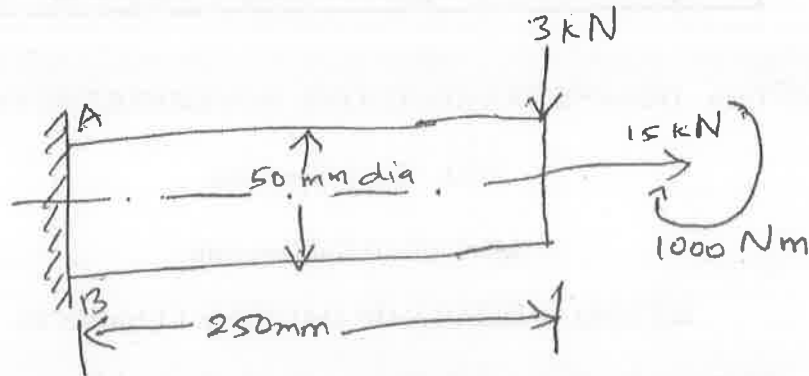

Figure 11(a)(i)

(ii) Define 'Design' and explain the design process. (5)

Or

(b) A crane hook has a section, which for the purpose of analysis is considered trapezoidal as shown in the figure 11(b). It is made of plain carbon steel with yield strength of 380 mpa in tension. Determine the load capacity of the hook, for a factor of safety of 3.
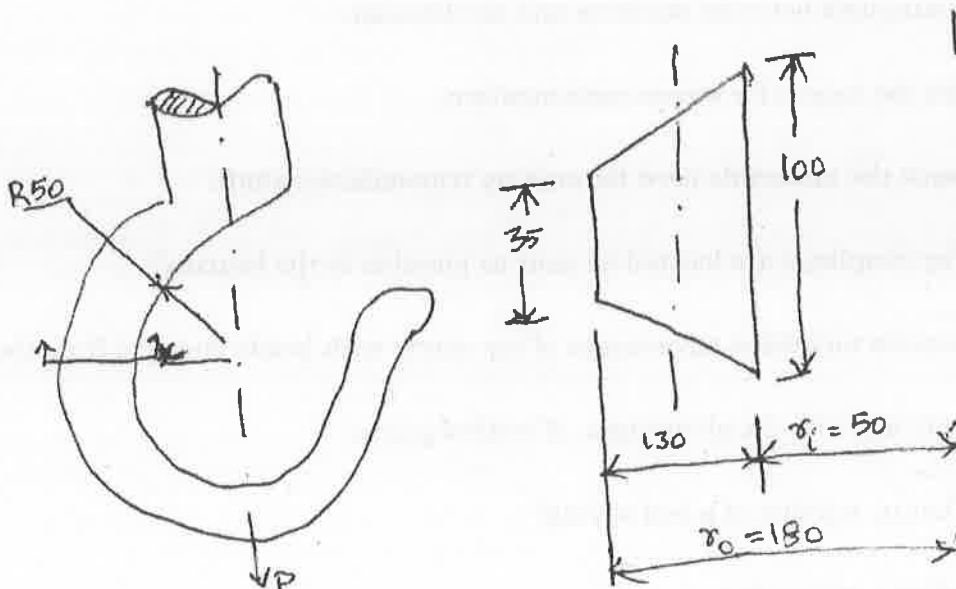

Figure 11(b)   Cross Section at X – X

12. (a) A rotating shaft, 50 mm in diameter, is made of plain carbon steel 40C8 (S_{yt} = 380 N/mm²). It is subjected to a steady torsional moment of 225 N-m and maximum bending moment of 850 N-m. Calculate the factor of safety based on,

(i) Maximum principal stress theory, and (7)

(ii) Maximum shear stress theory. (6)

Or

(b) A standard cross-section for a flat key, which is fitted on a 50 mm diameter shaft, is 16 × 10 mm. The key is transmitting 475 N-m torque from the shaft to the hub. The key is made of commercial steel (S_{yt} = S_{yc} = 230 N/mm²). Determine the length of the key, if the factor of safety is 3.

13. (a) A cylinder head is connected to the cylinder flange by means of 16 bolts. The inner diameter of the cylinder is 400 mm. The maximum pressure inside the cylinder is limited to 1.25 N/mm². The bolts are made of plain carbon steel 30C8 (S_{yt} = 400 N/mm²) and factor of safety is 5.5. Neglecting the effect of initial tightening, determine the size of bolts.

Or

(b) A steam engine cylinder has an effective diameter of 350 mm and the maximum steam pressure acting on the cylinder cover is 1.25 N/mm². Calculate the number and size of studs required to fix the cylinder cover. Assume the permissible stress in the studs to be 70 N/mm².

14. (a) A spring-loaded safety valve for a boiler is required to blow-off at a pressure 1.5 N/mm². The diameter of the valve is 60 mm. Design a suitable compression spring for the safety valve, assuming spring index to be 6, and 25 mm initial compression. The maximum lift of the valve is 15 mm. The shear stress in the spring material is to be limited to 450 MPa. Take G = 0.84 × 10⁵ MPa.

Or

(b) A right-angled bell crank lever is designed to raise a load of 5 kN at the short arm end. The lengths of the short and long arms are 100 and 450 mm respectively. The lever and pins are made of 30C8 (S_{yt} = 400 N/mm²) and the factor of safety is 5. The permissible bearing pressure on the pin is 10 N/mm². The lever has a rectangular cross section and the ratio of width to thickness is 3:1. The length to diameter ratio of fulcrum pin is 1.25:1. Calculate :

(i) the diameter and the length of fulcrum pin (5)

(ii) the shear stress in the pin; (4)

(iii) the dimensions of the boss lever at the fulcrum. (4)

15. (a) A single-row deep grove ball bearing No. 6002 is subjected to an axial thrust load of 1000 N and a radial load of 2200 N. Find the expected life that 50% of the bearings will complete under this condition.

Or

(b) A single row deep grove ball bearing is subjected to a radial force of 8 kN and a thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life L_{10th} of the bearing of the shaft is 75 mm. Select a suitable ball bearing for this application.

PART C — (1 × 15 = 15 marks)

16. (a) A solid shaft of diameter (D) is used in power transmission. Due to modification of existing transmission system, it is required to replace the solid shaft by a hollow shaft of the same material and equally strong in torsion. Further, the weight of the hollow shaft per meter length should be half of the solid shaft. Determine the outer diameter of hollow shaft in terms of (D).

Or

(b) A 50 kN capacity screw jack consists of a square threaded steel screw meshing with a bronze nut. The nominal diameter is 60 mm and the pitch is 9 mm. The permissible bearing pressure at the threads is 10 N/mm². Calculate

(i) The length of the nut, and (7)

(ii) The transverse shear stress in the nut. (8)