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Question Paper Code : 21301

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Fifth Semester

Mechanical Engineering

ME 3591 – DESIGN OF MACHINE ELEMENTS

(Regulations 2021)

Time : Three hours Maximum : 100 marks

(Use of PSG Design Data Book is permitted)

Assume suitable data wherever necessary.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List down any two significance of theories of failure in design of machine elements.

2. Mention any two factors that are taken into account when selecting a material for a machine component.

3. Differentiate splines and keys.

4. List down any two functions of transmission shaft.

5. Why are the stresses in the welded joints so difficult to obtain?

6. Give two reasons why riveted joints are being replaced by welded joints.

7. List down any two applications of springs.

8. Why flywheels are used in machines?

9. Why ball and roller bearings are called as 'antifriction' bearings?

10. State the importance of Sommerfeld Number in design of machine elements.

PART B — (5 × 13 = 65 marks)

11. (a) Discuss the factors that influence machine design, including material selection based on mechanical properties and the use of preferred numbers.

Or

(b) Analyze the approaches to designing for finite and infinite life under variable loading conditions, and the considerations for durability and reliability in machine components.

12. (a) Figure 1 depicts the layout of a gearbox shaft carrying two pulleys B and C and supported by bearings A and D. Power is supplied to the shaft via a vertical belt on pulley B, which is then transmitted to pulley C via a horizontal belt. On pulley B, the maximum tension in the belt is 2.5 kN. Both pulleys have a wrap angle of 180° and a friction coefficient of 0.24. The shaft is made of plain carbon steel 30C8 (Syt = 400 N/mm^2) with a safety factor of 3. Determine the shaft diameter based on strength. Also, draw the bending moment diagram.

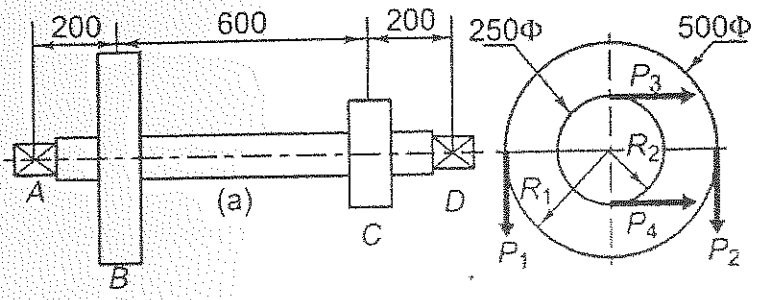

Figure 1

Or

(b) A standard splined connection 8 × 52 × 60 mm is used for the gear and the shaft assembly of a gearbox. The splines transmit 20 kW power at 300 rpm. The dimensions of the splines are as follows :

Major diameter = 60 mm

Minor diameter = 52 mm

Number of splines = 8

Permissible normal pressure on splines is 6.5 N/mm^2. The coefficient of friction is 0.06.

Calculate:

(i) The length of hub of the gear

(ii) The force required for shifting the gear

13. (a) Discuss the principles and considerations in designing both temporary and permanent joints in mechanical engineering. Differentiate between the two types of joints and explain when each type is preferred. (6+7)

Or

(b) A brake band attached to the hinge by means of a riveted joint is shown in Figure. 2. Determine the size of the rivets needed for the load of 10 kN. Also, determine the width of the band. The permissible stresses for the band and rivets in tension, shear and compression are 80, 60 and 120 N/mm^2 respectively. Assume, margin (m) = 1.5d, transverse pitch (Pt) = p. Find the pitch of the rivets.

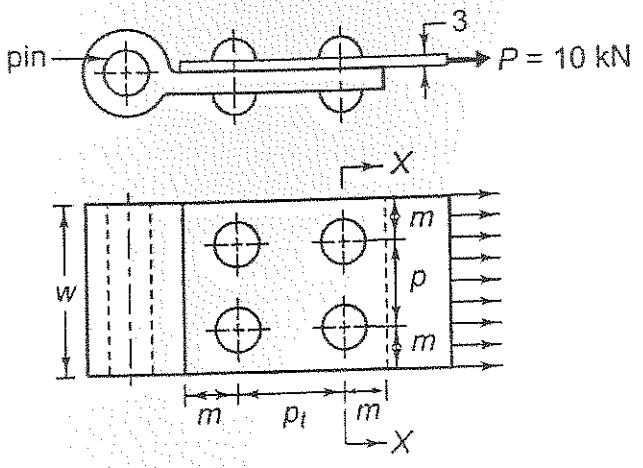

Figure. 2

14. (a) It is required to design a helical compression spring subjected to a maximum force of 1250 N. The deflection of the spring corresponding to the maximum force should be approximately 30 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81370 N/mm^2 respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate :

(i) wire diameter;

(ii) mean coil diameter;

(iii) number of active coils;

(iv) total number of coils;

(v) free length of the spring; and

(vi) Pitch of the coil.

Draw a neat sketch of the spring showing various dimensions.

Or

(b) In a neat tabular column, differentiate between solid and rimmed flywheels and using suitable examples explain when each type is preferred for specific applications.

15. (a) A single-row deep groove ball bearing No. 6002 is subjected to an axial thrust 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) Differentiate between the functions of seals and gaskets and provide real-world examples of their applications, such as in automotive engines or industrial machinery.

PART C — (1 × 15 = 15 marks)

16. (a) Discuss the concept of principal stresses and their significance in assessing structural integrity. Use practical examples to illustrate how eccentric loading and curved beams, such as a crane hook and 'C' frame, affect machine design.

Or

(b) Design a muff coupling to connect two steel shafts transmitting 25 kW of power at 360 rpm. Shafts and key are made up of Plain carbon steel 30C8 (S_{yt} = S_{yc} = 400 N/mm^2). The sleeve is made of FG 200 grey cast iron (S_{ut} = 200 N/mm^2). The shafts and key have a safety factor of 4. Based on ultimate strength, the sleeve has a factor of safety of 6.