(Please write your Exam Roll No.) Exam Roll No. 01014807422

END TERM EXAMINATION

FIFTH SEMESTER [B.TECH] JANUARY 2024

Paper Code: MAC-303 **Subject: Machine Design-I**

Time: 3 Hours **Maximum Marks: 75**

Note: Attempt five questions in all including Q. No.1 which is compulsory. Select one question from each unit. Assume suitable missing data, if any.

Q1 Explain the following topics:- **(10x1.5=15)**

(a) What is power screw? Write two advantages and applications of power screw.
(b) Draw a stress-time curve for fluctuating stress.
(c) What is stress concentration?
(d) List the different types of riveted joints and rivets.
(e) Define the term efficiency of a riveted joints.
(f) Distinguish betweensingle and double start threads.
(g) How the shaft is designed when it is subjected to twisting moment only?
(h) What are the various forces acting on spur gear?
(i) Why the piston pin is made hollow?
(j) Write two advantages and disadvantages of involute teeth gears over cycloidal teeth gears?

UNIT-I

Q2 (a) Distinguish between design synthesis and design analysis. What are the three basic types of standards used in a design office? **(5)**

(b) A 20 mm diameter shaft is made of forged steel 30C8 (S_{ut} = 600 N/mm^2). There is a step in the shaft and theoretical stress concentration factor at the step is 2.1. The notch sensitivity factor is 0.76. Determine the endurance limit of the shaft if it is subjected to a reversed bending moment. **(5)**

(c) What is the difference between failure due to static load and fatigue failure? What are the machine components that fail by fatigue? **(5)**

Q3 (a) How will you designate magnitude of tolerance? What are the guidelines for selection of clearance fit? Give examples. **(5)**

(b) Design a knuckle joint for a tie rod of a circular section to sustain a maximum pull of 60 kN. The ultimate tensile strength of rod material is 400 N/mm^2. The ultimate tensile and shearing strengths of pin material are 700 N/mm^2 and 400 N/mm^2 respectively. Use a factor of safety of 6. Assume permissible stress in tension and compression to be equal. **(7.5)**

(c) What are the methods of reducing stress concentration? **(2.5)**

UNIT-II

Q4 (a) Classify springs according to their shapes with neat diagram. **(5)**

(b) Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 180 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 100 rpm. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.2. The shock and fatigue factor for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa. **(10)**

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Q5 (a) Under what circumstances are hollow shafts preferred over solid shafts? Give any two examples where hollow shafts are used. **(5)**

(b) Design a helical spring for a spring loaded safety valve for the following conditions:

Diameter of valve seat = 60 mm
Operating pressure = 0.7 N/mm²
Maximum pressure when the valve blows off freely = 0.80 N/mm²
Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/mm² = 3.0 mm
Maximum allowable stress = 550 MPa
Modulus of rigidity = 84 kN/mm²
Spring index = 6
Draw a neat sketch of the free spring showing the main dimensions. **(10)**

UNIT-III

Q6 (a) A steel plate subjected to a force of 3 kN and fixed to a vertical channel by means of four identical bolts is shown in **Figure 1**. The bolt are made of plain carbon steel 45C8 (S_{yt} = 340 N/mm²) and the factor of safety is 2. Determine the diameter of shank. All dimensions are in mm. **(7.5)**

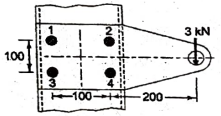

Figure 1

(b) A shaft of 20 mm diameter is welded coaxially with another shaft of much larger diameter. The shaft is to transmit a torque which is just safe for it. Calculate the width of the peripheral fillet weld between two shafts. The permissible shearing stress for the shaft material is 60 MPa and that for weld is 40 MPa. **(7.5)**

Q7 (a) What is the common material for rivet? Draw the diagram of double-riveted and chain-riveted lap joint. **(5)**

(b) A welded connection of steel plates, as shown in Figure 2, is subjected to an eccentric force of 10 kN. Determine the throat dimension of the welds, if the permissible shear stress is limited to 90 N/mm². Assume static conditions. All dimensions are in mm. **(7.5)**

(c) Why are square threads preferable to v-threads for power transmission? **(2.5)**

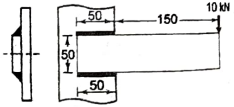

Figure 2

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MAC-303
2/2

UNIT-IV

Q8 (a) A pair of spur gears consists of a 24teeth pinion, rotating at 1000 rpm and transmitting power to a 48 teeth gear. The module is 6 mm, while the face width is 60 mm. both gears are made of steel with an ultimate tensile strength of 400 N/mm². They are heat treated to a surface hardness of 200 BHN. Assume that velocity factor accounts for the dynamic load. Calculate: **(10)**

(i) Beam strength
(ii) Wear strength
(iii) The rated power that the gears can transmit, if service factor and the factor of safety are 1.5 and 2 respectively.

(b) A 40 kN capacity screw jack consists of a square threaded steel screw meshing with a bronze nut. The nominal diameter is 50 mm and the pitch is 10 mm. The permissible bearing pressure at the threads is 15 N/mm². Calculate the length of the nut and the transverse shear stress of the nut. **(5)**

Q9 (a) A power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameters of screw collar are 50 mm and 20 mm respectively. The coefficient of thread friction and collar friction may be assumed as 0.2 and 0.15 respectively. The screw rotates at 12 rpm. Assuming uniform wear condition at the collar and allowable thread bearing pressure of 5.8 n/mm², find (i) the torque required to rotate the screw, (ii) the stress in the screw. **(7.5)**

(b) What is self-locking of power screw? What is the condition of self-locking? Write their applications where self-locking is essential. **(7.5)**

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MAC-303
3/2