Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV EXAMINATION – SUMMER 2020

Subject Code: 3141907 Date:28/10/2020

Subject Name: Fundamentals of Machine Design

Time: 10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms: **03**
(i) Center of gravity (ii) Polar Moment of inertia (iii) Standardization.

(b) Explain the basic procedure for design of machine elements. **04**

(c) A manufacturer is interested in starting a business with five different models of tractors ranging from 7.5 to 75 kW capacities. Specify power capacities of the models. There is an expansion plan to further increase the number of models from five to nine to fulfill the requirement of farmers. Specify the power capacities of the additional models. **07**

Q.2 **(a)** Determine the moment of inertia for rectangular cross-section about X-axis and Y-axis passing from their CG. **03**

(b) Define: (i) Poisson's ratio (ii) Bulk modulus (iii) Hooke's law (iv) Volumetric strain. **04**

(c) An I - section girder, 200 mm wide by 300 mm depth flange and web of thickness is 20 mm is used as simply supported beam for a span of 7 m. The girder carries a distributed load of 5 KN /m and a concentrated load of 20 KN at mid-span. Refer figure 1. Determine the following: **07**
(i) Moment of inertia for the cross-section of the girder
(ii) The maximum bending stress

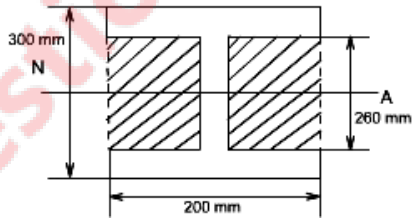

Figure 1

OR

(c) A composite bar made of aluminium and steel is held between the supports as shown in figure 2. The bars are stress free at a temperature of 37°C. What will be the stress in the two bars when the temperature is 20°C, if (a) the supports are unyielding; and (b) the supports yield and come nearer to each other by 0.10 mm? **07**

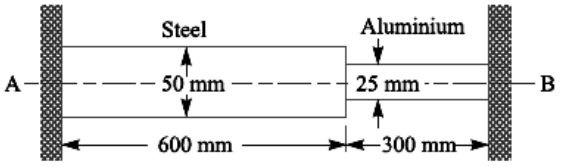

Figure 2

Q.3 **(a)** Why taper is provided on cotter? What is its normal value? State its applications. **03**

(b) List the different theories of static failures. Explain maximum shear stress theory in detail with its region of safety. **04**

(c) Design a knuckle joint to transmit load of 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression. **07**

OR

Q.3 **(a)** Define: (i) Preferred number (ii) Contact stress (iii) Principal stress. **03**

(b) Discuss the design procedure of a rocker arm for operating the exhaust valve. **04**

(c) A mild steel bracket as shown in figure 3, is subjected to a pull of 6000 N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross-sectional dimensions of the bracket if the permissible stress in the material of the bracket is limited to 60 MPa. **07**

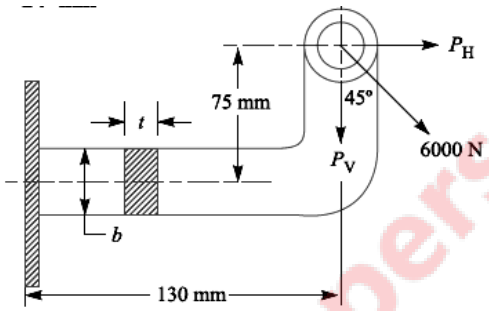

Figure 3

Q.4 **(a)** What do you mean by factor of safety? List the factors affecting for selection of factor of safety. **03**

(b) Describe the aesthetic and ergonomic considerations in design of machine component. **04**

(c) A screw jack is to lift a load of 80 kN through a height of 400 mm. The elastic strength of screw material in tension and compression is 200 MPa and in shear 120 MPa. The material for nut is phosphor-bronze for which the elastic limit may be taken as 100 MPa in tension, 90 MPa in compression and 80 MPa in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Consider factor of safety equal to 2 and coefficient of friction between screw and nut (μ)= 0.14. Design the screw and nut only. Refer the table shown as below for standard dimensions of screw. **07**

Nominal diameter (d_o), mm	Core diameter (d_c), mm	Pitch (p), mm
40	33	7
42	35	
44	37	
46	38	8

OR

Q.4 **(a)** Define 'slenderness ratio'. State the assumptions used in Euler's column theory. **03**

(b) An I-section 400 mm × 200 mm × 10 mm and 6 m long is used as a strut with both ends fixed. Find Euler's crippling load. Take Young's modulus for the material of the section as 200 kN/mm^2. **04**

(c) Derive an equation for finding torque required to raise the load by square threaded screws with usual notations. **07**

Q.5 **(a)** Discuss the various types of power threads with their relative advantages and disadvantages. **03**

(b) Compare the weight and strength of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length. **04**

(c) 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 200 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 120 r.p.m. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2 respectively. The allowable shear stress in the shaft may be taken as 35 MPa. Refer figure 4. **07**

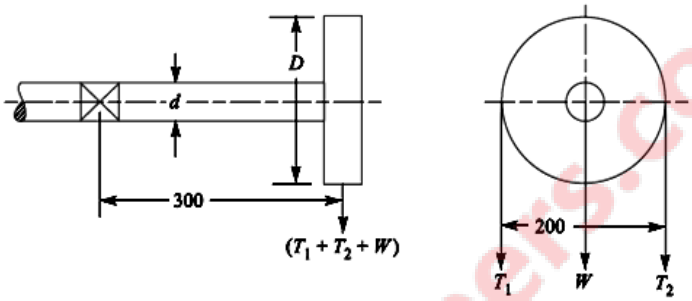

Figure 4

OR

Q.5 **(a)** Explain the following terms: **03**
(i) Cumulative damage in fatigue (ii) Fatigue failure (iii) Stress concentration.

(b) What is endurance limit? Discuss the different factors affecting endurance limit. **04**

(c) A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum value of P. Take a size factor of 0.85 and a surface finish factor of 0.9. **07**

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