Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2020

Subject Code:3141907 Date:15/02/2021

Subject Name:Fundamentals of Machine Design

Time:02:30 PM TO 04:30 PM Total Marks:56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms: **03**
(i) Hooke's law (ii) Poisson's ratio (iii) Preferred series.

(b) Define: (i) Bulk modulus (ii) Modulus of rigidity. Derive the relation between bulk modulus and modulus of rigidity with usual notations. **04**

(c) Explain the manufacturing considerations in design of machine component. **07**

Q.2 **(a)** Explain the parallel and perpendicular axes theorem for finding moment of inertia of planer cross-sections. **03**

(b) An unknown weight falls through 10 mm on a collar rigidly attached to the lower end of a vertical bar 3 m long and 600 mm^2 in section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and the value of unknown weight? Take E = 200 kN/mm^2. **04**

(c) A wall bracket with a rectangular cross-section is shown in Fig. 1. The depth of the cross-section is twice of the width. The force P acting on the bracket at 60^0 to the vertical is 5 kN. The material of the bracket is grey cast iron FG 200 and the factor of safety is 3.5. Determine the dimensions of the cross-section of the bracket. Assume maximum normal stress theory of failure. All dimensions shown in figure are in millimetre. **07**

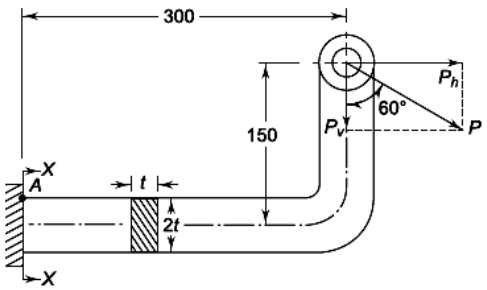

Fig. 1

Q.3 **(a)** Classify the principal static theories of failures. Explain the distortion energy (von Mises) theory with its necessary equation. **03**

(b) Define: (i) Principal stress (ii) Factor of safety (iii) Contact stress (iv) Bearing stress. **04**

(c) The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory. **07**

Q.4 **(a)** Differentiate between cotter and knuckle joint. Why one side of cotter is made tapered? **03**

(b) Discuss in detail the design procedure of a Bell cranked lever with its necessary diagram. **04**

(c) The big end of a connecting rod is subjected to a maximum load of 50 kN. The diameter of the circular part of the rod adjacent to the strap end is 75 mm. Design the **07**

gib and cotter joint, assuming permissible tensile stress for the material of the strap as 25 Mpa and permissible shear stress for the material of cotter and gib as 20 MPa.

Q.5 **(a)** Define: (i) Leverage (ii) Slenderness ratio (iii) Crushing stress. **03**

(b) Explain the different types of end conditions of column. Write the relations between equivalent length and actual length of a column for various end conditions. **04**

(c) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Fig. 2. The bolts are made from plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. Specify the size of bolts. All dimensions shown in figures are in mm. **07**

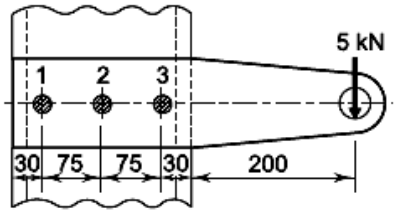

Fig. 2

Q.6 **(a)** Classify the basic types of screw fastening. Differentiate between bolt and screw. **03**

(b) Define: Self-locking screw. Derive the equation for finding efficiency of self-locking square threaded screw. **04**

(c) A vertical two start square threaded screw of a 100 mm mean diameter and 20 mm pitch supports a vertical load of 18 kN. The axial thrust on the screw is taken by a collar bearing of 250 mm outside diameter and 100 mm inside diameter. Find the force required at the end of a lever which is 400 mm long in order to lift and lower the load. The coefficient of friction for the vertical screw and nut is 0.15 and that for collar bearing is 0.20. **07**

Q.7 **(a)** Discuss the different terminology for power screw. **03**

(b) List the different theories of fatigue failure. Explain the Modified Goodman criteria of fatigue failure with diagram. **04**

(c) A 45 mm diameter shaft is made of steel with a yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 Mpa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2. **07**

Q.8 **(a)** Discuss the procedure for fatigue design under combined stresses. **03**

(b) Define: Cumulative fatigue damage. Derive the equation for finding cumulative damage in fatigue failure. **04**

(c) A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m^2 and – 150 MN/m^2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2. **07**

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