

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BE - SEMESTER-V EXAMINATION – WINTER 2015**

**Subject Code: 152503****Date: 08/12/2015****Subject Name: Design of Machine Elements-I****Time: 10:30am to 1:00pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Use of PSG Design Data Book is permitted.

- Q.1 (a)** A rod made of steel is to be subjected to varying axial load of 25 kN compressive to 35 kN tensile. Determine the required diameter of the rod by Soderberg criteria using a factor of safety as 2. The following data may be used. Ultimate tensile strength of steel: 1050 N/mm<sup>2</sup>, Yield stress as 900 N/mm<sup>2</sup> and Endurance limit as 550 N/mm<sup>2</sup>. Other correction factors are: Theoretical stress concentration factor: 2.5, Notch sensitivity: 0.8 **07**
- (b)** Explain the term “endurance limit” & discuss various factors affecting endurance strength of material. **07**
- Q.2 (a)** A closed coiled helical spring made of alloy steel of coil diameter 50 mm and spring index 5.0 to carry a load of 1 kN. If permissible deflection of the spring is 25 mm, calculate: (i) the maximum stress developed in the coil, (ii) the total number of turns, (iii) the free length, and (iv) the pitch of the spring. Take  $G = 80 \text{ GPa}$ . **07**
- (b)** A bracket, as shown in Fig. 1, supports a load of 50 kN. Determine the size of bolts, if the maximum allowable tensile stress in the bolt material is 70 MPa. The distances are:  $L_1=80\text{mm}$ ,  $L_2=250 \text{ mm}$  &  $L=500 \text{ mm}$ . **07**

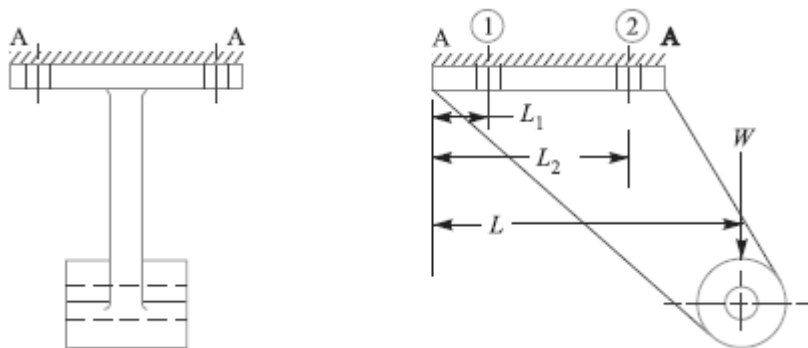


Fig.1

**OR**

- (b)** A semi-elliptical laminated spring is to carry a load of 6 kN and consists of 9 leaves being of full length. The spring is to be made 1000 mm between the eyes and is held at the centre by a 60 mm wide band. Assuming the design stress for spring material of 500 N/mm<sup>2</sup>, design the spring giving (i) the thickness of leaves, (ii) the maximum deflection and (iii) the length of leaves. Assume  $E = 2.1 \times 10^5 \text{ N/mm}^2$ . **07**

- Q.3 (a)** A multi-plate clutch is required to transmit 75 KW at the speed of 3500 rpm. The internal diameter of the friction surface is 0.8 of the external diameter. The mean allowable pressure is  $0.125 \text{ N/mm}^2$ . The co-efficient of friction is 0.15. Determine the number of plates required. **07**
- (b)** A single cylinder double acting steam engine delivers 200 kW at 150 r.p.m. The maximum fluctuation of energy per revolution is 15 per cent of the energy developed per revolution. The speed variation is limited to 1 per cent either way from the mean. The mean diameter of the rim is 2.4 m. Design the flywheel. **07**

**OR**

- Q.3 (a)** Describe with the help of a neat sketch the design procedure of an internal expanding shoe brake. **07**
- (b)** Following data refer to a single cylinder steam engine. **07**  
 Boiler pressure:  $1.2 \text{ N/mm}^2$ , Speed 230rpm, Mean effective pressure:  $0.5 \text{ N/mm}^2$ , Ratio of stroke to diameter: 1.5:1, Power: 72.5 KW, Diagram factor: 0.8  
 Gasket sealing pressure:  $2 \text{ N/mm}^2$ , Gasket stiffness co-efficient: 0.3  
 Calculate: (i) Thickness of the cylinder and flange, (ii) Thickness of the cylinder cover and (iii) Number and size of the bolts for tightening cover. Allowable stress for C.I. cylinder and cover in tension and shear  $15 \text{ N/mm}^2$  and for M.S. bolts in tension  $50 \text{ N/mm}^2$
- Q.4 (a)** A pair of  $20^\circ$  full depth involute spur gears is required to transmit 20 KW at 300 rpm. The velocity ratio is 1:3. Design the pair and check for possible failures. **10**
- (b)** What condition must be satisfied in order that a pair of spur gears may have a constant velocity ratio? **04**

**OR**

- Q.4 (a)** Design a pair of Helical gear to transmit 35KW power at 1500 rpm. The speed Reduction is 3. Working life of the gear is 10,000 hours. **10**
- (b)** Explain the phenomenon of interference in involute gears. **04**
- Q.5 (a)** An overhung cast iron pulley transmits 7.5 kW at 400 r.p.m. The belt drive is vertical and the angle of wrap may be taken as  $180^\circ$ . Find : **10**  
 (a) Diameter of the pulley. The density of cast iron is  $7200 \text{ kg/m}^3$ .  
 (b) Width of the belt, if the coefficient of friction between the belt and the pulley is 0.25.  
 (c) Diameter of the shaft, if the distance of the pulley centre line from the nearest bearing is 200 mm  
 (d) Dimensions of the key.  
 (e) Size of the arms.  
 The section of the arms may be taken as elliptical, the major axis being twice the minor axis. The following stresses may be taken for design purposes :  
 Shaft and key : Tension – 80 MPa  
 Shear – 50 MPa  
 Belt : Tension – 2.5 MPa  
 Pulley rim : Tension – 4.5 MPa  
 Pulley arms : Tension – 15 MPa
- (b)** State the assumptions used in Euler's column theory. **04**

**OR**

- Q.5 (a)** Determine the dimensions of an I-section connecting rod for a petrol engine from the following data : **10**
- Diameter of the piston = 100 mm  
Mass of the reciprocating parts = 1.75 kg  
Length of the connecting rod from centre to centre = 350 mm  
Stroke length = 160 mm  
R.P.M. = 1350 with possible over speed of 2250  
Compression ratio = 4 : 1  
Maximum explosion pressure = 2.5 N/mm<sup>2</sup>
- (b)** What are the advantages and disadvantages of V-belt drive over flat belt drive? **04**

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