Seat No.: Enrolment No._____


# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER– V (New) EXAMINATION – WINTER 2019**

**Subject Code: 2151907** **Date: 21/11/2019**

**Subject Name: Design of Machine Elements**

**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)** | What are the factors to be considered for selection of material for a machine component? | **03** |
| | **(b)** | Distinguish between open and cross belt drives. | **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)** | What is surge in spring? | **03** |
| | **(b)** | What are the types of end closure for cylindrical pressure vessel? | **04** |
| | **(c)** | A concentric spring consists of two helical compression springs having the same free length. The composite spring is subjected to a maximum force of 2000 N. The wire diameter and mean coil diameter of the inner spring are 8 and 64 mm respectively. Also, the wire diameter and mean coil diameter of the outer spring are 10 and 80 mm respectively. The number of active coils in the inner and outer springs are 12 and 8 respectively. Assume same material for two springs and the modulus of rigidity of spring material is 81370 N/mm$^2$. Calculate:<br>(i) the force transmitted by each spring;<br>(ii) the maximum deflection of the spring; and<br>(iii) the maximum torsional shear stress induced in each spring. | **07** |
| | | **OR** | |
| | **(c)** | A semi-elliptic leaf spring used for automobile suspension consists of three extra full-length leaves and 15 graduated-length leaves, including the master leaf. The centre-to-centre distance between two eyes of the spring is 1 m. The maximum force that can act on the spring is 75 kN. For each leaf, the ratio of width to thickness is 9:1. The modulus of elasticity of the leaf material is 207 000 N/mm$^2$. The leaves are pre-stressed in such a way that when the force is maximum, the stresses induced in all leaves are same and equal to 450 N/mm$^2$. Determine<br>(i) the width and thickness of the leaves;<br>(ii) the initial nip; and<br>(iii) the initial pre-load required to close the gap C between extra full-length leaves and graduated-length leaves. | **07** |
| **Q.3** | **(a)** | What are the advantages of V-belts over flat belts? | **03** |
| | **(b)** | What is slip & creep in belts? | **04** |
| | **(c)** | The following data is given for an open-type V-belt drive:<br>diameter of driving pulley = 200 mm, diameter of driven pulley = 600 mm, groove angle for sheaves = 34°, mass of belt = 0.5 kg/m, maximum permissible tension in belt = 500 N, coefficient of friction = 0.2, contact angle for smaller pulley = 157°, speed of smaller pulley = 1440 rpm, power to be transmitted = 10 kW.<br>How many V-belts should be used, assuming each belt takes its proportional part of the load? | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | What are advantages of Chain drives over belt drives? | **03** |
| | **(b)** | What is the polygonal action in roller chain? | **04** |
| | **(c)** | The following data is given for a open belt drive:<br>diameter of driving pulley is d (1440 rpm),<br>diameter of driven pulley is D (480 rpm), | **07** |

that transmitting 15 kW of power. The centre distance between the pulleys is twice the diameter of the bigger pulley. The belt should operate at a velocity of 20 m/s approximately and the stresses in the belt should not exceed 2.25 N/mm$^2$. The density of leather is 0.95 g/cc and the coefficient of friction is 0.35. The thickness of the belt is 5 mm. Calculate:
(i) the diameter of pulleys;
(ii) the length and width of the belt; and
(iii) the belt tensions.

**Q.4** **(a)** What are the methods of reducing stress concentration? **03**

**(b)** What is the difference between the Gerber curve and Soderberg and Goodman lines? **04**

**(c)** A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm$^2$. The bar is made of steel 40C8 ($S_{ut}$ = 600 N/mm$^2$). Calculate the life of the bar for a reliability of 90%. **07**

**OR**

**Q.4** **(a)** What is fluctuating stress? Draw a stress–time curve for fluctuating stress. **03**

**(b)** What is low-cycle and high-cycle fatigue? **04**

**(c)** A machine component is subjected to fluctuating stress that varies from 40 to 100 N/mm$^2$. The corrected endurance limit stress for the machine component is 270 N/mm$^2$. The ultimate tensile strength and yield strength of the material are 600 and 450 N/mm$^2$ respectively. Find the factor of safety using **07**
(i) Gerber theory
(ii) Soderberg line
(iii) Goodman line

**Q.5** **(a)** When do you use Lame's, Clavarino's and Birnie's equation for cylinder wall thickness? **03**

**(b)** What is autofrettage? What are the methods of pre-stressing the cylinder? **04**

**(c)** A high-pressure cylinder consists of a steel tube with inner and outer diameters of 20 and 40 mm respectively. It is jacketed by an outer steel tube, having an outer diameter of 60 mm. The tubes are assembled by a shrinking process in such a way that maximum principal stress induced in any tube is limited to 100 N/mm$^2$. Calculate the shrinkage pressure and original dimensions of the tubes (E = 207 kN/mm$^2$). **07**

**OR**

**Q.5** **(a)** What types of stresses are induced in the jacket and inner tube of compound cylinder? **03**

**(b)** What are the types of stresses in thick cylinders? **04**

**(c)** A tube, with 50 mm and 75 mm as inner and outer diameters respectively, is reinforced by shrinking a jacket with an outer diameter of 100 mm. The compound tube is to withstand an internal pressure of 35 MPa. The shrinkage allowance is such that the maximum tangential stress in each tube has same magnitude. Calculate **07**
(i) the shrinkage pressure; and
(ii) the original dimensions of tubes.
Assume E = 207 kN/mm$^2$.



**********