

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-V(New) • EXAMINATION – WINTER 2016

Subject Code:2151907

Date:22/11/2016

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 Answer the following questions.

14

1. Stress concentration factor is defined as ratio of
 - (a) maximum stress to the endurance limit
 - (b) nominal stress to the endurance limit
 - (c) maximum stress to the nominal stress
 - (d) nominal stress to the maximum stress
2. The endurance or fatigue limit is defined as the maximum value of the stress which a polished standard specimen can withstand without failure, for infinite number of cycles, when subjected to
 - (a) static load
 - (b) dynamic load
 - (b) static as well as dynamic load
 - (d) completely reversed load
3. The width of the pulley should be
 - (a) equal to the width of belt
 - (b) less than the width of belt
 - (c) greater than the width of belt
 - (d) none of these
4. In order to have smooth operation, the minimum number of teeth on the smaller sprocket, for moderate speeds, should be
 - (a) 15
 - (b) 17
 - (c) 21
 - (d) 25
5. When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is
 - (a) tensile stress
 - (b) compressive stress
 - (c) torsional shear stress
 - (d) bending stress
6. In leaf springs, the longest leaf is known as
 - (a) lower leaf
 - (b) master leaf
 - (c) upper leaf
 - (d) none of these
7. In case of pressure vessels having open ends, the fluid pressure indices
 - (a) longitudinal stress
 - (b) circumferential stress
 - (c) shear stress
 - (d) none of these
8. In a thick cylinder shell subjected to internal pressure 'p', the maximum radial stress at the outer surface of the shell is
 - (a) zero
 - (b) p
 - (c) -p
 - (d) 2p
9. Lamé's equation is derived based on
 - (a) maximum principal stress theory
 - (b) maximum strain theory
 - (c) maximum shear stress theory
 - (d) maximum distortion energy theory
10. Which one of the following is a positive drive?
 - (a) V – belt drive
 - (b) crossed flat drive
 - (b) rope drive
 - (d) chain drive

11. In flat belt drive, the belt can be subjected to maximum tension (T) and centrifugal tension (T_c). The condition for transmission of maximum power is given by
(a) $T = T_c$ (b) $T = 2T_c$ (c) $T = T_c/2$ (d) $T = 3T_c$
12. The series factor or geometric progression ratio for R10 series is
(a) 1.26 (b) 1.12 (c) 1.58 (d) 1
13. Birnie's equation is applicable to
(a) open cylinders made of ductile material
(b) closed cylinders made of ductile material
(c) cylinders made of brittle material
(d) open cylinders made of brittle material
14. The pitch of 16A (ANSI-80) chain is
(a) 25.4 mm (b) 12.70 mm (c) 16 mm (d) 40 mm
- Q.2** (a) Why is the cross-section of the pulley an elliptical arm? Why is major axis of the cross-section in the plane of rotation? **03**
- (b) State the advantage and disadvantage of the chain drive over belt and rope drive. **04**
- (c) A fan is driven by open belt from a motor runs at 880 rpm. A leather belt 8 mm thick and 250 mm wide is used. The diameter of motor pulley and driven pulley are 350 mm and 1370 mm respectively. The centre distance is 1370 mm and both pulleys are made of cast iron. The coefficient of friction of leather on cast iron is 0.35. The allowable stress for the belt is 2.5 MPa, which allows for factor of safety. The belt mass is 975 kg/m³. Determine the power capacity of belt drive. **07**
- OR**
- (c) Derive the relation for the ratio of driving tensions of a V-belt. **07**
- Q.3** (a) Name the various alloying elements in 'alloy' steels. **03**
- (b) A steel tank for shipping gas is to have an inside diameter of 200 mm and a length of 1000 mm. The gas pressure is 10.5 N/mm². The permissible stress is to be 56 MPa. **04**
- (a) Determine the required wall thickness, using the thin cylinder equation.
- (b) Determine the thickness using Clavarino's equation.
- (c) What are the principles of design for manufacture and assemblies (DFMA)? **07**
- OR**
- Q.3** (a) What are the Goodman and the Soderberg line? **03**
- (b) State the methods of reducing stress concentration. **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 value of load 'P' based on Goodman's formula. Take a size factor of 0.85 and a surface finish factor of 0.9. **07**
- Q.4** (a) What is surge in spring? **03**
- (b) What is the objective of nipping of leaf spring? **04**

- (c) The valve of an aircraft engine is operated by a cluster of two concentric springs made of same material. The maximum load on the spring is 6500 N. The permissible shear stress for the spring material is 625 N/mm². Assuming spring index for both springs as 6 and the deflection under the load should not exceed 30 mm. Calculate the main dimensions of the springs. $G = 8 \times 10^4$ N/mm². Use standard coil clearance. **07**

OR

Q.4 (a) What is shot peening? **03**

(b) A cast iron pulley transmits 20 kW at 300 rpm. The diameter of pulley is 550 mm and has four straight arms of elliptical cross-section in which the major axis is twice the minor axis. Find the dimensions of the arm if the allowable bending stress is 15 MPa. **04**

(c) A semi-elliptical spring has ten leaves in all, with the two full length leaves extending 625 mm. It is 62.5 mm wide and is made of strips 6 mm thick. The leaves are pre-stressed so as to equalize stresses in all leaves. Design a helical spring, with spring index of 6, which will have approximately the same values of induced stress and deflection for any load. Take, $E = 2.1 \times 10^5$ MPa and $G = 8.4 \times 10^4$ MPa. **07**

Q.5 (a) What is autofrettage? **03**

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

(c) A thick cylinder having 120 mm external diameter and 60 mm internal diameter is subjected to an internal fluid pressure of 15 MPa and external fluid pressure of 6 MPa. Determine the resultant hoop and radial stresses at inner and outer surface of cylinder. Also sketch curves showing the stresses distribution. **07**

OR

Q.5 (a) An accumulator is required to store 150 liters of water at a pressure 20 MPa. Assuming the length of stroke to be 3 meter, determine: **03**

- (a) The diameter of the ram.
- (b) The internal diameter of the cylinder, assuming a clearance of 40 mm.
- (c) The thickness of the cylinder, if the permissible stress of the cylinder (made of CI) is 60 N/mm².

(b) Derive the Lamé's equation for thick cylinders. **04**

(c) A high-pressure cylinder consists of a steel tube with inner and outer diameters of 20 mm 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/mm². Calculate the shrinkage pressure and original dimensions of the tubes ($E = 207$ kN/mm²). **07**
