Enrolment No.

## **GUJARAT TECHNOLOGICAL UNIVERSITY** ME – SEMESTER I (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2710801

**Subject Name: Advanced Machine Design** 

# nm

Total Marks: 70

Date:18/05/2016

# Time:02:30 pm to 05:00 pm

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 (a) Explain the important guidelines of design for manufacturing and assembly 07 (DFMA) in detail.
  - (b) Explain the design considerations for aesthetics and ergonomics in product 07 design.
- Q.2 (a) The AISI 4340 steel is subjected to cyclic loading with a tensile mean stress of  $\sigma_m = 200$  MPa.
  - (a) What life is expected if the stress amplitude is  $\sigma_a = 450$  MPa?

(b) Also estimate the alternating stress amplitude ( $\sigma_a$ ) versus fatigue life data (N<sub>f</sub>) curve for this mean stress  $\sigma_m$  value. Take constants b= - 0.0977,  $\sigma'_f = 1758$  MPa.

(b) (I) Define the terms: (i) Surface fatigue damage

(ii) Linear Elastic Fracture Mechanics (LEFM)

(iii) Stress intensity factor (SIF).

(II) Explain the Miner's rule for cumulative damage in fatigue.

## OR

- (b) What is creep? Explain mathematical representation of creep curves with its 07 significances in design.
- Q.3(a)(i) Explain three modes of fracture with neat sketches.03(ii) Explain the terms: (a) Crack resistance (b) Stable and unstable crack growth.04
  - (b) A center cracked plate as shown in figure 1 has dimensions b=50 mm, t=5 mm 07 large h and a force of P=50 kN applied.
    - (a) What is the stress intensity factor K for a crack length of a = 10 mm?
    - (b) For a = 30 mm?
    - (c) What is the critical crack length  $a_c$  for fracture if the material is 2014-T651 aluminum?



- Q.3 (a) What are the criteria for selection of material for machine part? Explain the 07 importance of Ashby's material selection chart in machine design.
  - (b) An overhead crane wheels run slowly on a steel rail. What is the size of the contact patch between wheel and rail and what are the stresses? What is the depth of the maximum shear stress? The wheel is in 305 mm diameter by 22 mm in thick and rail is flat. Both parts are steel. The radial load is 22 kN. Consider it as static loading problem.

03

04

A wall bracket with a rectangular cross section is shown in figure 2. The depth **Q.4** (a) 07 of the cross section is twice of the width. The force P acting on the bracket at  $60^{\circ}$  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 sections of the bracket. Assume maximum normal stress theory of failure.



What are the selection criteria for the use of appropriate static theories of **(b)** 07 failures?

#### OR

- Explain the modified Coulomb-Mohr's theory with suitable diagram in detail. Q.4 **(a)** 07
  - **(b)** A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 07 N-m and a torque T. Take factor of safety is 1. If the yield point of steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to 1. Maximum Principle stress theory 2. Maximum shear stress theory 3. Maximum distortion strain energy theory of vielding.
- Q.5 (i) Define the following terms: 03 **(a)**

(a)Transient creep (b) Steady state creep (c) Stress Relaxation

- (ii) Explain Sherby-Dorn and Larson-Miller Parameters for creep deformation. 04
- **(b)** A chemical reaction chamber working at a temperature of 500 <sup>o</sup>C uses steel bolts 07 to tighten the two parts. The test on bolt material at this temperature resulted into strain rates of 3 x  $10^{-18}$  / hour and 2 x  $10^{-18}$  / hour at 30 MPa and 25 MPa stress levels respectively. If the bolts are tightened to a stress level 68 MPa initially, calculate in what time the stress will be reduced to half this value. Assume that the chamber is made of same material and flange is very rigid. Modulus of elasticity E at 500  $^{\circ}$ C is equal to 1.7 x 10<sup>5</sup> MPa.

### OR

Q.5	<b>(a)</b>	(I) Explain the terms: (i) Hydrostatic lubrication (ii) Hydrodynamic lubrication	03
		(iii) Elastohydrodynamic lubrication.	
		(II) The following data is given for a $360^{\circ}$ hydrodynamic bearing:	04
		Length to diameter ratio=1	
		Journal speed=1350 rpm	
		Journal diameter $=100$ mm	
		Diametral clearance = $100 \ \mu m$	
		External load = $9 \text{ kN}$	
		Sommerfeld number $(S) = 0.0828$	
		The value of minimum film thickness variable is 0.3. Find the viscosity of oil that	
		need be used.	
	<b>(b</b> )	What is Hartz's contact stress theory? Explain in detail for spherical and	07

cylindrical contact with suitable example.

\*\*\*\*\*