Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (NEW) EXAMINATION – WINTER 2016

Subject Code: 2710801 **Date:05/01/2017**

Subject Name: Advanced Machine Design

Time: 2:30 pm to 5:00 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)** Explain: Concurrent engineering. Describe the Quality Function Deployment (QFD) in detail. **07**

(b) Explain the importance of Ashby material selection charts in design of machine parts. List down the factors affecting for material selection. **07**

Q.2 **(a)** Define creep and discuss significance of creep curve in design along with its mathematical representation. **07**

(b) A ball thrust bearing with 7 spherical balls are 10 mm diameter each is equally loaded axially across its flat races through the balls. Consider it as a static loading problem. What is the size of the contact patch on a race and what are the stresses developed in balls and races? What is the depth of the maximum shear stress in a ball? All parts of bearing are made from hardened steel material. The axial load is 672 N or 96 N per ball. Take modulus of elasticity for steel material is 207 x 10^3 N/mm^2 and poisson's ratio is 0.28. **07**

OR

(b) A 25-mm-diameter cylindrical roller is preloaded against a 75-mm-diameter cylindrical roller in a traction drive as shown in Figure 1. The steel rollers are 25 mm wide and the preload force is 200 N. The axes of the cylinders are parallel. Calculate the maximum contact pressure, the width, and the area of contact. Also determine the maximum value of the subsurface shear stress. **07**

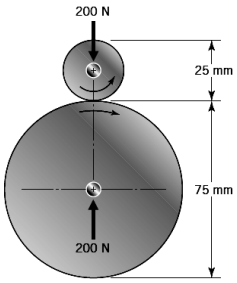

Figure 1

Q.3 **(a)** Explain the following terms related to fatigue failure. **07**

(a) Linear Damage (Miner's rule) (b) Manson's Method (c) Cumulative fatigue damage (d) Fatigue under complex stresses

(b) A cantilever beam made of cold drawn carbon steel of circular cross-section as shown in Figure 2, is subjected to a load which varies from – F to 3 F. Determine the maximum load that this member can withstand for an indefinite life using a factor of safety as 2. The theoretical stress concentration factor is 1.42 and the notch sensitivity is 0.9. Assume the following values: **07**

Ultimate stress = 550 MPa, Yield stress = 470 MPa, Endurance limit = 275 MPa, Size factor = 0.85, Surface finish factor = 0.89.

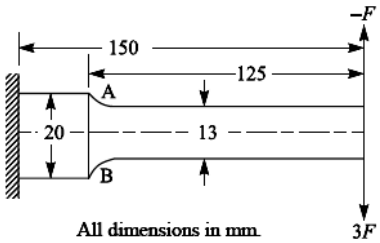

Figure 2

OR

Q.3 **(a)** Discuss the following in detail. **07**

(i) Griffith theory (ii) Maximum Principal strain theory (iii) Strain Vs Life Curve

(b) A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using following static theories of failure, and assuming a factor of safety of 2. Take E = 210 GPa and poisson's ratio = 0.25. **07**

(i) Maximum shear stress theory (ii) Maximum strain energy theory.

Q.4 **(a)** A block of the granite rock of Table 1 is subjected to a confining pressure on all sides of p = 150 MPa, due to the weight of rock above, as well as a shear stress τ_{xy}, as shown in Figure 3. (a) What value of shear stress τxy will cause the block to fracture? (b) What is the largest value of τxy that can be allowed if a safety factor of 2.0 against fracture is desired? **09**

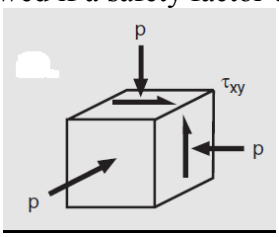

Figure 3

Table 1

Strengths and Coulomb–Mohr Fitting Constants for Some Brittle Materials

	Tension	Compression	Coulomb–Mohr Fit				
Material	σ_{ut}, MPa	$\lvert\sigma_{uc}\rvert$, MPa	m	b, MPa	μ	τ_i, MPa	θ_c, deg
Siliceous sandstone	3^7	100	0.700	33.37	0.979	23.35	22.8
Granite rock	13.4	143	0.824	22.00	1.455	19.42	17.3

(b) Define the terms: (i) Fracture toughness (ii) Stress intensity factor (S.I.F.) (iii) Fatigue crack propagation (iv) Fatigue crack growth rate (v) Fracture stresses (Griffith's). **05**

OR

Q.4 **(a)** A triaxial stress element has σ_x=275 Mpa, σ_y= -138 Mpa, σ_z= -70 MPa, τ_{xy}=35 Mpa, τ_{yz}= -10MPa, τ_{zx}=18 MPa. Find the principle stresses using a numerical method and draw the resulting mohar's circles. **09**

(b) Define the terms: (i) Linear Elastic Fracture Mechanics (LEFM) (ii) Elasto-hydrodynamic lubrication (iii) Surface fatigue strength (iv) Stress relaxation (v) Heartz's Contact stress. **05**

Q.5 (a) **(i)** Explain curved surface contact stresses in brief. **03**

(ii) Discuss effect of roughness, velocity and lubrication on friction. **04**

(b) A component of jet engine is to function for 10,000 hours without extending by 0.2%. The experiment performed on the alloy of which this component will be made yielded following results. Check if the Sherby- Dorn parameter may be applied and determine the stress which when applied on the component for 10,000 hours at a temperature of 620 ^{0}c will not cause extension greater than 0.2%. **07**

Stress σ (MPa)	Temp. (^{0}c)	Time for 0.2 % Elongation (hrs)
135	800	316
135	775	1000
205	810	20.5
270	690	100
270	670	318.5

OR

Q.5 (a) Explain the following time-temperature parameters and life estimate for creep deformation in detail. (i) Sherby-Dorn Parameter (ii) Larsen- Miller parameter **07**

(b) For an alloy steel two sets of data are available: **07**

At stress σ_0 = 165 MPa a rupture occurs after 0.1 hr at 615 ^{0}c and rupture occurs after 100 hr at 490 ^{0}c. At 650 ^{0}c rupture occurs after 0.1 hr at 70 MPa and occurs after 100 hrs at 32 MPa. Tubes of a super heater section of a boiler which are 62.5 mm in diameter and 9 mm thick are made out of this alloy steel. The super heater temperature is maintained constant at 593 ^{0}c. It is desired that the circumferential expansion of tubes over a period of 10^5 hrs be less than 10%. Calculate maximum allowable pressure in the tube.

****