Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – SUMMER 2022

Subject Code:3171925 Date:10/06/2022

Subject Name:Advanced Machine Design

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	What are the important theories of elastic failures & explain why it is required to consider?	**03**
	(b)	Define the terms:(i)Linear Elastic Fracture Mechanics(LEFM)(ii)Elasto-hydrodynamic lubrication (iii) Griffith's Fracture stress (iv) Hertz's Contact stress.	**04**
	(c)	The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. The elastic limit in bolt material is reached at 280 MPa. Determine the diameter of bolt using (a) Maximum shear stress theory (b) Distortion energy theory. Take FOS 3 on elastic limit and Poisson's ratio equal to 0.3.	**07**
Q.2	**(a)**	What is stress concentration? State the causes for the same.	**03**
	(b)	Explain the factors that affect endurance limit. Also explain how they are considered for design of mechanical element subjected to cyclic load.	**04**
	(c)	A component machined from a plate made of steel 45C8 (Sut=630 N/mm^2) is shown in **figure 1**. It is subjected to a completely reversed axial force of 50 kN. The expected reliability is 90% and the factor of safety is 2. The size factor is 0.85. Determine the plate thickness 't' for infinite life, if the notch sensitivity factor is 0.8.	**07**
		OR	
	(c)	A cantilever beam made of cold drawn steel 40C8(S_{ult}=600 N/mm^2& S_{yt}=380 N/mm^2) is shown in **figure 2**. The force P acting at the free end varies from -50 N to + 150 N. The expected reliability is 90% and the factor of safety is 2. The size factor is 0.85. The notch sensitivity factor at the fillet is 0.9. Determine the diameter 'd' of the beam at the fillet cross-section using modified Goodman diagram as failure criterion.	**07**
Q.3	**(a)**	What is creep? Explain various stages of creep with diagram.	**03**
	(b)	Explain the Larson-Miller Parameters for creep deformation with diagram.	**04**
	(c)	During the creep rupture testing of 713C alloy, following observations were recorded.	**07**

Stress(MPa)	Temperature (˚C)	Time for 0.2% elongation (hrs.)
68	1100	5
34	1100	500
136	1035	3
68	1035	400

The Jet engine turbine blades are made in 713C alloy and after a period of 30,000 hrs. all the bladesare to be replaced.Calculate the stress level which can be safely applied to the turbine blade if operating temperature is 900˚C.Assume Larson-Miller parameter applies to 713 C alloy.

OR

Q.3 **(a)** Explain the following: **03**
(i) Transient creep (ii) True stress (iii) Steady state creep

(b) Explain the stress relaxation. **04**

(c) A component of jet engine must function for 10,000 hrs.without extending by 0.2%. The experiment performed on the alloy of which this component will be made yielded following results. Using Sherby-Dorn parameters, determine the stress which when applied on the component for 10,000 hrs. at a temperature of 620˚C will not cause extension greater than 0.2%. **07**

Stress(MPa)	Temperature (˚C)	Time for 0.2% elongation (hrs.)
135	800	316
135	775	1000
205	810	20.5
270	690	100
270	670	318.5

Q.4 **(a)** Explain the terms: (i) Hydrostatic lubrication (ii) Hydrodynamic lubrication **03**

(b) What is wear? Explain any one mechanism of wear in detail. **04**

(c) The ball and socket joint as shown in **figure 3** at the end of a rocker arm has a hardened-steel spherical surface 10 mm in diameter fitting in a hard-bronze bearing alloy spherical seat 10.1 mm in diameter. What maximum contact stress will result from a load of 2000 N? Take E= 207 GPa for steel & 110 GPa for bronze material.Poisson's ratio is 0.3 for steel and 0.33 for bronze. **07**

OR

Q.4 **(a)** What is Mechanical Seal?State the required properties of material for mechanical seal. **03**

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

(c) A pin-on-disk friction testing apparatus as shown in **figure 4** involves the unlubricated rounded end of a copper pin of 80 Vickers hardness being pressed with a force of 20 N against the surface of a rotating steel disk of 210 Brinell hardness. The rubbing contact is at a radius of 16 mm; the disk rotates 80 rpm. After 2 hours the pin and disk are weighed. It is determined that adhesive wear has caused weight losses equivalent to wear volumes of 2.7mm^3 and 0.65 mm^3 for the copper and steel, respectively. Compute the wear coefficients. **07**

Q.5 **(a)** Define the terms: (i) Fracture toughness (ii) Stress intensity factor (iii) Fatigue crack propagation **03**

(b) Discuss the different modes of crack face displacement with neat sketches. **04**

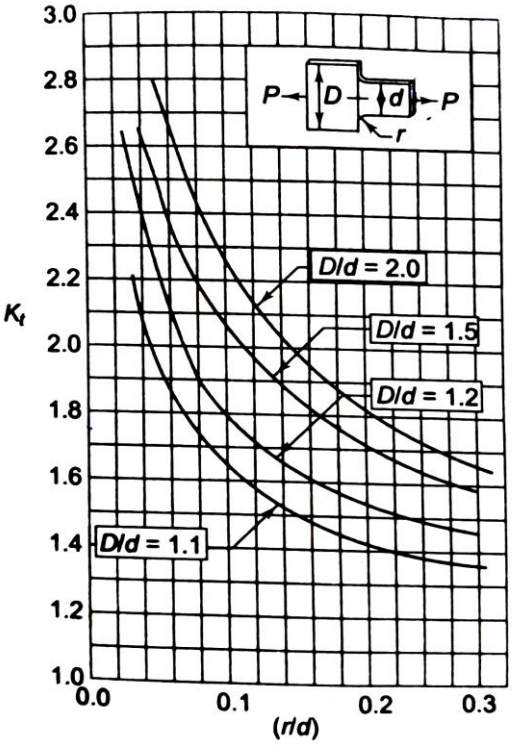
(c) A center cracked plate as shown in **figure 5** has dimensions b=50 mm, t=5 mm and large h. It is subjected to a force of P=50 kN. (a) What is the stress intensity factor K for a crack length of a = 10 mm? (b) For a = 30 mm? **07**

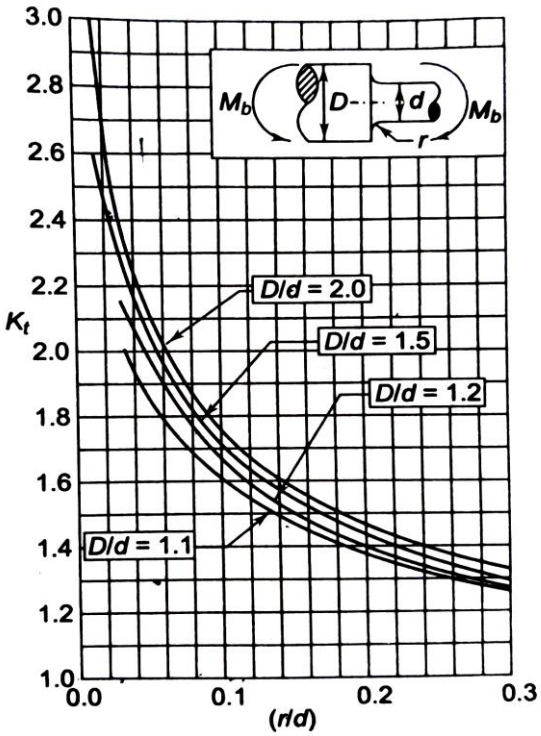
OR

Q.5 **(a)** Explain the Maximum Principal strain theory. **03**

(b) What is Mechanical Housing? Explain the importance of housing. **04**

(c) A wide plate of mild steel is subjected to uniform tensile load causing a stress of 100 MPa. Calculate the critical crack length in the center of plate which when reached will cause the plate to fracture. In a separate fracture test a 3-point bend specimen of thickness 20 mm & depth 25 mm is supported over a span of 100 mm. The specimen is precracked. The fracture occurs at a load of 16513 N and crack length is measured after fracture as 10.25 mm. Calculate the K_{IC} from the data & use in the first part. **07**

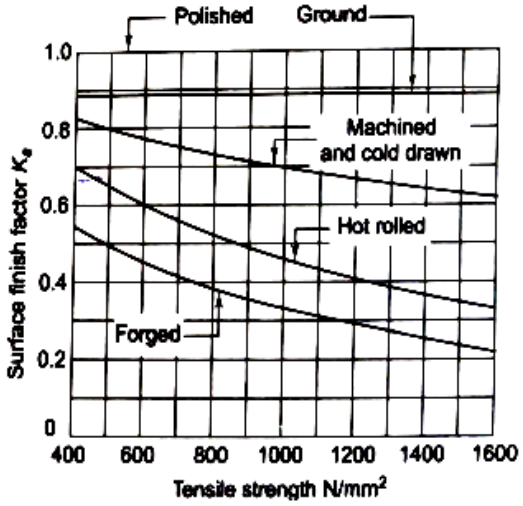




Stress Concentration Factor(Flat Plate withShoulder Fillet in Tension or Compression)

Stress Concentration Factor(Round Shaft with Shoulder Fillet in Bending)

Reliability R (%)	K_c
50	1.000
90	0.897
95	0.868
99	0.814
99.9	0.753
99.99	0.702
99.999	0.659



Reliability Factor(K_c)Surface Finish Factor (K_a)

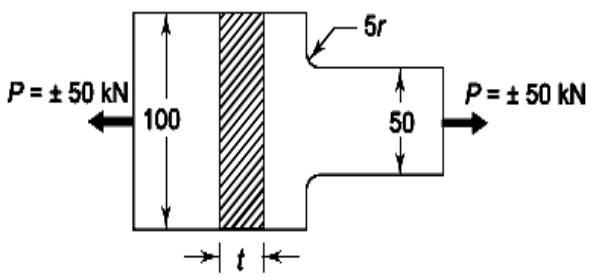


Figure 1

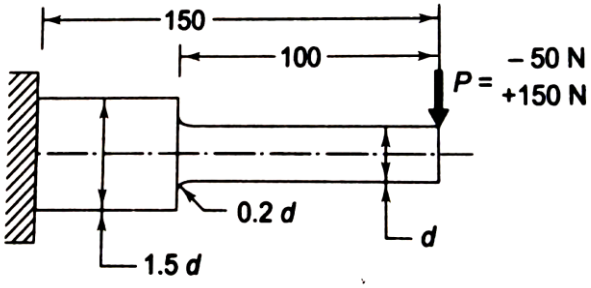


Figure 2

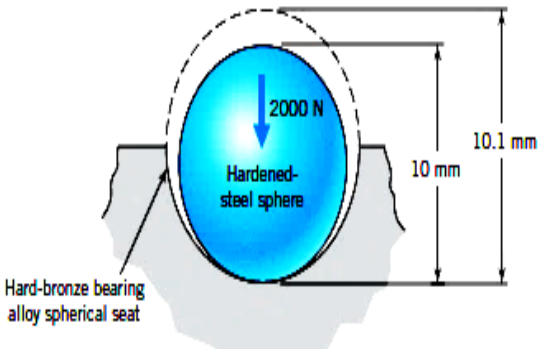


Figure 3

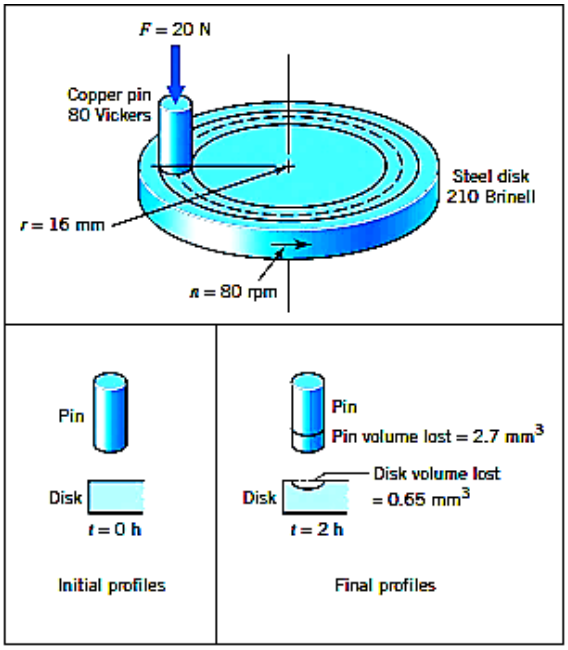


Figure 4

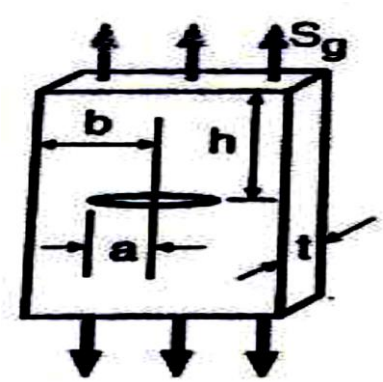


Figure 5