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GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3171925 Date: 19/06/2023

Subject Name: Advanced Machine Design

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.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of Design Data book is permitted.**

			MARKS
Q.1	**(a)**	What is deformation in material? Explain two types of deformations in brief.	**03**
	(b)	Discuss griffith's explanation on "stress concentration at tip of crack" with figure.	**04**
	(c)	Using one example, explain use of "cycle counting method" for cumulative damage.	**07**
Q.2	**(a)**	List five general categories of surface failure and explain any one in brief.	**03**
	(b)	An overhead crane wheel runs slowly on a steel rail. The wheel is 305 mm diameter by 22.23 mm thick and the rail is flat. Both parts are steel. The radial load is 22.241KN. Calculate the size of contact patch between wheel and rail. Assume the rotational speed is sufficiently slow and as this can be considered a static loading problem.	**04**
	(c)	For the C-frame as shown in Figure 1, calculate the safe load when a = 5 mm, depth h of section AB = 40 mm, and L = 150 mm. Thickness/Width of the section B is 25 mm. Given K_{IC} = 59 Mpa, σ_y = 1500 Mpa. For beam segment with crack under bending moment take, $Y_M = 1.122 - 1.4\alpha + 7.33\alpha^2 - 13.08\alpha^3 + 14\alpha^4$ $Y_P = 1.12 - 0.23\alpha + 10.55\alpha^2 - 21.08\alpha^3 + 30.39\alpha^4$	**07**
		OR	
	(c)	Write steps to estimate the mean S-N curve for polished titanium alloys specimens and based on that draw the sample S-N curve.	**07**
Q.3	**(a)**	Discuss effect of following parameters on fatigue strength of any machine element. i. Material composition ii. Operating temperature iii. Grain size	**03**
	(b)	Explain crack initiation phase in detail.	**04**

(c) An alloy steel strut for an experimental aircraft application is fabricated with cross-sectional area of 50 mm^2. Fatigue properties under test conditions that match the actual operating conditions, as shown in the table of experimental results (Table 1). In service, the strut is to be subjected to the following spectrum of completely reversed axial loads during each duty cycle: **07**

P_a = 50 KN for 1000 cycles
P_b = 40 KN for 4000 cycles
P_c = 30 KN for 5,00,000 cycles

This duty cycle is to be repeated three times during the life of the strut. Using linear damage rule, would this strut be expected to survive all three duty cycles, or would it fail prematurely? Assume the governing failure mode is fatigue.

Table 1: Table of experimental results

Stress amplitude (N/mm^2)	**Cycles to failure (N)**
1000	6600
900	30000
800	48000
700	116000
650	∞

OR

Q.3 **(a)** Discuss the cumulative damage concept with S-N diagram. **03**

(b) Draw and discuss any two types of mean zero stress-time patterns. **04**

(c) An axially loaded straight cylindrical bar is to be made of 1020 steel, with fatigue properties as shown in Figure 2. The bar is to be subjected to a completely reversed axial force of 31.138 KN maximum. Fatigue is the governing failure mode. If infinite life is desired for this part, what is the minimum diameter that the bar should be made? **07**

Q.4 **(a)** Explain in brief: **03**

i. Failure due to Creep
ii. Failure due to Damping

(b) Explain the effect of complex multiaxial stress on machine element. **04**

(c) A hollow cylindrical 4340 steel member has 25.4 mm outside diameter, wall thickness of 6.35 mm, and total length of 762 mm. As shown in Figure 3, the member is simply supported at the ends, and symmetrically loaded at the one-third points by 4448 N loads. The tubular bar is simultaneously subjected to an axial force of 22241 N tension and a torsional moment of 338954 N-mm. For the critical point at mid-span, determine the principal stresses σ_1, σ_2 and σ_3. **07**

OR

Q.4 **(a)** Draw and explain the strain versus time behavior during creep under constant force. **03**

(b) An engineering component made of the heat-resisting Fe-Cr-Ni-Co alloy S-590 is subjected in service to a static stress of 200 MPa at a temperature of 600°C. Using Larson-Miller parameter (Refer Figure 4), what creep–rupture life in days is expected? **04**

Use $P_{LM} = T\ (\log t_r + C)$

(c) Explain Linear Elastic Fracture Mechanics for fatigue crack growth for the multiaxial loading. **07**

Q.5 **(a)** Explain creep deformation under varying stress. **03**

(b) Explain sines method for fluctuating simple multiaxial stresses with necessary equations for equivalent mean stress. **04**

(c) Answer the followings: **07**

i. Write two main functions of housings.

ii. Write two most general materials used for housing.

iii. Write three points of difference between split housing and non-split housing.

OR

Q.5 **(a)** Refer the Figure 5 and write three points on effect of temperature on stress versus steady-state strain rate for a material A201 steel. **03**

(b) Explain energy dissipation in material under damping. **04**

(c) Answer the followings: **07**

i. Describe various types of housing seals.

ii. Discuss stresses and deformation induced in housing.

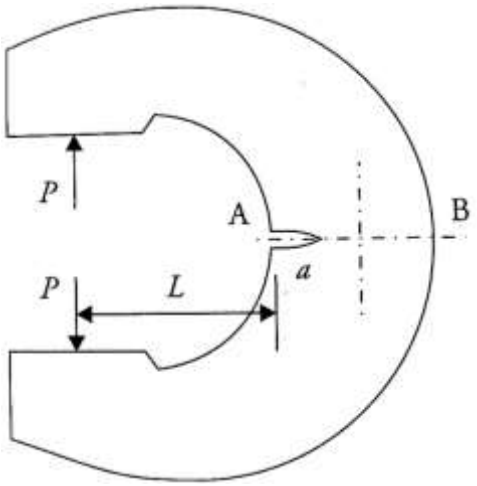
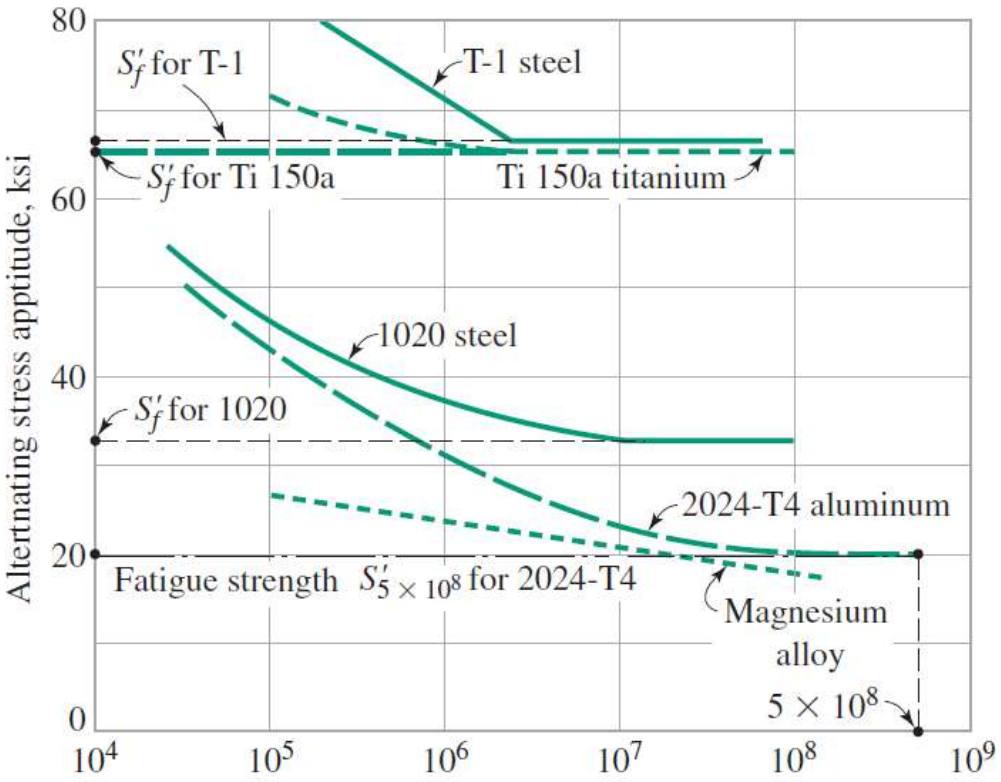


Figure 1. (Que. 2 (c))



(Unit conversion: 1ksi = 6.89476 N/mm^2)

Figure 2. (Que. 3 (c) OR)

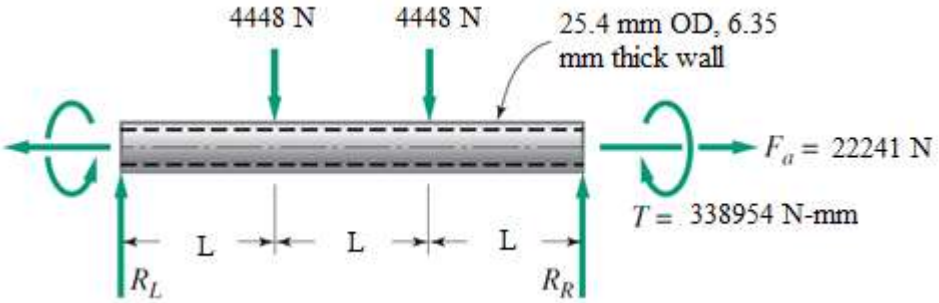


Figure 3. Que. 4 (c)

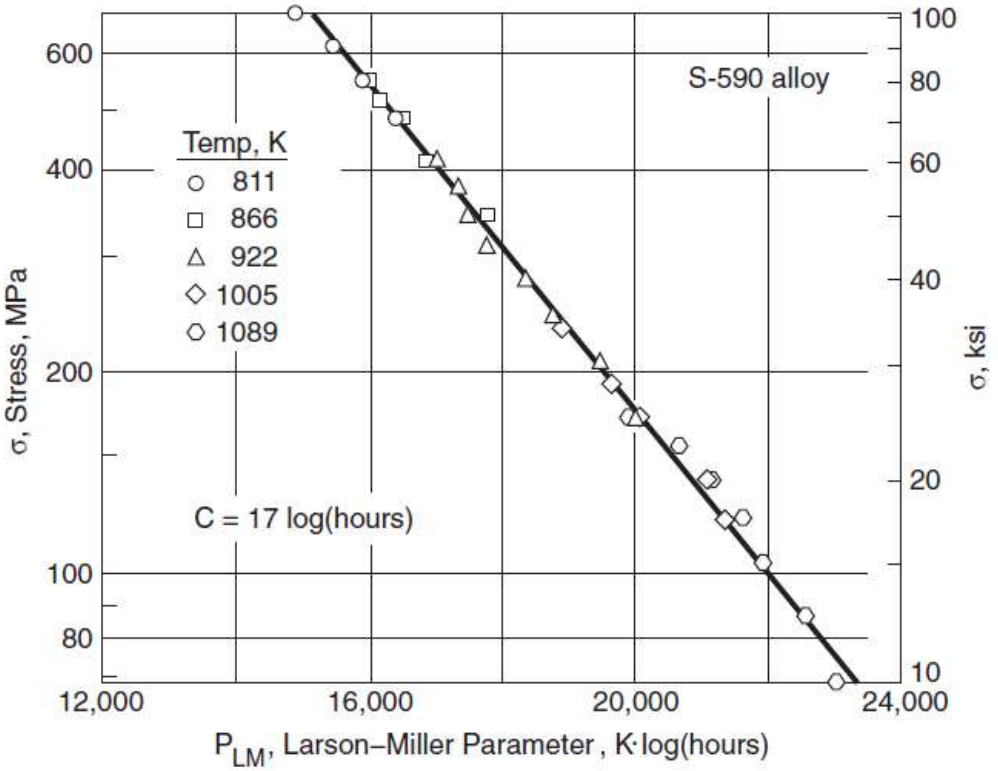


Figure 4. (Que. 4(b) OR)

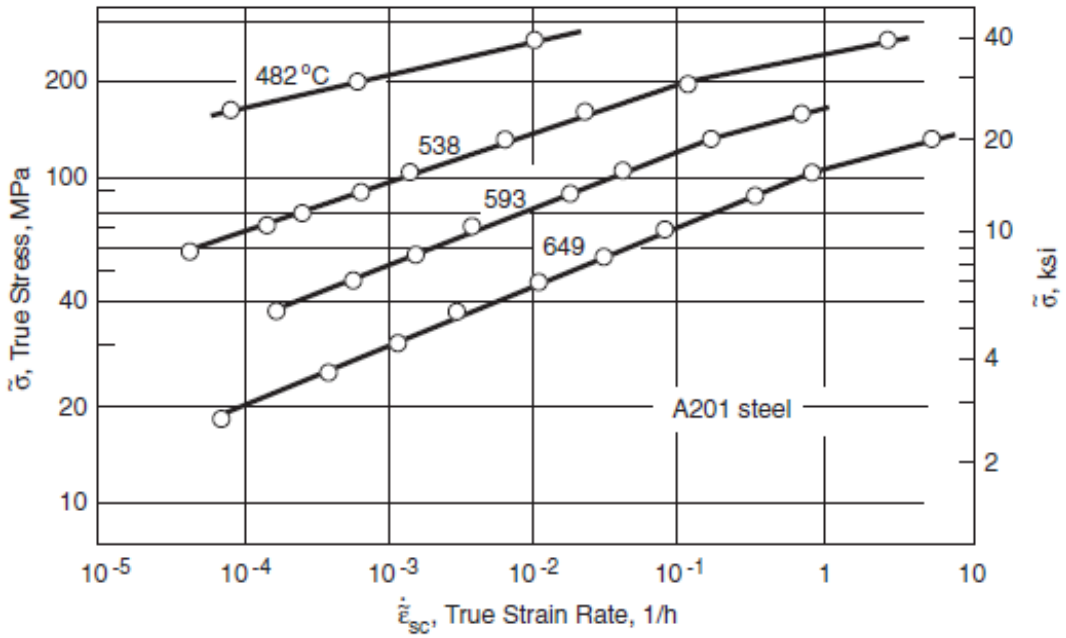


Figure 5. Stress versus steady-state strain rate (Que. 5(a) OR)

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