U.S.N.

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2023 Semester End Main Examinations

Programme: B.E.   **Semester: VI**
Branch: Aerospace Engineering   **Duration: 3 hrs.**
Course Code: 20AE6DEFFM   **Max Marks: 100**
Course: Fatigue and Fracture Mechanics   **Date: 19.07.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
            2. Missing data, if any, may be suitably assumed.
            3. Write Sketches wherever necessary.

<table>
<tr><td colspan="3" align="center">UNIT - I</td><td>CO</td><td>PO</td><td>Marks</td></tr>
<tr><td>1</td><td>a)</td><td>Draw a typical <i>S-N</i> curve for mild steel and explain the effect of mean stress with necessary plots.</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Draw a typical fatigue stress cycle indicating (i) mean, (ii) max, (iii) amplitude and (iv) stress ratio, on it.</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>04</td></tr>
<tr><td></td><td>c)</td><td>Define the following: i) stress concentration factor, K_t ii) fatigue-notch factor, K_f iii) Notch sensitivity factor, q</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>06</td></tr>
<tr><td colspan="3" align="center">OR</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>a)</td><td>Define fatigue failure. Explain the Goodman, Soderberg and Gerber plot of <i>S-N</i> curve with necessary equations.</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Draw and compare the <i>S-N</i> curves of a notched and un-notched mild-steel specimen.</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>04</td></tr>
<tr><td></td><td>c)</td><td>Draw the Haigh diagram indicating stress ratio (R), max. stress, mean stress and number of cycles to failure (N) for an un-notched metallic specimen.</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>06</td></tr>
<tr><td colspan="3" align="center">UNIT - II</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>a)</td><td>Briefly explain the Coffin-Manson relationship with a plot.</td><td><i>CO 2</i></td><td><i>PO1 PO2</i></td><td>06</td></tr>
<tr><td></td><td>b)</td><td>Represent the following schematically:

i)   Stress-controlled loading, strain response for cycle hardening and strain response for cyclic softening</td><td><i>CO 1</i></td><td><i>PO1 PO2</i></td><td>06</td></tr>
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		ii) Strain controlled loading, stress response for cyclic hardening, stress response for cyclic softening				
	c)	Define Low Cycle Fatigue. Explain Neuber's rule with a plot.	CO 1	PO1 PO2	**08**
		UNIT - III			
4	a)	List the four fatigue cycle counting techniques and explain any one.	CO 2	PO1	**10**
	b)	Define "Fatigue Damage". Explain the Miner's rule and mention its limitations.	CO 2	PO1	**10**
		UNIT - IV			
5	a)	Explain the Griffith's energy balance criterion and derive an expression for stress required to fracture a plate having a through thickness elliptical crack.	CO 3	PO1	**08**
	b)	Describe a typical fatigue crack growth rate curve highlighting the Paris region and the governing equation.	CO 3	PO1	**06**
	c)	Explain the effect of specimen thickness on the critical stress intensity factor.	CO 3	PO1	**06**
		OR			
6	a)	Explain the formation of crack tip plasticity under cyclic loading	CO 3	PO1	**08**
	b)	Write the expression relating energy release rate and stress intensity factor for plane strain and plane stress conditions.	CO 3	PO1	**04**
	c)	Define linear elastic fracture mechanics. Highlight the importance of stress intensity factor approach as compared to stress concentration approach.	CO 3	PO1	**08**
		UNIT - V			
7	a)	Elaborate on "Safe-life" and "Fail-safe" design philosophies highlighting at least one limitations in each.	CO43	PO1	**06**
	b)	What are the recommended practices to improve fatigue design of a structure?	CO 1	PO1	**08**
	c)	How is damage tolerance evaluation done?	CO 1	PO1	**06**

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