Lib 8/5/17

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

Examination

May 2017

Max. Marks: **100** | Duration: **4 Hours**

Class: **M.Tech.** Semester: **II** | Program: **M.Tech. in Machine Design**

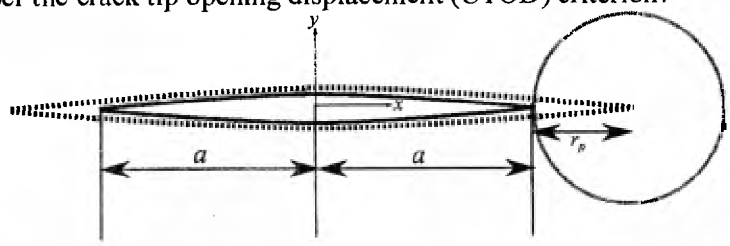
Name of the Course: **Fracture Mechanics** | Course Code: **MTMD201**

Master file.

Instructions:

- Question no. **1** is **compulsory**. Attempt any **four** out of remaining six questions.
- Answers to all sub questions should be grouped together.
- Assume suitable data if necessary.

			Max. marks	CO No.	Module No.
Q1		State 'True' or 'False'			
	a)	J-integral is a path independent integral.	**(2)**	*1*	*4*
	b)	An overload cycle increases crack growth rate.	**(2)**	*2*	*6*
	c)	The mode-I plastic zone size at crack tip for plane strain is more than that of plane stress case.	**(2)**	*1*	*1*
	d)	The displacement based SIF calculation method is more accurate than stress based method in displacement based FEM.	**(2)**	*2*	*3*
	e)	As per the MTPS criterion, crack propagates at an angle corresponding to maximum tangential stress.	**(2)**	*3*	*7*
	f)	SIF depends on the material property.	**(2)**	*4*	*6*
	g)	The energy release rate (G) and SIF are related.	**(2)**	*2*	*2*
	h)	Cleavage fracture is more likely when plastic flow is restricted.	**(2)**	*2*	*1*
	i)	The size of the plastic zone scales as $(K/\sigma_y)^2$.	**(2)**	*2*	*1*
	j)	Low temperature causes embrittlement and this causes catastrophic failure through crack propagation.	**(2)**	*1*	*1*
Q2		A large steel plate of an elastic, ideally plastic material (σ_y = 500 MPa) contains a through thickness centre crack of total length ($2a$) 50 mm. At a tension test of the plate, the crack was found to start growing at the remote stress of 300 MPa. (a) Find out the remote stress at which a crack of length $2a$ = 150 mm starts to grow as per the crack tip opening displacement (CTOD) criterion?	**(6)**	*4*	*2*



[Hint 1: CTOD criterion says crack will propagate when the COD $\delta(x=a)$ reaches a critical value]

[Hint 2: Use Dugdale COD: $\delta(x=a) = \pi\sigma^2 a/E\sigma_y$ where E = 120GPa]

(b) For the two cases, $2a = 50$ mm and $2a = 150$ mm, calculate the size of the plastic zone (r_p) at the crack tip when the crack is about to propagate? **(10)** *4* *2*

(c) Compute the critical energy release rate (G_c) of SIF (K_{Ic})? **(4)** *1* *2*

Q3 A large thin plate contains a centre crack of length $2a_0$ and is subjected to a constant amplitude tensile cyclic stress normal to the crack with maximum stress $\sigma_{max} = 200$ MPa and stress range $\Delta\sigma = \sigma_{max} - \sigma_{min}$, $\sigma_{min} = 0$. The fatigue crack growth is governed by equation, $da/dN = 3.9 \times 10^{-14}(\Delta K)^{3.7}$ where da/dN is expressed in m/cycle and ΔK in MPa$\sqrt{}$m.

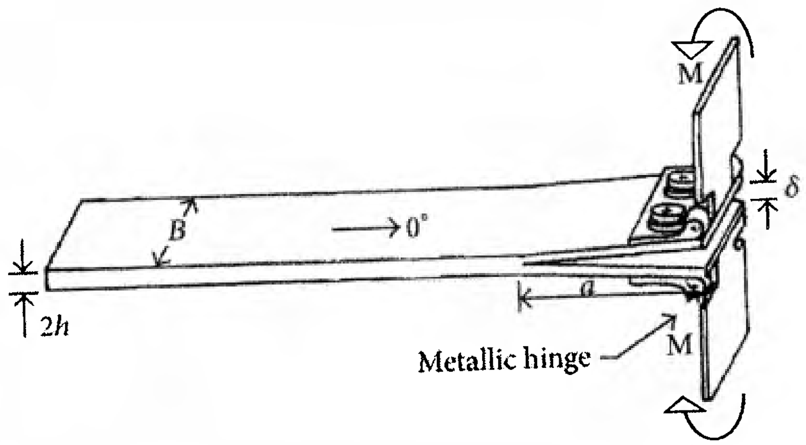
(a) Determine a_f. Use $K_{Ic} = 24$ MPa$\sqrt{}$m, and use units $\Delta\sigma$: MPa, K: MPa$\sqrt{}$m, length: m in all your calculations. **(4)** *4* *6*

(b) Determine the fatigue lifetime (N_f) of the plate for $2a_0 = 2$ mm. **(8)** *2* *6*

(c) Clearly step-wise highlight the procedure to find the fatigue life time if there is an overload cycle after half of fatigue life time i.e. $N_f/2$ obtained in above case [Hint: Use Wheeler's retardation model]. **(8)** *4* *6*

Q4 (a) Define J-integral and provide two important characteristics of J-integral? **(4)** *2* *4*

(b) Determine J-integral for the following specimen. Calculate SIF? Mention all the assumptions clearly. Consider Young's modulus as E and Poisson's ratio as ν. **(10)** *3* *4*



(c) Compare the obtained J-integral result obtained using potential or strain energy release rate. **(6)** *2* *2*

Q5 a) The weight function for an edge crack in a finite plate of width w is given by **(10)** *1* *3*

$$m(x,a) = \frac{2}{\sqrt{2\pi(a-x)}}\left[1 + m_1\frac{a-x}{a} + m_2\left(\frac{a-x}{a}\right)^2\right]$$

$$m_1 = A_1 + B_1 r^2 + C_1 r^6, m_2 = A_2 + B_2 r^2 + C_2 r^6$$

$$\text{for } 0 \le r \le 1, r = a/w$$

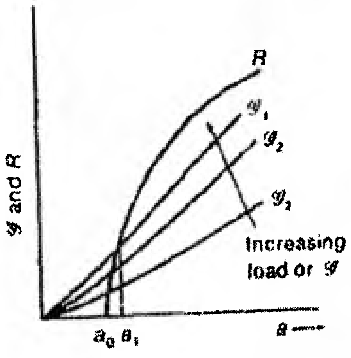
$$A_1 = 0.6147, B_1 = 17.1884, C_1 = 8.7822$$

$$A_2 = 0.2502, B_2 = 3.2899, C_3 = 70.0444$$

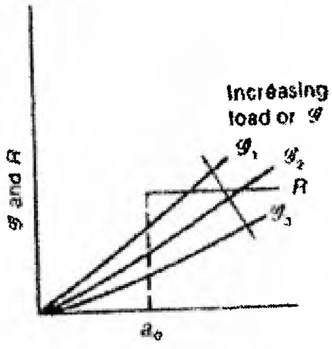
Calculate K_I for remote end load σ and $r = 0.5$

b) What is R-curve? Why is there no possibility of unstable crack propagation in case of displacement loading? **(4)** *4* *4*

c) From the figures below, can you determine which R-curve corresponds to brittle material and which one is for ductile material? Explain in few lines **(6)** *2* *4*



(a)



(b)

Q6 a) Derive the expression for σ_{xy} for mode II problem using Williams' Eigenfunction Expansion approach. Draw the variation of σ_{xy} ahead of crack tip along x-axis. Also, draw the variation of COD, u (along x-axis), behind the crack tip. **(16)** *1* *3*

b) What are the parameters that are obtained experimentally for fracture toughness measurement? Mention one ASTM standard for determining fracture toughness? **(4)** *3* *5*

Q7 a) Estimate the direction of crack extension for a through-the-thickness crack in a thin cylinder when it is subjected to a torque T = 50 kNm and an axial load P = 1 MN, which is distributed over the cross section. Cylinder has a internal radius r = 300mm and wall thickness t = 10 mm. Crack size $2a$ = 12 mm (Fig.7(a)). **(10)** *4* *7*

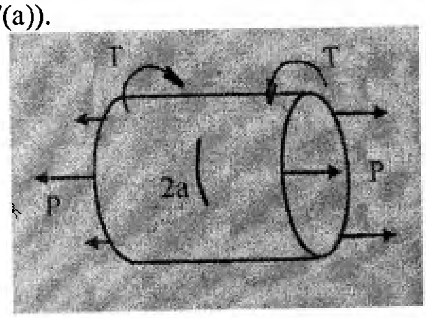


Fig. 7(a)

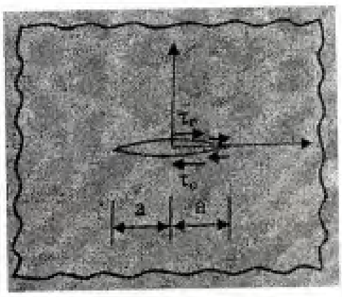


Fig. 7(b)

b) Determine the SIF at the right crack tip for the case shown below. Shear stress varies linearly from τ_o at centre to zero at the crack tip (Fig.7(b)). **(10)** *1* *3*

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Lib ~~Exam~~ 15/05/17

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END SEM

May 2017 | **Date: 15 May 2017**

Program: M.Tech Machine Design | **Duration: 4 Hours**

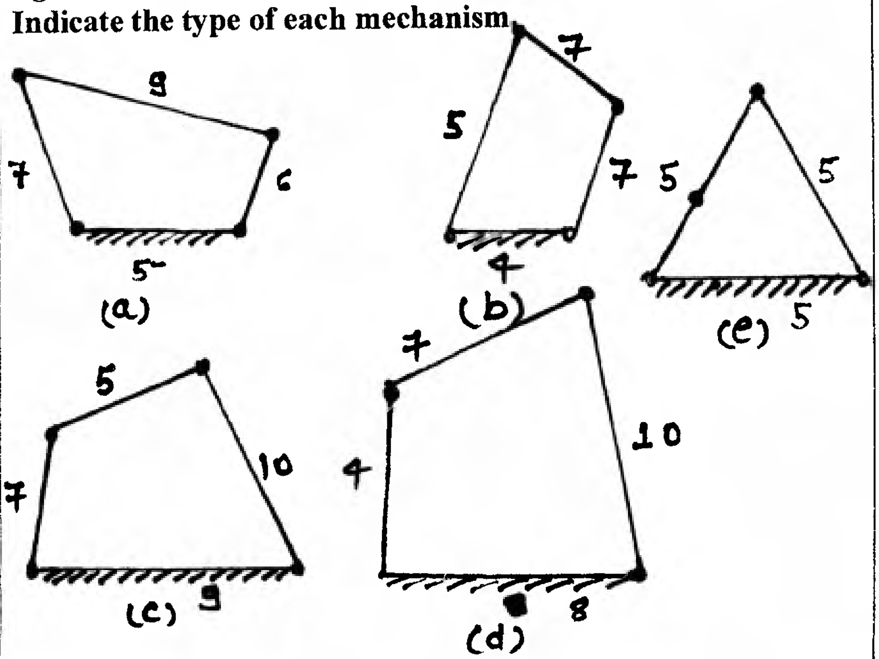
Course code: MTMD205 | **Maximum Marks: 100**

Name of the Course: Analysis and Synthesis of Mechanisms | **Semester: II**

Instructions:

- **Question no. 1 is compulsory.**
- **Attempt any four questions out of remaining six.**
- **Assume Suitable data if necessary.**
- **All sub questions should be grouped together.**

Master file.

Q. No.		Max. Marks	CO No.	M.No.
Q1	(a) What do you mean by degree of freedom of a kinematic pair? How are pairs classified? Give examples.	06	03	01
	(b) What is kutzback's criterion for degree of freedom of plane mechanisms? In what way is Grubler's criterion different from it?	06	03	01
	(c)Figure shows some four-link mechanisms in which the figures indicate the dimensions in standard units of length. Indicate the type of each mechanism. 	08	03	01

Q2	(a) Design a four-link mechanism if the motions of the input and the output links are governed by a function $y=x^{1.5}$ and x varies from 1 to 4. Assume θ to vary from 30° to 120°and φ from 60° to 130°. The length of the fixed link is 30 mm. Use Chebyshev spacing of three accuracy points.	10	01	02
	(b)Describe synthesis, types of kinematic synthesis and tasks of kinematic synthesis.	10	03	02
Q3	Explain the following concepts with examples			
	(a) Four Bar Coupler curve equation.	06	01	03
	(b) Roberts-Chebyshev theorem.	06	03	03
	(c) Overlay Method of kinematic synthesis.	08	04	06
Q4	(a)Solve the Euler's Savary equation with inflection points and inflection circle.	10	03	04
	(b)Synthesize the function y= sin (x) for $0° \leq x \leq 90°$. The range in φ is 120° and the range in ψ is 60°. Chebyshev spacing yielded the following precision points: $\varphi_2-\varphi_1= 52°$ $\psi_2 - \psi_1 = 36.15°$ $\varphi_3 - \varphi_1 = 104°$ $\psi_3 - \psi_1 = 53.40°$ Here $R\varphi = 4/3$ and $R\ \psi=60°$, using freudenstein equation.	10	04	05
Q5	Derive the freudenstein's equation for three-point function generation.	20	04	07
Q6	(a)Explain equivalent linkages in detail with suitable sketches.	10	01	01
	(b)Describe the concept of kinematic inversion in planar mechanisms for 4R, 3R-1P, and 2R-2P.	10	03	02
Q7	(a) Determine the Chebyshev spacing for a four bar linkage generating the function $y = 2x^2-1$, in the range of $1 \leq x \leq 2$, where four precision points are to be prescribed (n=4). Take $\Delta x = 1.0$ (circle diameter), sides of polygon is 2n.	10	03	02
	(b)Describe the concept of poles, relative poles and determine the pole triangle of four bar mechanism.	10	03	05