

Unit 6 - Week 4

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Assignment 4

The due date for submitting this assignment has passed. **Due on 2019-08-28, 23:59 IST.**
 As per our records you have not submitted this assignment.

- Instructions for answering numerical questions
- In all numerical type questions, you are expected to round off the answers to two decimal places accuracy unless otherwise specified.
 Examples: 1. Ans: 9.825, you report as 9.83
 2. Ans: 9.8, you report as 9.80
 3. Ans: 9, you report as 9.00
 - The style of reporting is essential for computer based automated correction of your answers.
 - The answers for various quantities asked are to be reported in the following units unless otherwise specified, Stress- MPa, Stress Intensity Factor- MPa/m, Strain energy- Nm, Energy release rate- J/m², deflection - mm.

1) Which definition of Energy Release Rate (G) is correct? **1 point**

- Energy released per unit extension of crack front per unit thickness of the body per crack tip
- Energy released per unit extension of crack front for all crack tips
- Energy released per unit thickness of the body per crack tip
- G is the Total strain energy of the body

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 Energy released per unit extension of crack front per unit thickness of the body per crack tip

2) What is the unit of Energy Release Rate (G)? **1 point**

- J/m²
- N/m
- Both a and b
- None of the above

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 Both a and b

3) For a central crack of length 2a, in infinite panel of unit thickness subjected to uniaxial stress σ , strain energy U_s is given by **1 point**

- $U_s = \frac{\pi\sigma^2 a^2}{E}$
- $U_s = \frac{\pi\sigma^2 a}{E}$
- $U_s = \frac{\pi\sigma^2 a^2}{G}$
- $U_s = \frac{\pi\sigma a^2}{E}$

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 $U_s = \frac{\pi\sigma^2 a^2}{E}$

4) For what condition does crack branching occur? **1 point**

- G=R
- G=2R
- $G = \frac{R}{2}$
- none of the above

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 G=2R

5) The Figure gives the R curve for plane stress condition. As shown in the figure, σ_c is the fracture strength at the crack length **1 point**

a_1

At any crack length a

$a_1 + \Delta a_1$

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 a_1

6) Which of the following is true for energy release rate (G_I)? **1 point**

- It is the energy released per unit extension of crack front per unit thickness of the body per crack tip
- For brittle materials, it can be obtained from the relation, $G_I = \frac{K_I^2}{E}$ where K_I is the opening mode SIF and E is the Young's modulus.
- Crack growth begins only when the energy release rate (G_I) is equal to the critical energy release rate (G_{IC}) for the material
- All of the above

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 All of the above

7) What understanding does a simplistic extension of Inglis's solution for stress field around an elliptical hole to a crack provide? **1 point**

- Even for small loads, the crack may grow and break the component into pieces
- The crack grows and breaks when the applied stress reaches a critical value
- The crack grows when sufficient energy is provided externally to overcome the surface energy for the formation of the cracks
- None of the above

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 Even for small loads, the crack may grow and break the component into pieces

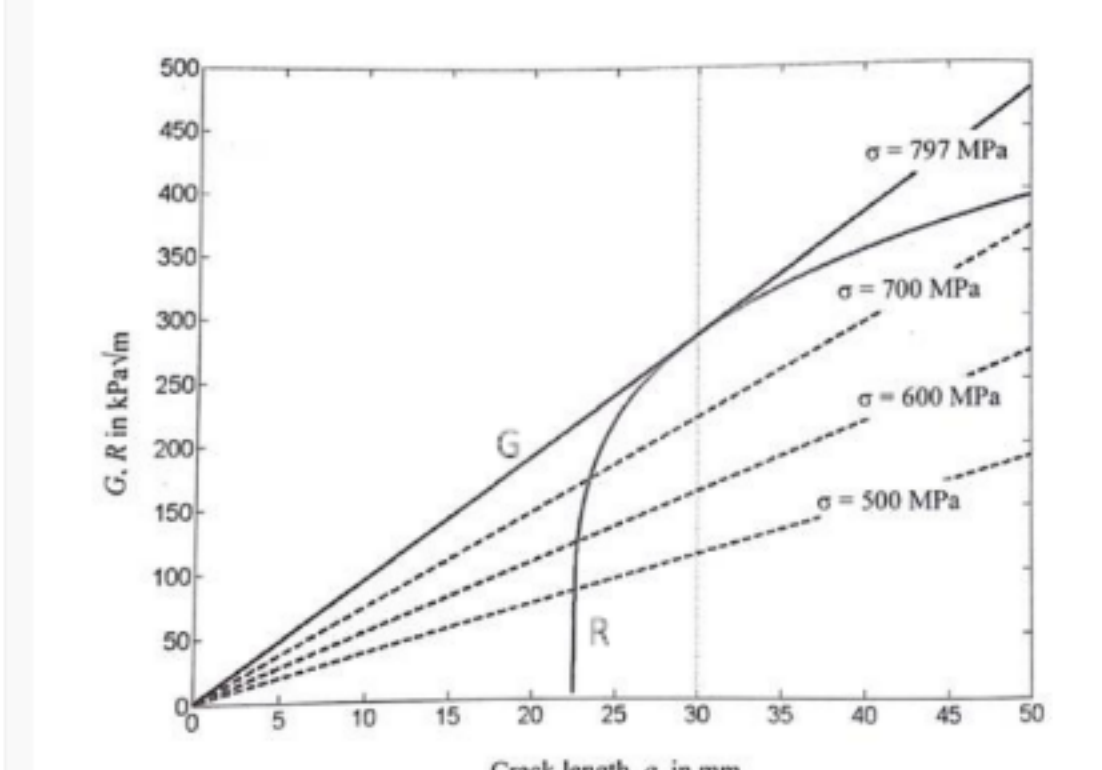
8) For a crack to propagate, which are the necessary and sufficient conditions, respectively, for ductile materials? Strain energy in the presence of crack is U_s and surface energy is given by U_s . **1 point**

- $\frac{\partial U_s}{\partial a} = -\frac{\partial U_s}{\partial a}$
- $\frac{\partial U_s}{\partial a} = -\frac{\partial U_s}{\partial a}$ and $G_I = R$
- $G_I = R$ and $\frac{\partial G_I}{\partial a} = \frac{\partial R}{\partial a}$
- $G_I = \sqrt{R}$ and $\frac{\partial G_I}{\partial a} = \frac{\partial R}{\partial a}$

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 $G_I = R$ and $\frac{\partial G_I}{\partial a} = \frac{\partial R}{\partial a}$

An infinite panel of width 1200 mm has a centre crack of length $2a = 45$ mm. A remote load was gradually applied and it was observed that there was stable fracture followed by catastrophic failure.

From the independent test of the panel material, R and G are plotted as shown in the Figure. Using this data,



9) Determine the extent of stable crack growth Δa in mm. **1 point**

- 2.5
- 7.5
- 14.5
- 20.15

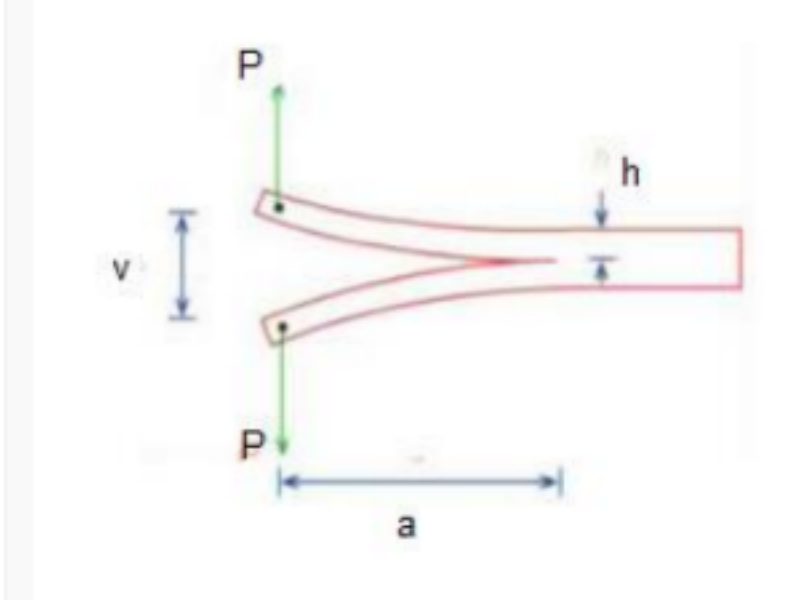
No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 7.5

10) What is the fracture stress **1 point**

- 500 MPa
- 600 MPa
- 700 MPa
- 797 MPa

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 797 MPa

For the double cantilever beam shown in Figure, find the following values.



11) Total deflection at the end of beam, is given by **2 points**

- $\delta = \frac{Pa^3}{3EI}$
- $\delta = \frac{2Pa^3}{3EI}$
- $\delta = \frac{Pa^3}{6EI}$
- $\delta = \frac{Pa^3}{8EI}$

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 $\delta = \frac{2Pa^3}{3EI}$

12) What is the compliance of the body? **2 points**

- $C = \frac{4a^3}{EBh^3}$
- $C = \frac{4a^3}{EB^3h}$
- $C = \frac{8a^2}{EB^3h}$
- $C = \frac{8a^2}{EBh^3}$

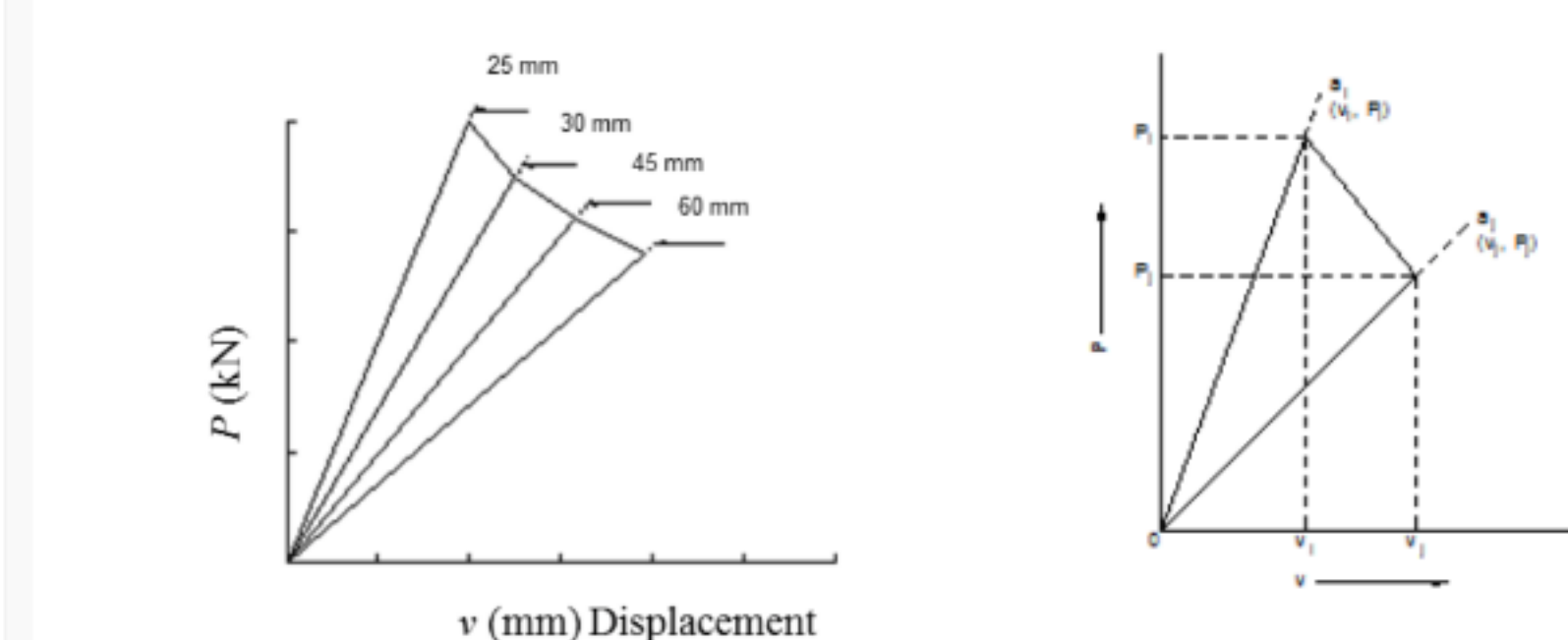
No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 $C = \frac{8a^3}{EBh^3}$

13) For energy release rate to be constant in the above case, which conditions are desirable? **1 point**

- Varying the thickness B of the beam
- Varying a, B and h such that the quantity $\frac{a^2}{B^2h^3}$ remains constant
- Varying a, B and h such that the quantity $\frac{a^2}{h^3}$ remains constant
- None of the above

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 None of the above

The following data were obtained from a test conducted on pre-cracked specimens of thickness 10 mm.



Crack Length a (mm)	Critical Load P (kN)	Critical Displacement v (mm)
25	45	0.40
30	40	0.50
45	35	0.62
60	30	0.75

where, P and v are the critical load and displacement respectively at the crack growth. The load displacement record for all crack lengths is linearly elastic up to the critical point.

From the data provided, answer the following questions.

14) When the crack grows from 25 mm to 30 mm, change in potential energy is _____ Joule. **1 point**

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 (Type: Range) 3.00,3.50

15) If the crack grows as shown in the graph, the total energy release rate is _____ N/mm. **2 points**

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 (Type: Range) 110.00,120.00

16) When the crack grows from 45 mm to 60 mm, the change in compliance with respect to crack length is _____ $\times 10^{-5} kN^{-1}$ **2 points**

No, the answer is incorrect.
 Score: 0
 Accepted Answers:
 (Type: Range) 45.00,50.00