Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–III • EXAMINATION – SUMMER 2014

Subject Code: 730902 **Date:02/05/ 2015**

Subject Name: Fracture Mechanics

Time:2:30 pm to 5:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive the relation between strain energy release rate and the stress intensity factor. **07**

(b) Discuss the crack growth resistance curve with stability condition for ductile and brittle materials. **07**

Q.2 **(a)** Find the stress intensity factor for the Griffith crack. **07**

(b) Find the energy release rate for the following geometry (Fig. 1). **07**

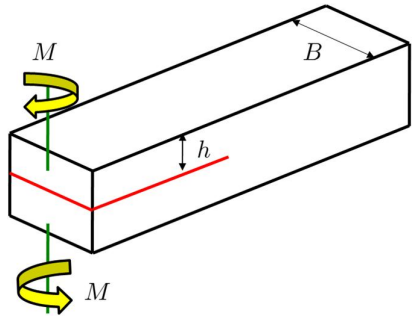

Fig.1

OR

(b) Determine the energy release rate for the double cantilever beam subjected to end load. **07**

Q.3 **(a)** Find the plastic zone size in front of the crack tip under plane stress condition using von Mises criteria. **07**

(b) Verify the Westergaard function for an infinite plate with a crack of length $2a$ subjected to a pair of forces at $x = b$. (Fig. 2) **07**

$$Z_I = \frac{P}{\pi(z-b)}\left(\frac{a^2-b^2}{z^2-a^2}\right)^{1/2}$$

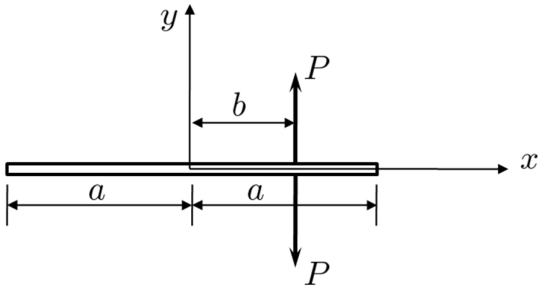

Fig. 2

OR

Q.3 **(a)** Find the plastic zone size using Dugdale model. **07**

(b) Find the Westergaard function and the stress intensity factor for the following loading. (Fig. 3) **07**

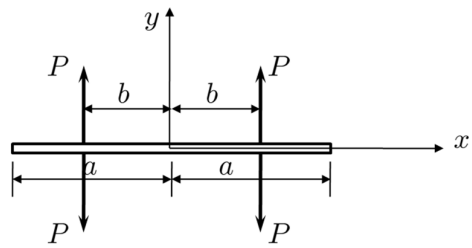

Fig. 3

Q.4 **(a)** Find the relation between the crack tip opening displacement and the energy release rate. **07**

(b) Two infinite layers of height h_1 and h_2 and large thicknesses are made of different materials with modulli of elasticity and Poissonôs ratios E_1, υ_1 and E_2, υ_2, respectively as shown in Fig. 4. The layers are joined across their interface forming a semi-infinite crack, and are subjected to bending moments M. Determine the value of the J- integral. **07**

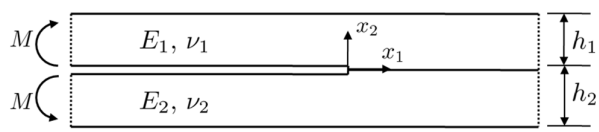

Fig. 4

OR

Q.4 **(a)** Prove that the J- integral is path independent. **07**

(b) Determine the J-integral for the double cantilever beam loaded as shown in Fig. 5. **07**

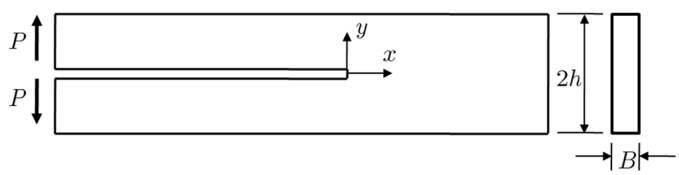

Fig. 5

Q.5 A large thick plate of steel contains a crack of length 5 mm oriented at an angle $\beta = 30^0$ with respect to the direction of applied uniaxial stress σ. Calculate the angle of initial crack extension and the value of the critical stress σ_c for crack growth according to the strain energy density criterion when the stress σ is

(a) tensile and **07**

(b) compressive, K_{Ic} = 60 MPaãm, E = 210 GPa, υ = 0.3 **07**

OR

Q.5 **(a)** Explain Fracture process in Composites **07**

(b) Explain different manifestation of damage **07**

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