Menoufiya University **Faculty of Engineering** **Shebin El- Kom** **Mid-Term Exam.** **Academic Year: 2012 – 2013** **Date: 15/ 6/ 2013**	**Dept. : Production Engineering and Mechanical Design** **Year : Third Year** **Subject: Fracture Mechanics and Stress Analysis** **Code : PRE 322** **Time Allowed: 3 hours** **Total Marks: 85 Marks**

Allowed Tables and Charts: None

This exam measures ILOs No.: (a1,a13,a19, b2, b7, b14, c1, c12, c16, d6, d7 and d9)

Answer all the following Questions:

(Any missing data can be reasonably assumed)

Question 1: **(6+7+7 marks)**

i. Explain Griffith theory of brittle fracture and derive Griffith's equation for predicting the fracture strength of a completely brittle material.

ii. Illustrate the differences between Charpy and Izod tests for determining the notch toughness with the aid of neat sketches. Explain graphically the concept of transition temperature.

iii. What is the concept of compliance and prove that the energy release rate can be computed from the relationship

$$G = \frac{P^2}{2B}\frac{dC}{da}$$ for both load control and displacement control.

Question 2: **(6+7+7 marks)**

i. Interpret the following equation and carefully define each symbol used :

Failure is predicted to occur if $Y\ \sigma\sqrt{\pi a} \geq K_{Ic}$ and discuss the factors that affect the level of K_{Ic}.

ii. Describe a method for determining the critical load, P_Q, the relationship for computing the provisional fracture toughness, K_Q, and the validity requirements for $K_Q = K_{IC}$.

iii. A plate of steel with a central through-thickness flaw of length 16 mm is subjected to a stress of 345 MPa normal to the crack plane. If the yield strength of the material is 1400 MPa, what are the plastic zone size and the effective stress intensity level at the crack tip? If a second plate of steel with the same crack size and applied stress level was heat treated to provide a yield strength of 400 MPa, determine the effective stress intensity value and comment on your results.

Question 3: **(6+7+7 marks)**

i. Draw a schematic representation of a fatigue fracture surface in a steel shaft, showing the mechanism of fatigue failure indicating the significance of beach marks.

ii. What is meant by: i) Endurance limit and fatigue strength, ii) Stress ratio, R and mean stress σ_m. iii) R= 0 and R = -1.

iii. An aircraft is made up of aluminum which has a fracture toughness K_{Ic} = 32 MPa$\sqrt{m}$. and the smallest detectable flaw is 4 mm. If the stresses vary from 140 MPa to 20 MPa, (between take-off and landing) and the material parameters C = 5×10^{-11} m/cycle, and n = 3. Calculate the critical crack size, and by using Paris equation; find the number of cycles before the crack will propagate to its critical length.

Question 4: **(5+7 marks)**

i. Explain the effect of cooling rate on the hot ductility of steel?

ii. Discuss the effect of strain rate on the hot ductility of steel indicating the concept of HDL, Trough and HDH.

Question 5: **(4+9 marks)**

i. Discuss the effect of temperature oscillation on the hot ductility of both Nb and Ti steels?

ii. Differentiate between:
   a) Fine precipitations and coarse precipitations.
   b) Air cast and vacuum cast.
   c) Primary cooling and secondary cooling.

Good Luck