Menoufiya University **Faculty of Engineering** **Shebin El- Kom** **Final Term Examination** **Academic Year: 2014 – 2015** **Date: 9/6/ 2015**		**Dept. : Production Engineering** **Year Third Year** **Subject: Fracture Mechanics** **Code : PRE 322** **Time Allowed: 3 hr.** **Total Marks: 85 Marks**
Allowed Tables and Charts: None		

Answer all the following Questions

(Any missing data can be reasonably assumed)

Question (1) **(5+5+5 Marks)**

a) Derive Griffith's equation for determining the stress required to propagate a crack in a brittle material.

b) Explain the concept of fracture toughness, indicating how the critical stress intensity, K_C, depends on the thickness and discuss the factors that affect the plane strain fracture toughness

c) A material has a yield strength of 345 MPa and a plane strain linear elastic fracture toughness of 120 MPa$\sqrt{m}$. Determine the minimum specimen dimensions (B, a, W) required to perform a valid K_{IC} test on this material. Comment on the feasibility of testing a specimen of this size

Question (2) **(7 + 8 Marks)**

a) Prove that the estimation of crack tip zone by Dugdale model is consistent with that by Irwin model.

b) You have a 2024-T351 aluminum plate of width 150 mm and thickness 1.5 mm with a central through-thickness flaw of length 25 mm is subjected to a tensile load, F normal to the crack plane.

Determine the maximum load can be applied without causing a sudden fracture and comment on your results if the yield strength of the material is 500 MPa and the plane strain fracture toughness is 28.6 MPa$\sqrt{m}$.

Question (3) **(5 + 5 Marks)**

a) From your study to some cases, list the main reasons that cause failure in metallic components and the suggested corrections?

b) Explain graphically the concept of ductile to brittle transition temperature.

Question (4) **(6+ 9 Marks)**

a) Explain an experimental test for determining the fatigue limit or the endurance limit indicating the mechanism of fatigue fracture.

b) A large center-cracked plate containing an initial crack of length $2a_o$ = 10 mm is subjected to a constant amplitude cyclic tensile stress ranging between a minimum value of 100 MPa and a maximum of 200 MPa. Assuming the fatigue crack growth rate is governed by the equation

$$\frac{da}{dN} = 0.42 \times 10^{-11}(\Delta K)^3 \qquad \text{(m/cycle)}$$

i) Calculate the crack growth rate when the crack length has the following values 2a =10 mm and when 2a = 50 mm.

ii) The critical crack size.

iii) Assuming further that the relevant fracture toughness is 60 MPa$\sqrt{m}$, estimate the number of cycles to failure.

Question (5) **(15 Marks)**

i) What is the effect of cooling rate on the hot ductility of steel?

ii) Explain the following:

a) Continuous casting.

b) Transverse cracking.

c) HDL, Trough and HDH.

Question (6) **(15 Marks)**

i) What is the effect of temperature oscillation on the hot ductility of both Nb and Ti steels?

ii) Explain the differences between:

a) Fine precipitations and coarse precipitations.

b) Linear cooling and temperature oscillation.

c) Primary cooling and secondary cooling.

GOOD LUCK