Registration No: | | | | | | | | | | |

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M.TECH
MDPE101

1st Semester Regular/Back Examination – 2014
FATIGUE, CREEP AND FRACTURE
BRANCH(S): MACHINE DESIGN,MECHANICAL SYSTEM DESIGN
Time: 3 Hours
Max Marks: 70
Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 Answer the following questions: (2 x 10)

a) Describe the phenomenon of fatigue failure in metals. Define "Endurance Limit".
b) Describe the effect of surface finish on endurance limit.
c) Determine the design stress for a piston rod where the load is completely reversed. The surface of the rod is ground and the surface finish factor is 0.9. There is no stress concentration. The load is predictable and the factor of safety is 2. Assume load correction factor is 0.8.
d) Write down the factors to be while designing machine parts to avoid fatigue failure.
e) Explain the phenomenon of creep in metals.
f) Define creep stress relaxation with neat curve.
g) Write down the assumptions while considering creep in torsion.
h) Distinguish between brittle & ductile fracture.
i) Define fracture toughness. Write down the factors affecting fracture toughness.
j) Write down the methods of protection against fracture.

Q2 a) Describe different stages of creep in creep-time curve. (4)
b) Show the variation of stress, creep and time with changes in temperature. (3)
c) Derive the creep-stress-rupture relations for members subjected to combined stress. (3)

Q3 Derive the expression showing the ratio of creep bending stress and elastic bending stress (creep stress ratio) considering creep in bending. (10)

Q4 a) Describe the methods of reducing stress concentration. (4)
b) A machine component is subjected to a flexural stress which fluctuates between +300MN/m^2 AND -150 MN/m^2. Determine the value of minimum ultimate strength according to: (6)
i) Gerber relation ii) Modified Goodman relation iii) Soderberg relation

Q5 a) Compare Goodman, Soderberg and Gerber fatigue design formulae. Show them on graph. (5)

b) A circular bar of 500mm length is supported freely at its two ends. It is acted upon by a central cyclic load having a minimum value of 20 KN and a maximum value of 50 KN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect 0.85, surface finish factor of 0.9 and fatigue stress concentration factor of 1. The material properties of the bar are given by: ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa. (5)

Q6 a) Explain Griffith theory of brittle fracture. (5)

b) Explain Irwin's theory of fracture. (3)

c) A glass sample has a crack length of 4.2 μm. if the young's modulus of the glass is 70 GN/m^2 and the specific energy is 1.1 J/m^2. Estimate its fracture strength using Griffith's equation. (2)

Q7 a) Define stress intensity factor. (3)

b) What would be the critical crack length according to Griffith-orown equation for the following: fracture stress = 1000 MPa, young's modulus = 210 GPa, plastic work required to extend the crack wall = 1000 J/m^2. (3)

c) Describe the three modes of fracture with appropriate sketches. (4)

Q8 a) Write down the creep stress time relations for simple tension considering different methods for short time and long time. (4)

b) Derive an expression for angle of twist per unit length considering creep in torsion. (4)

c) The length of a crack in a steel is 4μm. taking E=200 GN/m^2, estimate the brittle fracture strength using Griffith's equation at low temperatures, if the true surface energy is 1.48 J/m^2. (2)