USN

12MMD/MDE321

Third Semester M.Tech. Degree Examination, Dec.2013/Jan.2014

Fracture Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Derive an expression for fracture strength of a brittle solid containing a crack using Griffith's energy balance criterion. **(10 Marks)**

b. What is the surface energy? Explain. **(04 Marks)**

c. A flat plate with a through thickness crack is subjected to a 200 MPa tensile stress and has a fracture toughness K_{IC} of 50 MPa$\sqrt{m}$. Determine the critical crack length assuming the material is linear elastic. Also calculate the energy release rate (G_c) of the material. Assume E = 207000 MPa. **(06 Marks)**

2 a. Show that stress intensity factor for Mode – I (K_I) for the single edge notched tensile panel reduces to; $K_I = 1.12\sqrt{\pi a}$ for a << w. **(08 Marks)**

b. What is the relation between stress intensity factor and energy release rate. **(05 Marks)**

c. A material exhibits the following crack growth behaviour of resistance; $R = 26.95\,(a - a_0)^{1/2}$ where a_0 is the initial crack size in M, R has units of kJ/m^2. The elastic modulus of this material is 207000 MPa. Consider a wide plate with a through crack (a << w) that is made from this material.

If this plate fractures at 138 MPa compute the half crack size at failure and the amount of stable crack growth (at each crack tip) that precedes failures ($a_c - a_o$) and assume Poisson's ratio as 0.3. **(07 Marks)**

3 a. Define CTOD and explain. **(05 Marks)**

b. Derive the relation for non-linear energy release rate for linear elastic mode-1 loading. **(08 Marks)**

c. A middle tensile (MT) panel shown in Fig.Q3(c) is 1m wide and 25 mm thick with 200 mm crack size must carry a load of 700 MN. For the material K_{IC} = 200 MPa$\sqrt{m}$, σ_{YS} = 350 MPa and σ_{TS} = 450 MPa, use the strip yield criteria FAD to determine the whether or not the crack will fast. **(07 Marks)**

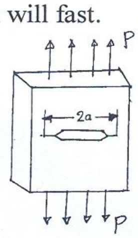

Fig.Q3(c)

4 a. Describe fracture toughness test for a SENB specimen. **(08 Marks)**

b. What is J integral? Explain. **(05 Marks)**

c. A center cracked tension panel of width 2W (= 200 mm) and with a crack of length 2a (= 60 mm) is loaded to failure in the direction perpendicular to the crack plane. The material has a yield strength σ_{YS} = 300 MPa and a fracture toughness K_{IC} = 80 MPa$\sqrt{m}$. At what value of the applied stress σ will fracture occur? Estimate the failure load and comment. B = thickness of the plate = 4 mm. **(07 Marks)**

2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

5 a. Explain micro mechanisms of fracture in metals. (10 Mark

b. What is parts law? Explain. (07 Mark

c. List the parameters affecting CTOD. (03 Mark

6 a. Explain creep crack growth with neat sketch. (10 Mark

b. Explain Dugdale's plastic strip model and show that internal stress must be equal to th yield strength of the material. (10 Mark

7 a. An SEN bend bar of a steel alloy was used to conduct a J integral test. The specimen ha dimensions of B = 10 mm, W = 20 mm, S = 80 mm and a = 10 mm. The alloy possessed th following mechanical properties: E = 205 GPa, μ = 0.25. The J test developed and the are between the loading and unloading found to be equal to 5 Nm^2 and maximum load equals t 15 kN. Calculate the value of J for this material. Use $K = \frac{p\rho}{BW^{1.5}} f(a/w)$ an

$$f\left(\frac{a}{w}\right) = \frac{3(a/w)^{0.5}}{2(1+2a/w)(1-a/w)^{1.5}} \times \left[(1.99 - a/w)(1-a/w)\left(2.15 - 3.93\,a/w + 2.7\,a^2/w^2\right)\right].$$ (10 Marks)

b. An edge crack detected on a large plate, is of length 3.1 mm under a constant amplitud cyclic load having σ_{max} = 310 MPa and σ_{min} = 172 MPa of the plate is made of a ferrite pearlite steel and $K_{IC} = 165\ MPa\sqrt{m}$, determine:

i) Propagation life upto failure and

ii) Propagation life if the crack length 'a' is not allowed to exceed 25 mm Use $C = 6.8 \times 10^{-2}$, m = 3, f = 1.12. (10 Marks)

8 Write short notes on the following (any FOUR):

a. Elastic-plastic fracture mechanics.

b. Role of NDT in design against fracture

c. Dynamic fracture and crack arrest

d. Fast safe and safe life approach to design

e. Brittle and Ductile fracture. (20 Marks)

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12MMD333/12MDE333

Third Semester M.Tech. Degree Examination, Dec.2013/Jan.2014
Design for Manufacture

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions.*
2. Use of data hand book permitted.
3. Write neat sketches wherever necessary.

1 a. Enumerate the general guidelines for design for manufacture. **(10 Marks)**

b. Select a suitable material by weighted point method. There are four materials selected on the basis of design requirement whose details are given in Table.1. The material is to be used for a cryogenic storage tank for transporting liquid nitrogen at -196°C. **(10 Marks)**

Table 1

Material	Toughness	Yield strength (MPa)	E (GPa)	Specific gravity	Thermal expansion
Aluminum 2014 – T6	75.5	420	74.2	2.8	21.4
Stainless steel – 301	770	1365	189	7.9	16.9
Ti – 6Al-4V	179	475	112	4.43	9.4
Inconel	239	1190	217	8.51	11.5

Rank the properties on scale of 1 to 5.

2 a. Explain the meaning of the surface finish symbol used in the drawing of a component shown in Fig. Q2 (a) **(05 Marks)**

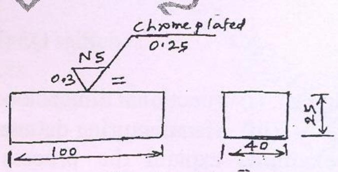

Fig. Q2 (a)

b. Explain the meaning of the geometric tolerance symbols used in the drawing of a component shown in Fig. Q2 (b) **(05 Marks)**

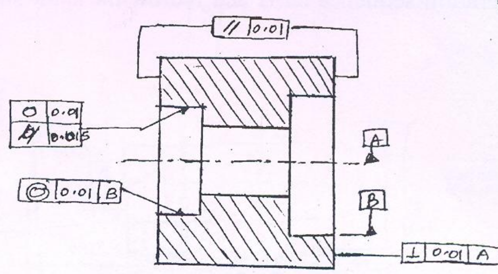

Fig. Q2 (b)

c. A hole is dimensioned as 25 ± 0.075 mm. The shaft diameter can be held to a tolerance of ± 0.050 mm. Distribution of variations of diameters for both the parts resembles a truncated normal curve with 16 truncation. Find the mean diameter of the shaft to be specified on the drawing if the permissible size of the assembly with a clearance of 0.025 mm or less is to be 2%. **(10 Marks)**

3 a. The fit requirement between the pin and the bore of the arrangement shown in Fig. Q3 (a) is $C = 0.005 \pm 0.008$ mm. Assume that the hole basis system is followed and the basic size of the hole is 9 mm. It is required to achieve the above fit by following the selective assembly procedure. Specify the size range and tolerance range for different mating groups that would satisfy the requirement of the fit. Assume $g_h = g_s$. Show the size zones of the hole and shaft components side and side. **(08 Marks)**

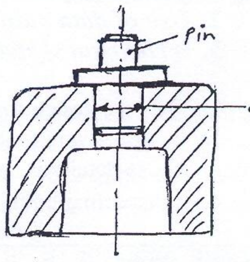

Fig. Q3 (a)

b. For the automobile steering box assembly shown in Fig. Q3 (b), determine the limits on related dimensions of various components to achieve an assembly tolerance of 0.1 to 0.2 mm. Use the method of laminated shims to achieve this assembly tolerance. **(12 Marks)**

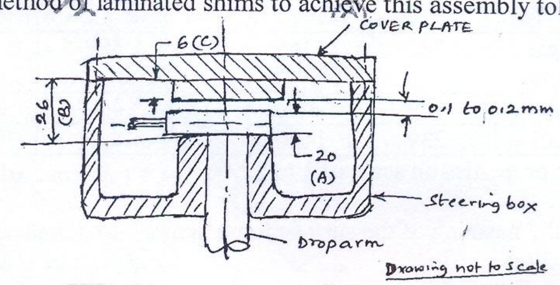

Fig. Q3 (b)

4 a. Explain the meaning of, (i) Functional dimension (ii) Functional datum (iii) Manufacturing datum. **(04 Marks)**

b. With a simple example, explain the process of changing the functional datum to manufacturing datum. **(06 Marks)**

c. A location shaft shown in Fig. Q4 (c) is to be manufactured in batches of 100. Prepare a suitable operation sequence chart and redraw the shaft showing appropriate manufacturing dimensions. **(10 Marks)**

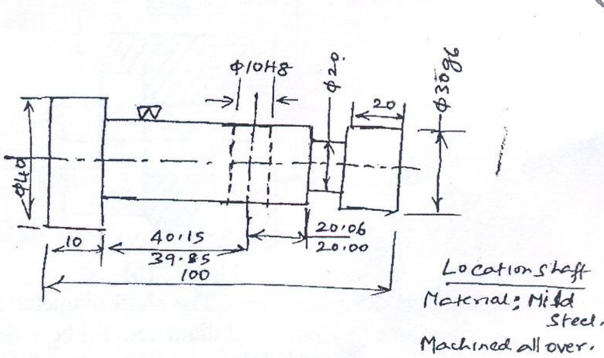

Fig. Q4 (c)

5 a. Explain the following:
(i) Machined holes (ii) Cored holes (iii) Cast holes. **(05 Marks)**

b. Explain the considerations given in the selection of porting lines. **(03 Marks)**

c. A cast iron connecting bracket is shown in Fig. Q5 (b). Identify the most suitable parting line and introduce design modifications to obviate the use of sand cores. **(12 Marks)**

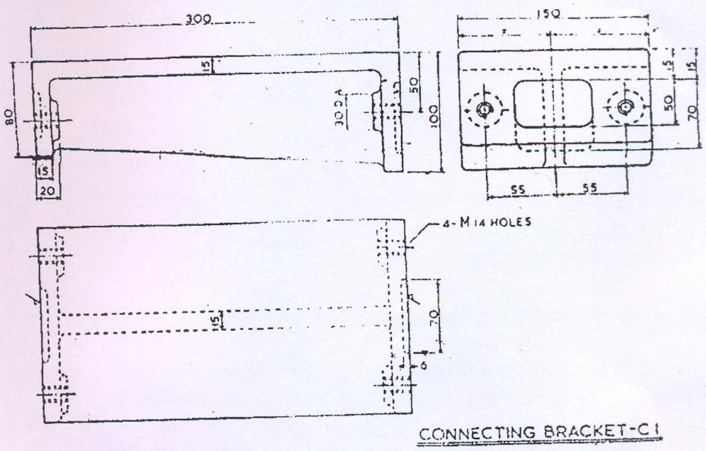

Fig. Q5

6 a. Explain the design considerations given for the following:
(i) Internal screw threads.
(ii) Blind bored holes.
(iii) Ground surfaces. **(08 Marks)**

b. Explain the following with relevant sketches:
(i) Reduction of machined areas.
(ii) Dowels and Dowelling procedure.
(iii) Simplification by separation. **(12 Marks)**

7 a. Find the value of the maximum inclination accepted by the fixed gage designed for the part given in Fig. Q7 (a), when the hole is at (i) MMC (ii) LMC. **(06 Marks)**

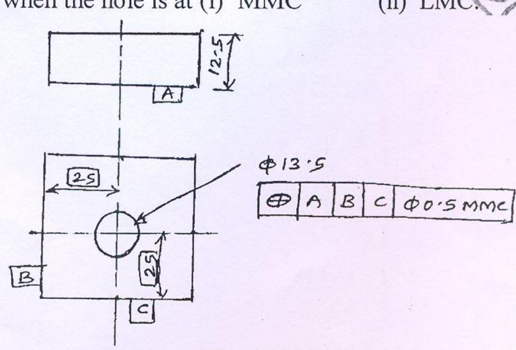

Fig. Q7 (a)

7 b. A series of parts shown in Fig. Q7 (b) are to be assembled next to each other. Determine the value of the tolerance T_1 to ensure assembly. **(06 Marks)**

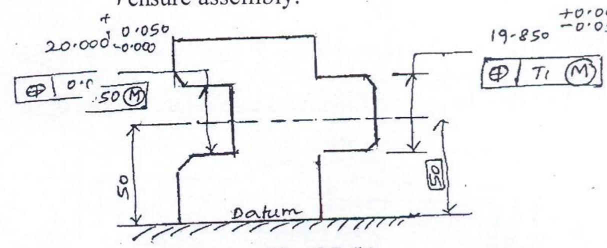

Fig. Q7 (b)

c. Explain the following :
(i) Maximum material condition (ii) Least material condition
(iii) Virtual size. **(04 Marks)**

d. Explain the advantages of true position Tolerancing. **(04 Marks)**

8 a. Explain the various allowances that must be taken into account in the manufacture of a gage. **(05 Marks)**

b. Explain the Taylor's principle of gage design. **(05 Marks)**

c. Explain the following types of gages with neat sketches:
(i) Plain plug gage (ii) Snap gage – plate type (iii) Plain ring gage. **(10 Marks)**

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