BACHELOR OF METALLURGICAL ENGG. EXAMINATION, 2011

(3rd Year, 2nd Semester, Supplementary)

Testing Materials & Quality Control

Time : Three hours Full Marks : 100

Answer any ***five*** questions.
All questions carry equal marks.
Answers must be brief and to the point.
All parts of the same question
must be answered contiguously.

1. a) Briefly describe how you will carry out a tensile test with a specimen of cylindrical gage geometry. Comment on the data resolutions desirable for such a test. 8

   b) In a schematic engineering stress-strain diagram, mark the significant engineering strength and ductility parameters that are determined from such a test. 6

   c) How will the values of these parameters be affected if the specimen gauge length and diameter are changed in a proportionate manner? Explain your answer. 6

2. a) Define Brinell, Vicker, Meyer, Rockwell and Knoop hardness numbers. 10

b) Identify, with reasons, the hardness testing method(s) best suited for determining (i) hardness profile across a weld joint with narrow heat affected zones, (ii) hardness of cast iron material to be used as base of lathe machines, (iii) hardness of case carburized steel gears. 2x3

c) To what extent is it possible to infer plastic deformation properties from hardness test data? 4

3. a) Impact testing with Charpy V notch specimens is extensively used to characterize the ductile to brittle transition (DBT) behaviour. In a schematic plot, show how the DBT behaviour is reflected in the variation of Charpy impact energy, and macroscopic fracture appearance, with temperature. 10

b) Is it possible to study the DBT phenomenon using tension tests with smooth cylindrical gauge specimens? Give reasons for your answer. 5

c) Austenitic steels do not show the DBT behaviour. Why? 5

4. a) Describe how you will carry out constant load creep tests in lever arm creep testing machines. Explain the test requirements for permissible load and temperature variations, and resolution for the extensometer. 4+6

c) Except at very low loads, Vicker hardness number is independent of the applied load. Why?

d) The high cycle fatigue lives of welded joints are generally significantly lower than that of base materials. Why?

e) What are persistent slip bands?

f) Why is it necessary to exercise caution in extrapolating laboratory creep and stress rupture test data to service conditions?

g) Identify, with reasons, a suitable NDE method for detecting slag inclusions in steels.

h) Explain when you will prefer neutron radiography to X-ray or g -ray radiography.

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b) Draw a typical three stage creep curve as would be obtained by isothermal constant tensile load creep testing. Identify the important parameters characterizing creep deformation and fracture on this plot. 4+6

5. a) Describe how you will determine the S-N curve for a ferritic steel using smooth specimens, taking into consideration the statistical nature of fatigue properties. 8

b) With the help of a neat sketch, show how mean affects the fatigue properties. 8

c) Why shot-peening improves high cycle fatigue life? 4

6. Answer any two of the following : 10x2

a) Briefly explain the steps in *either* liquid penetrant test *or* magnetic particle inspection for detection and sizing of cracks in ferritic steel components.

b) Describe a stress relaxation test, and explain its applications and limitations.

c) Critically discuss the factors that may limit the suitability of compression tests for generating plastic flow data for metal working processes.

d) Explain the process of development of cup and cone fracture in tension tests with specimens of cylindrical gauge geometry.

7. a) What do you understand by deformation under plane stress and plane strain conditions? Why plane strain deformation condition is sought to be maintained for determining fracture toughness of a material? 6+4

b) What are the size restrictions imposed on the specimen for determining valid K_{IC}? 4

c) Explain the necessity and the conceptual basis of Irwin's plastic zone size correction. 6

8. Very briefly answer any ***four (4)*** of the following questions. 5x4

a) How can you *experimentally* demonstrate that the yield point phenomenon observed in C-steels in ambient temperature tension tests is actually because of interstitial solutes?

b) Show that for a rate-insensitive material, the true strain at maximum load in tension equals the strain exponent in Hollomon work hardening equation.