Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	MATERIAL ENGINEERING TECHNOLOGY
COURSE CODE	:	BNQ 30503
PROGRAMME	:	3 BNN
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) (i) Define the term '*hardness*' and '*anelastic*' in mechanical properties of metals.

(2 marks)

(ii) Explain **TWO (2)** reasons why hardness tests are preferable compared to other mechanical tests.

(6 marks)

(b) A cylindrical specimen of steel having an original diameter of 15.5 mm is tensile-tested to fracture and found to have an engineering fracture strength, σ_f of 420 MPa. If its cross-sectional diameter at fracture is 9.2 mm;

(i) Calculate the ductility in terms of percentage reduction in area

(3 marks)

(ii) Determine the true stress at fracture

(4 marks)

(c) A cylindrical specimen of aluminium having a diameter of 30 mm and length of 240 mm is deformed elastically in tension with a force of 50, 000 N. Using the data presented in **TABLE Q1 (c)**;

TABLE Q1 (c) : Room-Temperature Elasticity and Shear Moduli and Poisson's Ratio for Varius Metal Alloy.

Metal Alloy	Modulus of Elasticity (GPa)	Shear Modulus (GPa)	Poisson's Ratio
Aluminium	69	25	0.33
Brass	97	37	0.34
Copper	110	46	0.34
Magnesium	45	17	0.29
Nickel	207	76	0.31
Steel	207	83	0.30
Titanium	107	45	0.34
Tungsten	407	160	0.28

(i) Calculate the amount by which this specimen will elongate in the direction of the applied stress.

(3 marks)

(ii) Analyse the change in diameter of the specimen, either increase or decrease.

(2 marks)

Q2 (a) **FIGURE Q2 (a)** shows a portion of the titanium-copper phase diagram.

(i) Examine all temperature composition points at which eutectics, eutectoids, peritectics, and congruents phase transformations occur.

(4 marks)

(ii) For each point in Q2 (a) (i), identify the equation of reaction upon cooling.

(4 marks)

(b) **FIGURE Q2 (b)** shows a magnesium-lead phase diagram. A magnesium-lead alloy of mass 6.0 kg consists of a solid α phase that has a composition just slightly below the solubility limit at 200 °C (473 K).

(i) Calculate the mass of lead in the alloy

(2 marks)

(ii) If the alloy is heated to 350 °C (623 K), calculate the mass of lead that may be dissolved in the α phase without exceeding the solubility limit of this phase.

(3 marks)

(c) **FIGURE Q2 (c)** shows Iron-Carbine Phase Diagram. Consider 2 kg of austenite containing 1.15 wt % C, cooled to below 725°C (998 K).

(i) Calculate the mass of each total ferrite and cementite formed.

(2 marks)

(ii) Determine the quantity of pearlite and proeutectoid phase formed.

(2 marks)

(iii) Draw and label the resulting microstucture.

(3 marks)

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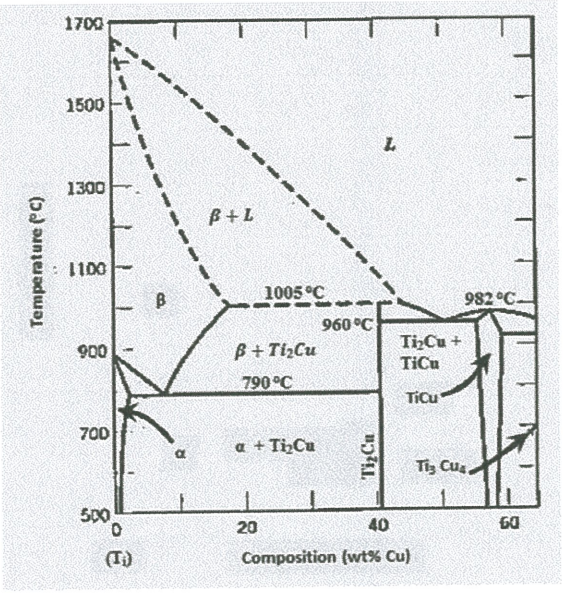

FIGURE Q2 (a): Titanium-Copper Phase Diagram

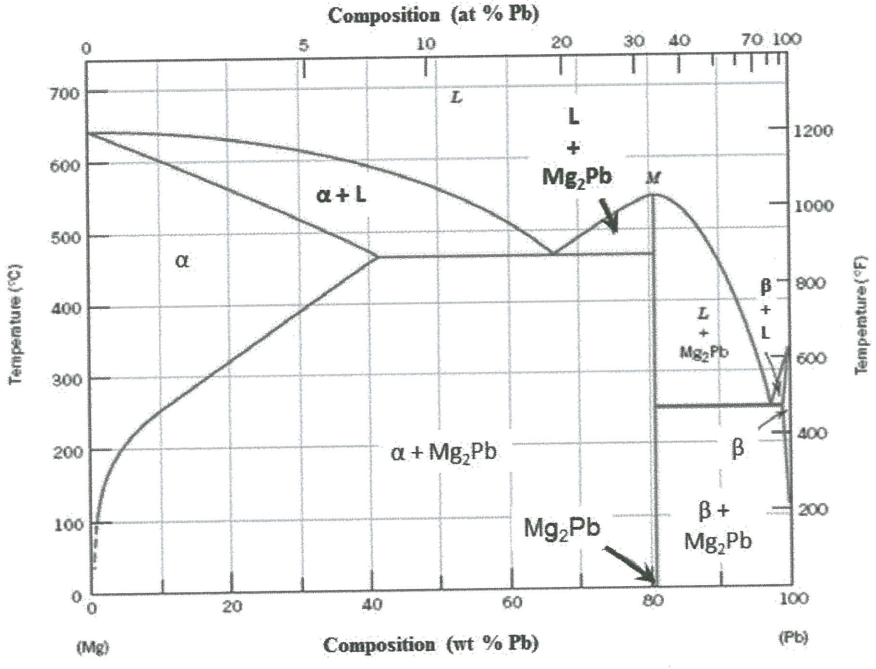

FIGURE Q2 (b): Magnesium – Lead Phase Diagram

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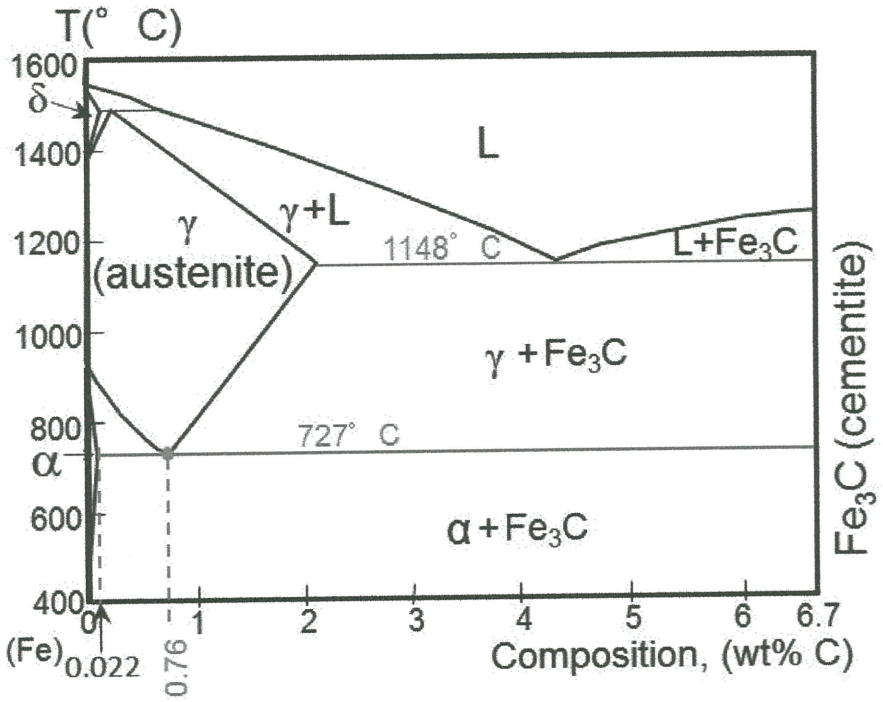

FIGURE Q2 (c): Iron-Carbide Phase Diagram

Q3 (a) A cylindrical bar of 1045 steel having the S-N behaviour shown in **FIGURE Q3 (a)** is subjected to rotating-bending tests with reversed-stress cycles. Given the bar diameter is 20.0 mm, factor of safety 2.5 and distance between loadbearing points is 55.0 mm. Determine the maximum cyclic load that maybe applied to ensure that fatigue failure will not occur.

(4 marks)

(b) (i) Environmental factors may also affect the fatigue behaviour of material. Two commonly known environmental-assisted fatigue failure are thermal fatigue and corrosion fatigue. Briefly explain your understanding on both term '*Thermal Fatigue*' and '*corrosion fatigue*'. Your explanation should be able to cover the aspect of what, why and the effects of thermal and corrosion fatigue.

(8 marks)

(ii) The presence of chemically active environment may lead to a reduction in fatigue life for corrosion fatigue. Based on corrosion fatigue phenomena, propose **TWO (2)** measures that may be taken to prevent or reduced the occurrence of corrosion fatigue and **TWO (2)** measures that can be taken to extend fatigue life.

(8 marks)

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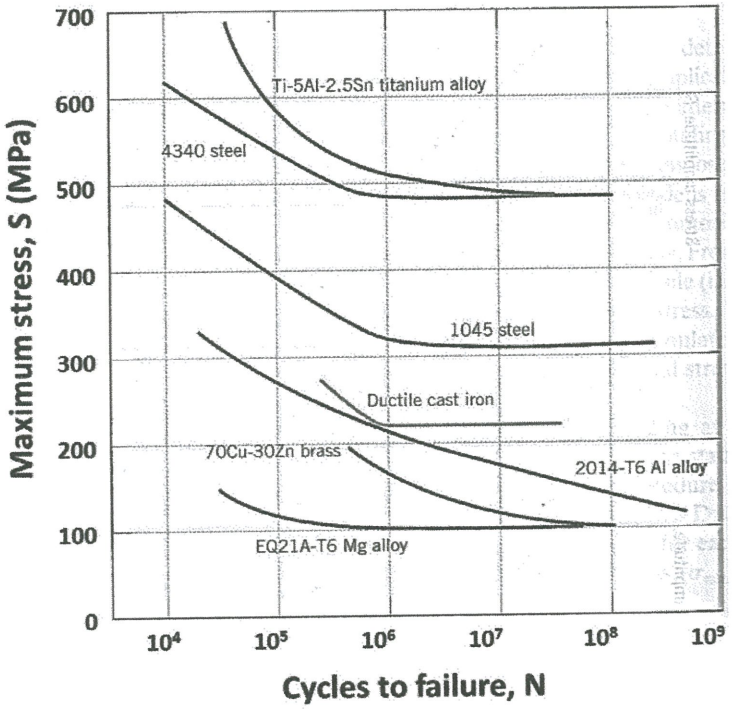

FIGURE Q3 (a): Maximum stress (S) versus logarithm of the number of cycles to fatigue failure (N) for seven metal alloys.

Q4 (a) (i) Define the term '*activation polarization*' in corrosion and degradation of materials.

(2 marks)

(ii) Referring to Q4 (a) (i), explain why the term '*activation*' is applied in this type of polarization.

(2 marks)

(iii) Describe the phenomenon of '*passivity*'.

(2 marks)

(iv) Name **TWO (2)** common types of alloy that passivate

(2 marks)

(b) (i) Define the term '*inhibitors*' in corrosion prevention.

(2 marks)

(ii) Propose **THREE (3)** of the possible mechanism that account for inhibitor effectiveness.

(6 marks)

(c) For the following pairs of alloys that are coupled in seawater, predict the possibility of corrosion; if corrosion is probable, indicate which metal/alloy will corrode. Refer **FIGURE Q4 (c)** (if applicable).

(i) Aluminium and magnesium
(ii) Zinc and low-carbon steel

(4 marks)

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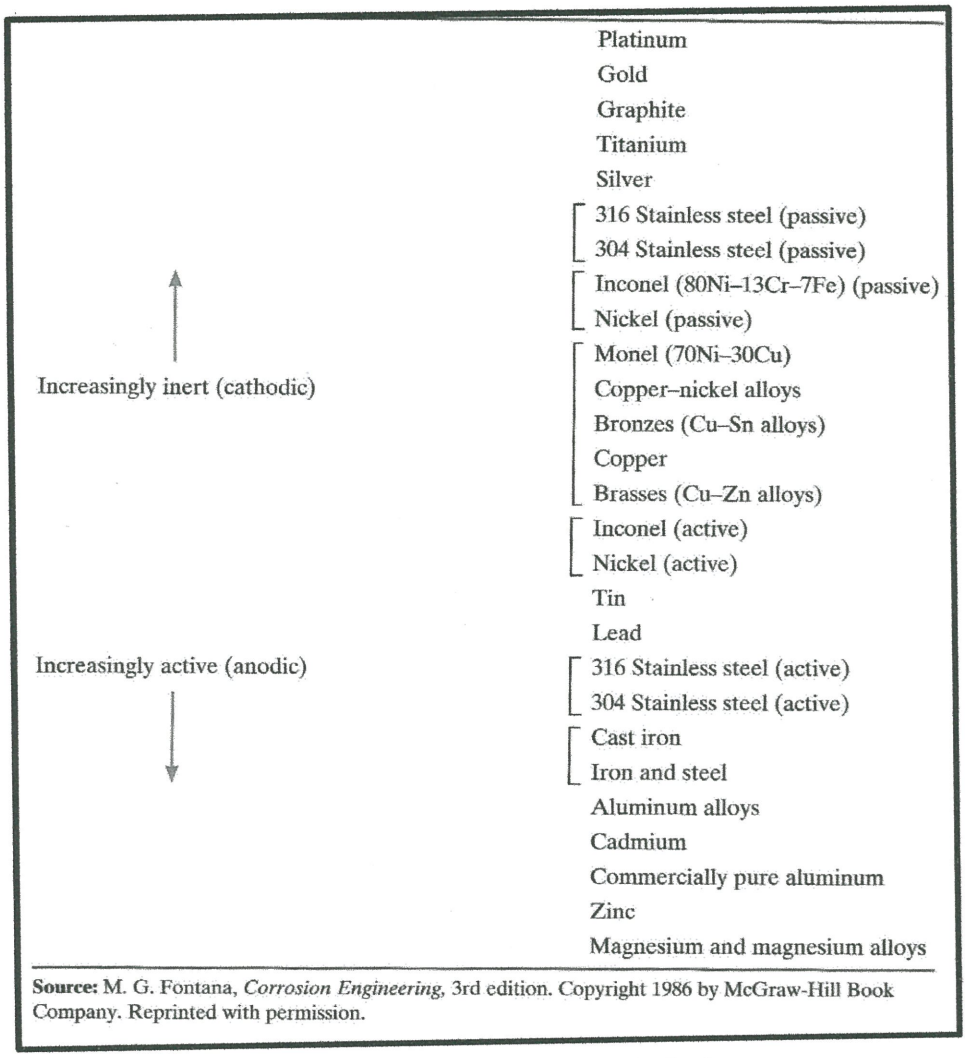

Source: M. G. Fontana, *Corrosion Engineering*, 3rd edition. Copyright 1986 by McGraw-Hill Book Company. Reprinted with permission.

FIGURE Q4 (c): Galvanic Series

Q5 (a) (i) List **TWO (2)** advantages and **TWO (2)** disadvantages for each destructive testing and non-destructive (NDT) testing.

(4 marks)

(ii) Name **TWO (2)** examples of destructive testing and **TWO (2)** examples of non-destructive testing (NDT)

(2 marks)

(iii) Compare liquid penetrant inspection, magnetic particle inspection, and radiography in terms of the principle of methods, its advantages and limitations. For each comparison on advantages and limitations, minimum **TWO (2)** examples is required. Your format answer should be in a table form.

(9 marks)

(b) (i) Recommend a suitable method together with an equipment that can be used to inspect the inside of an air ducts or pipelines for surface flaws.

(2 marks)

(iii) List **THREE (3)** reasons of chosen method and equipment in Q5 (b) (i)

(3 marks)

- END OF QUESTION -