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# UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2014/2015 Academic Session

June 2015

## EBB 225/3 – Physical Metallurgy *[Metalurgi Fizikal]*

Duration : 3 hours  
*[Masa : 3 jam]*

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Please ensure that this examination paper contains SEVEN printed pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

This paper consists of SEVEN questions. ONE question in PART A, THREE questions in PART B and THREE questions in PART C.

*[Kertas soalan ini mengandungi TUJUH soalan. SATU soalan di BAHAGIAN A, TIGA soalan di BAHAGIAN B dan TIGA soalan di BAHAGIAN C.]*

**Instruction:** Answer FIVE questions. Answer ALL questions from PART A, TWO questions from PART B and TWO questions from PART C. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.

**[Arahan:** Jawab LIMA soalan. Jawab SEMUA soalan dari BAHAGIAN A, DUA soalan dari BAHAGIAN B dan DUA soalan dari BAHAGIAN C. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

*[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]*

You may answer a question either in Bahasa Malaysia or in English.

*[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

In the event of any discrepancies in the examination questions, the English version shall be used.

*[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]*

**PART A / BAHAGIAN A**

1. [a] Differentiate between embryo and nucleus in metal solidification process?

*Bezakan antara embrio dan nucleus dalam proses pemejalan logam?*

(15 marks/markah)

- [b] During solidification process, growth of solid nuclei depends on how heat is removed from the molten material. Explain how heat was removed and the growth mechanism of planar and dendritic occurred.

*Semasa proses pemejalan, pertumbuhan pepejal nuclei bergantung kepada bagaimana haba dipindahkan dari leburan bahan. Jelaskan bagaimana haba disingkirkan dan mekanisme pertumbuhan planar dan dendrit berlaku.*

(35 marks/markah)

- [c] With the aid of the Fe-Fe<sub>3</sub>C equilibrium phase diagram, explain the eutectoid and peritectic reactions in this system by referring to temperature, composition, and the phases involved.

*Dengan bantuan gambarajah fasa keseimbangan Fe-Fe<sub>3</sub>C, terangkan tindakbalas eutektoid dan peritektik dalam sistem ini dengan merujuk kepada suhu, komposisi dan fasa yang terlibat.*

(50 marks/markah)

**PART B / BAHAGIAN B**

2. [a] What are non ferrous metals? Discuss the properties of copper, magnesium, titanium and their alloys.

*Apakah logam bukan ferus? Bincangkan sifat-sifat tembaga, magnesium, titanium dan aloinya.*

(50 marks/markah)

- [b] A single crystal of a FCC metal is oriented so that the [001] direction is parallel to an applied stress of 35 MPa. Calculate the resolved shear stress acting on the (111) slip plane in the  $[1\bar{1}0]$ , [011],  $[\bar{1}11]$  and [101] slip directions. Which slip system (s) will become active first?

*Satu kristal logam FCC diorientasikan supaya arah [001] selari dengan tegasan yang dikenakan sebanyak 35 MPa. Hitung tegasan ricih yang bertindak ke satah gelinciran (111) pada arah gelincir  $[1\bar{1}0]$ , [011],  $[\bar{1}11]$  and [101]. Sistem gelinciran yang mana akan menjadi aktif dulu?*

(50 marks/markah)

3. [a] Define what is solid solubility? Explain three different types of solubility and give example of each case.

*Takrifkan apakah kebolehlarutan pepejal? Jelaskan tiga jenis kebolehlarutan dan beri contoh bagi setiap kes.*

(50 marks/markah)

- [b] Primary solid solution and secondary solid solution are two strengthening method to improve mechanical properties of the metal. For each case explain the detail of the mechanism.

*Larutan pepejal primer dan larutan pepejal sekunder ialah dua kaedah penguatan untuk meningkatkan sifat mekanik logam. Jelaskan butiran mekanisma dengan terperinci bagi setiap kes tersebut.*

(50 marks/markah)

4. [a] Explain why a metal like lead does not work-harden when deformed at room temperature, whereas a metal such as iron does.

*Jelaskan mengapa logam seperti plumbum tidak boleh kerja keras apabila diubah bentuk pada suhu bilik, manakala logam seperti besi boleh.*

(30 marks/markah)

- [b] The Al-Cu alloy had undergone aging after solution treatment process. Describe the precipitation hardening process and sketch precipitate obtained:

- (i) Under aging temperature
- (ii) At aging temperature
- (iii) Overaging temperature

*Aloi Al-Cu mengalami penuaan selepas proses rawatan larutan. Huraikan proses pengerasan mendakan dan lakarkan mendakan yang diperolehi:*

- (i) *di bawah suhu penuaan*
- (ii) *pada suhu penuaan*
- (iii) *di atas suhu penuaan*

(70 marks/markah)

**PART C / BAHAGIAN C**

5. [a] Explain the effect of decarburization on a component and how is it being reduced in steel?

*Jelaskan kesan penyahkarbonan pada komponen dan bagaimana ia dikurangkan di dalam keluli?*

(30 marks/markah)

- [b] List and describe the three steps in quenching process.

*Senarai dan terangkan tiga langkah-langkah yang terlibat dalam pelindapkejutan proses.*

(30 marks/markah)

- [c] What are the purposes of tempering? List problems that occur during tempering of steel.

*Apakah tujuan pembajaan? Senaraikan masalah yang berlaku semasa pembajaan keluli.*

(40 marks/markah)

6. Describe any four from the following statement:
- [a] Metallographic examination for composite materials.
  - [b] Rough grinding and fine grinding.
  - [c] Comparison between the procedure for sample mounting in a hot mounting and cold mounting press.
  - [d] Give a reason why cold mounting being used.
  - [e] Indicate why quantitative metallography being used in microstructured analysis.

*Huraikan mana-mana empat dari kenyataan berikut:*

- [a] *Pemeriksaan metalografi bagi bahan komposit.*
- [b] *Pencapaian kasar dan pencapaian halus.*
- [c] *Bincangkan perbezaan di antara prosedur untuk pencagakan sampel dalam pencagakan tekanan panas dan pencagakan sejuk.*
- [d] *Berikan sebab kenapa pencagahan sejuk digunakan.*
- [e] *Nyatakan kenapa metalografi kuantitatif digunakan dalam analisis mikrostruktural.*

(100 marks/markah)

7. [a] Describe the classification of ferrous alloys by taking consideration on its carbon content and alloying elements.

*Huraikan pengelasan bagi aloi-aloi ferus dengan mengambilkira kandungan karbon dan elemen-elemen pengaloiian.*

(30 marks/markah)

[b] Explain the characteristic of following phases:

- (i)  $\alpha$ - ferrite
- (ii) Cementite.
- (iii) Pearlite.
- (iv) Martensite.
- (v) Austenite

*Terangkan ciri-ciri bagi fasa-fasa berikut:*

- (i)  $\alpha$ - ferit.
- (ii) Cementit.
- (iii) Pearlit.
- (iv) Martensit
- (v) Austenit

(30 marks/markah)

[c] Eutectic steel can form coarse and fine pearlite grains. With a proper sketches of TTT diagram and microstructure as well as heat treatment conditions, explain how you can produce coarse and fine pearlite grains.

*Keluli eutektik boleh membentuk pearlit bersaiz butir kasar dan halus. Dengan lakaran gambarajah TTT dan mikrostruktur yang bersesuaian, dan juga keadaan rawatan haba, terangkan bagaimana anda boleh menghasilkan pearlit bersaiz butir kasar dan halus.*

(40 marks/markah)