UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua

Sidang Akademik 1998/99

Februari 1999

EBB 512/3 – GAMBARAJAH & SESEIMBANGAN FASA

Masa : [3 jam]

Arahan Kepada Calon :

Sila pastikan bahawa kertas soalan ini mengandungi **EMPAT BELAS (14)** mukasurat bercetak sebelum anda memulakan peperiksaan ini.

Kertas ini mengandungi **ENAM (6)** soalan.

Jawab hanya **LIMA (5)** soalan.

Mulakan jawapan pada muka surat baru.

Semua jawapan mesti dalam Bahasa Malaysia atau maksimum **DUA (2)** soalan boleh dijawab dalam Bahasa Inggeris.

...2/-

1. A) Untuk Rajah 1.

(i) Gunakan hukum fasa Gibbs untuk pelbagai titik-titik dalam gambarajah fasa Al_2O_3 - SiO_2.

(ii) Terangkan secara kualitatif perkembangan mikrostruktur semasa penyejukan perlahan

a) a 50 mol % Al_2O_3 - 50 mol % SiO_2 Ceramic and
b) a 70 mol % Al_2O_3 - 30 mol % SiO_2 Ceramic.

(60 markah)

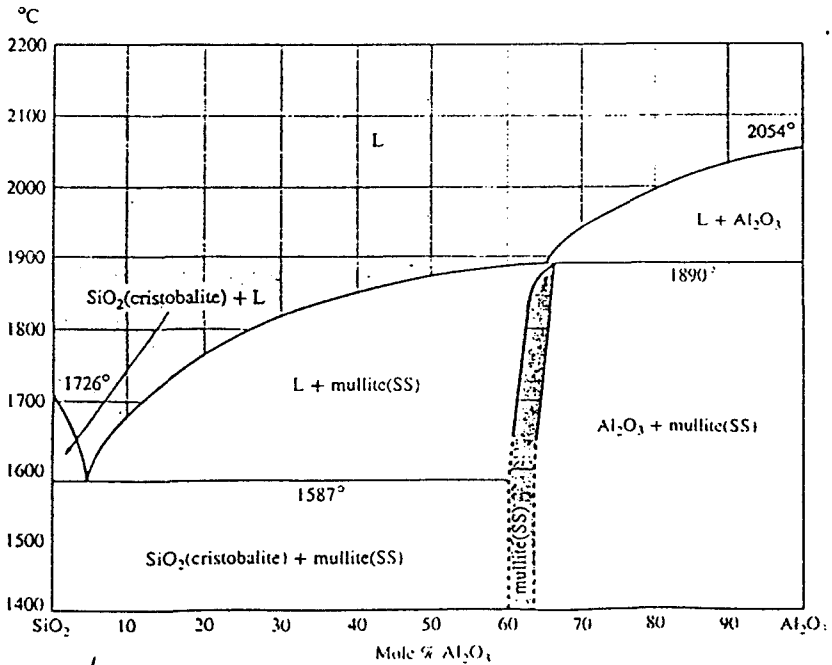

FIGURE 1 *Al_2O_3–SiO_2 phase diagram. Mullite is an intermediate compound with ideal stoichiometry $3Al_2O_3 \cdot 2SiO_2$. (After F. J. Klug, S. Prochazka, and R. H. Doremus, J. Am. Ceram. Soc. 70, 750 (1987).)*

Rajah 1

...3/-

B) Kira jumlah setiap fasa hadir dalam 10 kg bagi 50% berat Pb - 50% Sn aloi pateri pada

a) 300°C, b) 200°C, c) 100°C, and 0°C

Rujuk Rajah 2.

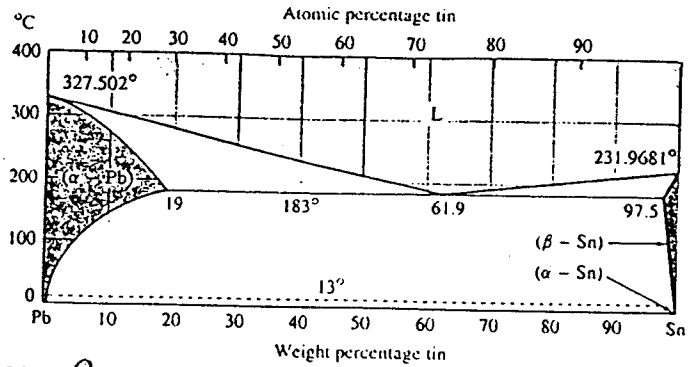

FIGURE 2. *Pb–Sn phase diagram. (After* Metals Handbook, *8th ed., Vol. 8:* Metallography, Structures, and Phase Diagrams, *American Society for Metals, Metals Park, Ohio, 1973, and* Binary Alloy Phase Diagrams, *Vol. 2, T. B. Massalski, ed., American Society for Metals, Metals Park, Ohio, 1986.)*

Rajah 2

(40 markah)

1. A) For Figure 1 :

(i) Apply the Gibbs phase rule to various points in the Al_2O_3 - SiO_2 phase diagram.

(ii) Describe qualitatively the microstructural development during the slow cooling of

a) a 50 mol % Al_2O_3 - 50 mol % SiO_2 Ceramic and

b) a 70 mol % Al_2O_3 - 30 mol % SiO_2 Ceramic.

(60 marks)

...4/-

B) Calculate the amount of each phase present in 10 kg of a 50 wt % pb - 50wt % Sn solder alloy at

a) 300°C, b) 200°C, c) 100°C, and 0°C

See Figure 2.

(40 marks)

2. A) Kira jumlah setiap fasa hadir dalam 1 kg refraktori, alumina yang komposisinya 70% mol Al_2O_3 - 30 % mol SiO_2 pada

a) 2000°C, b) 1900°C and c) 1800°C.

Jisim atom Al = 26.98, O = 16 and Si = 28.09.

(40 markah)

B) Plotkan peratus berat fasa yang hadir melawan fungsi suhu daripada 800 ke 300°C untuk aloi 95 Al - 5 Cu. Guna Rajah 3.

(60 markah)

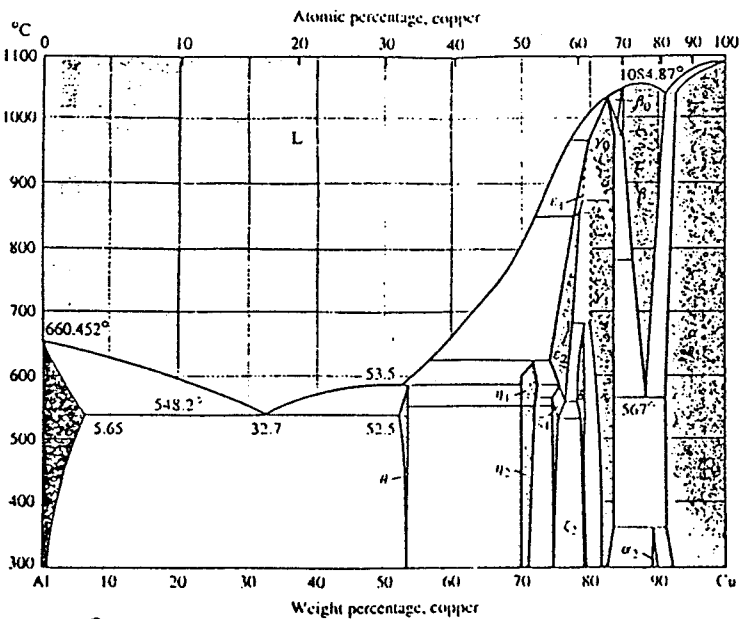

FIGURE 3 *Al–Cu phase diagram. (After* Binary Alloy Phase Diagrams, *Vol. 1, T. B. Massalski, ed., American Society for Metals, Metals Park, Ohio, 1986.)*

Rajah 3

...5/-

2. A) Use Figure 1. Calculate the amount of each phase present in a 1 kg alumina refactory with composition 70 mol% Al_2O_3 - 30 mol % SiO_2 at

a) 2000°C, b) 1900°C and c) 1800°C.

Atomic mass Al = 26.98, O = 16 and Si = 28.09.

(40 marks)

B) Plot the weight percent of phases present as a function of temperature from 800 to 300°C for 95 Al - 5 Cu alloy. Use Figure 3.

(60 marks)

3. A) Titik lebur A, B dan C ialah 1000°C, 900°C dan750°C. Juzuk sistem binari bagi sistem ternari ABC menunjukkan keterlarutan sempurna dalam keadaan cecair dan pepejal. Data berikut merujuk kepada aloi-aloi tiga binari :

Komposis (% berat)			°C	
A	B	C	Cecair	Pepejal
50	50	-	975	950
50	-	50	920	850
-	50	50	840	800

...6/-

Untuk sistem ternari, lukis dan labelkan juzuk-juzuk di dalam gambarajah dengan data-data di atas untuk mewakili bentuk yang mungkin bagi

a) unjuran cecair menunjukkan isothermal pada 950°C dan 850°C,
b) unjuran pepejal menunjukkan isothermal pada 950°C dan 850°C,
c) bahagian isothermal pada 950°C,
d) penghubung bahagian menegak A ke titik tengah BC.

Anggap permukaan cecair dan pepejal tidak mempamerkan maksima atau minima.

(50 markah)

B) Satu sistem ternari ABC menunjukkan keterlarutan cecair sempurna dan mengandungi hanya 2 fasa pepjal. Namakan 2 larutan pepejal ditandakan sebagai α dan β. Data berikut merujuk pada komposisi cecair α dan β yang wujud bersama dalam keseimbangan pada suhu yang ditunjukkan :

Suhu (°C)	Komposisi		
	L	α	β
550	69 %A, 19%B, 12%C	57%A, 41%B, 2%C	20%A, 78%B, 2% C
520	66%A, 18%B, 16%C	56%A, 40%B, 4%C	19%A, 78%B, 3%C
500	63%A, 17%B, 20%C	55%A, 39%B, 6%C	18%A, 78%B, 4%C

i) Kira % keseimbangan bagi cecair,α dan β yang hadir dalam satu aloi yang mengandungi 44%A, 50%B dan 6%C pada 520°C.

...7/-

ii) Kira nisbah kederas fasa cecair yang hadir pada 550, 520 dan 500°C.

(50 markah)

3. A) The melting points A, B and C are 1000°C, 900°C and 750°C, respectively. The constituent binary systems of the ternary system ABC each show complete solubility in both the liquid and the solid states. The following data refer to three binary alloys :

Composition (wt %)			°C	
A	B	C	Liquids	Solidus
50	50	-	975	950
50	-	50	920	850
-	50	50	840	800

For the ternary system draw and label diagrams consistent with the above data to represent the possible forms of

a) a liquids projection, showing isotherms for 950°C and 850°C,

b) a solidus projection showing isotherms for 950°C and 850°C,

c) an isothermal section at 950°C,

d) a vertical section joining A to the mid-point of BC.

Assume that the liquids ans solidus surfaces do not exhibit a maximum or a minimum.

(50 marks)

B) A ternary system ABC shows complete liquid solubility and contains only two solid phases, namely two solid solutions designated α and β respectively.
The following data refer to the compositions of liquid, α and β coexisting in equilibrium at the temperature shown :

Temperature (°C)	Compositions		
	L	α	β
550	69 %A, 19%B, 12%C	57%A, 41%B, 2%C	20%A, 78%B, 2% C
520	66%A, 18%B, 16%C	56%A, 40%B. 4%C	19%A, 78%B, 3%C
500	63%A, 17%B, 20%C	55%A, 39%B, 6%C	18%A, 78%B, 4%C

i) Calculate the equilibrium percentage of liquid, α and β respectively, present in an alloy containing 44%A, 50%B and 6%C at 520°C.

ii) Calculate the ratio of the proportions of liquid phase present at 550, 520 and 500°C.

(50 marks)

4. A) Jelaskan penjelmaan bagi keluli karbon biasa (1.2%C)daripada 950°C ke suhu di bawah eutektoid (723°C)?

(50 markah)

B) Satu keluli karbon biasa hipoeutektoid disejuk perlahan dari kawasan austerit ke suhu bilik, dan mengandungi 9.1 % berat hypoeutektoid ferit. Anggap tiada perubahan struktur semasa penyejukan daripada suhu di bawah eutektoid ke suhu bilik. Apakah kandungan karbon di dalam keluli. Guna Rajah 4.

(50 markah)

...9/-

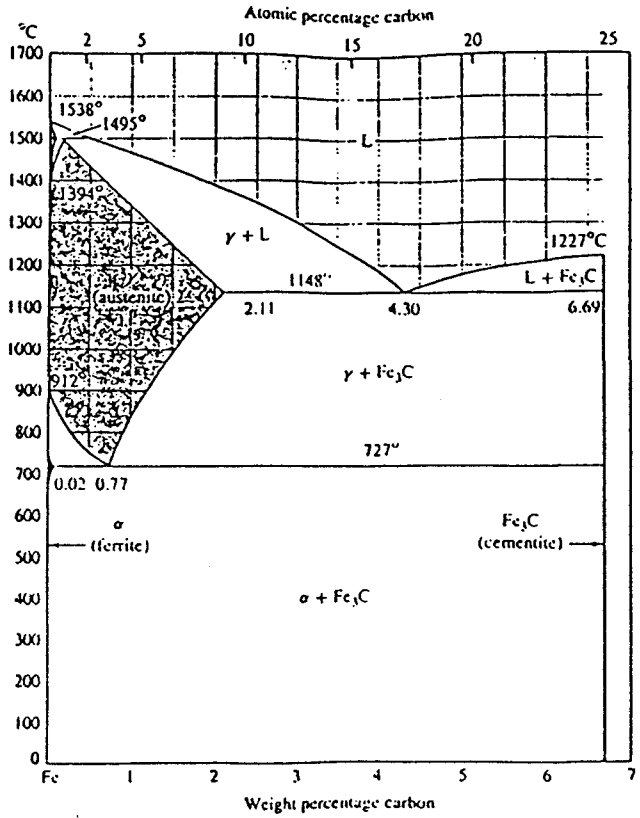

FIGURE 4.1 *Fe-Fe_3C phase diagram. Note that the composition axis is given in weight percent carbon even though Fe_3C, and not carbon, is a component. (After* Metals Handbook, *8th ed., Vol. 8:* Metallography, Structures, and Phase Diagrams, *American Society for Metals, Metals Park, Ohio, 1973, and* Binary Alloy Phase Diagrams, *Vol. 1, T. B. Massalski, ed., American Society for Metals, Metals Park, Ohio, 1986.)*

Rajah 4

4. A) Explain the transformation of 1.2%C plain-carbon steel from 950°C to just below Eulectiod temperature (723°C)?

(50 marks)

...10/-

B) A hypoeutectiod plain-carbon steel which was slow cooled from the austerictic region to room temperature contains 9.1 wt% hypoeutoid ferrite. Assume no change in structure on cooling from just below the eutectiod temperature to room temperature, what is the carbon conlent on the steel. Use Figure 4. (50 marks)

5. A) Jelaskan penjelmaan penyejukan berterusan (CCT) untuk keluli karbon biasa eutektoid.

(40 markah)

B) 1) Anggarkan kadar lindapkejut yang diperlukan untuk mengelak pembentukan pearlit dalam

i) keluli 0.5% berat C

ii) keluli 0.77% berat C

iii) keluli 1.13% berat C

2) Anggarkan kadar lindapkejut yang diperlukan untuk mengelak pembentukan pearlit dalam

i) keluli 0.5% berat C

ii) keluli 0.77 % berat C

iii) keluli 1.% berat C

Guna Rajah 5, 6 dan 7.

(60 markah)

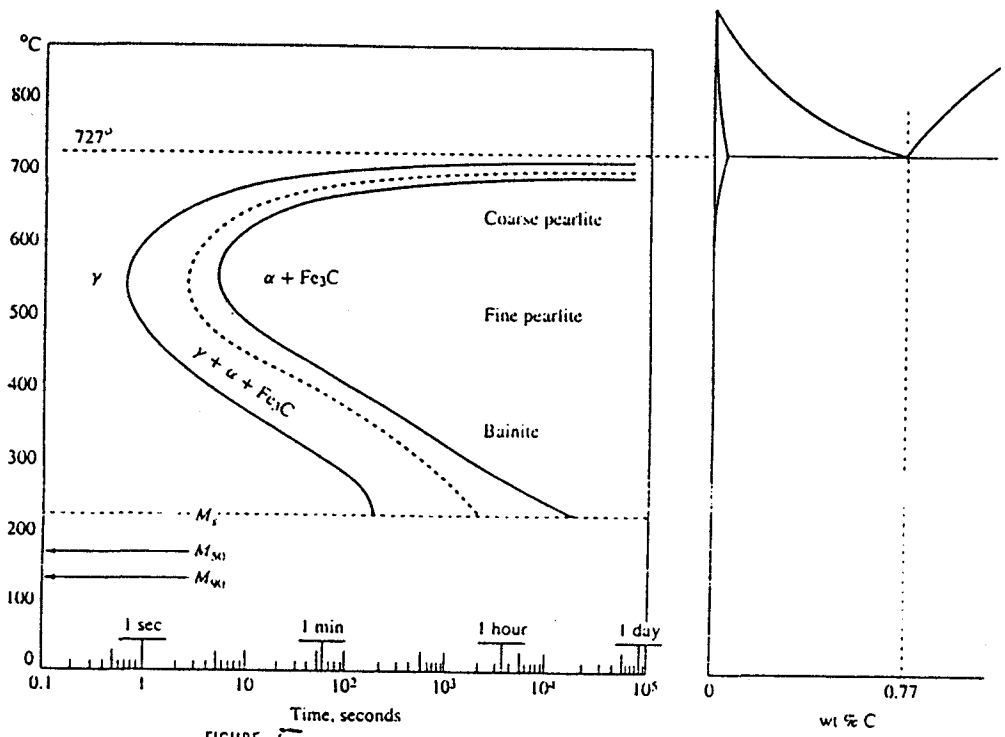

FIGURE 5 *A more complete TTT diagram for eutectoid steel*

Rajah 5

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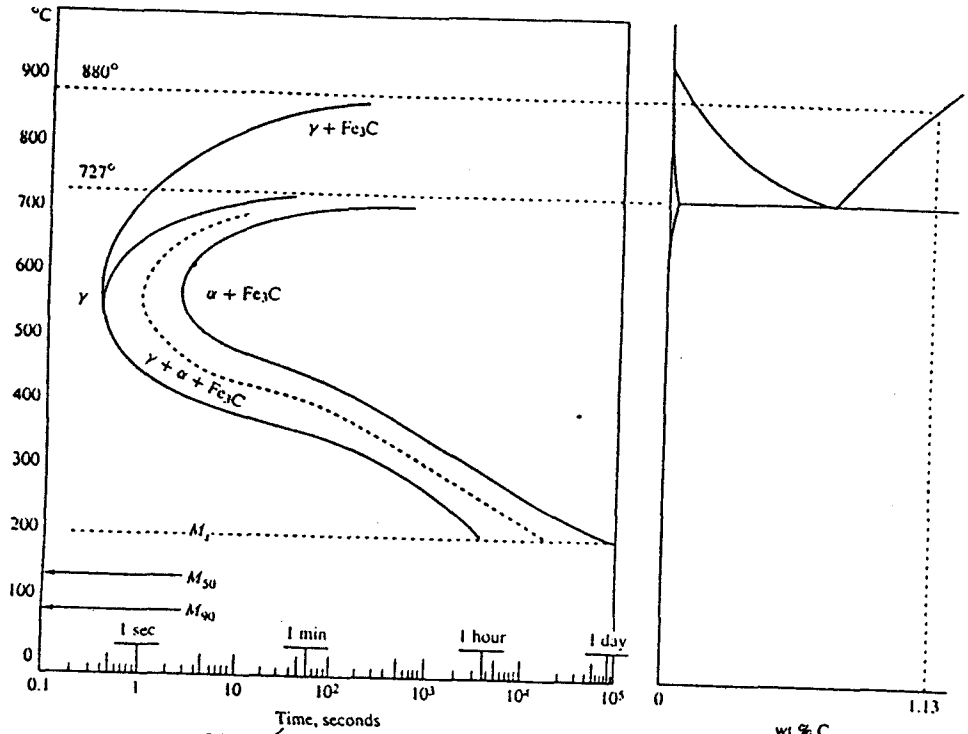

FIGURE 6 *TTT diagram for a hypereutectoid composition (1.13 wt % C) cr*

Rajah 6

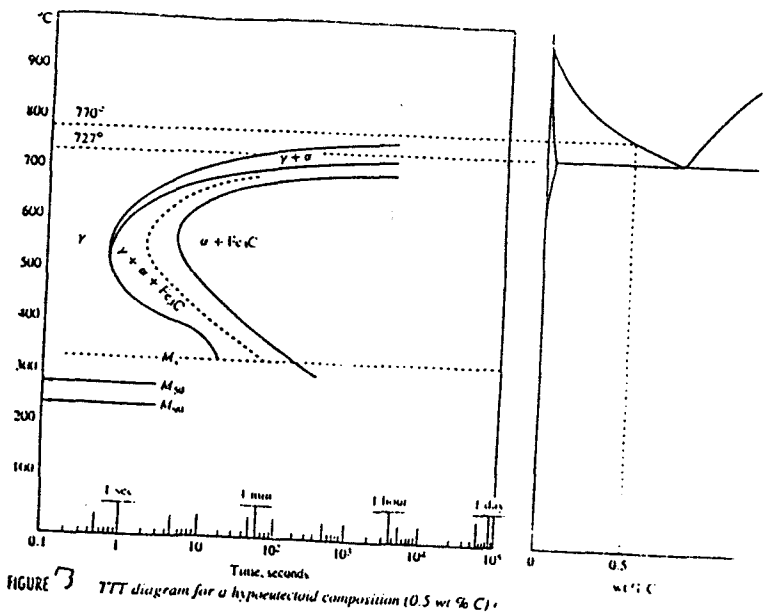

FIGURE 7 *TTT diagram for a hypereutectoid composition (0.5 wt % C)*

Rajah 7

...13/-

5. A) Explain the continuous-cooling transformation (CCT) diagram for Eulectiod plain carbon steel.

(40 marks)

B) 1) Estimate the quench rate needed to avoid pearlite formation in

i) 0.5 wt% C steel

ii) 0.77 wt% C steel

iii) 1.13 wt% C steel

2) Calculate the time required for austempering at 5°C above Ms temperature for

i) 0.5% wt C steel

ii) 0.77 wt% C steel

iii) 1.13 wt% C steel

Use Figure 5, 6 and 7. (60 marks)

6. A) Jelaskan proses berikut

Penyepuhlindapan, pernormalan dan pembajaan keluli karbon biasa.

(40 markah)

B) Apakah kebolehkerasan dan bagaimana ianya diukur.

(60 markah)

6. A) Explain the following process

Annealing, normalizing and tempering of plain carbon steel. (40 marks)

B) What is Harderability and how can be measured?

(60 marks)

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