

---

# UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2008/2009

November 2008

## **EBB 427/3 - Technology & Application of Engineering Polymer** **[Teknologi & Penggunaan Polimer Kejuruteraan]**

Duration : 3 hours  
[Masa : 3 jam]

---

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

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

This paper contains 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.]*

**Instructions:** 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 in the answer sheet will be graded.

**[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.]

Answer to any question must start on a new page.

*[Mulakan jawapan anda untuk setiap 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.]*

**PART A**

**BAHAGIAN A**

1. [a] Select a suitable processing method for producing mineral water bottle. With a suitable diagram, discuss the operation of this processing and name 3 types of defects which normally occur in this processing.

*Pilih satu kaedah pemprosesan bagi menghasilkan botol air mineral. Dengan bantuan gambarajah, bincangkan operasi pemprosesan ini dan berikan 3 jenis kecacatan yang biasanya hadir di dalam pemprosesan ini.*

(50 marks/markah)

- [b] Write a short note on the following:

- (i) Esterified epoxy
- (ii) Halogenated epoxy
- (iii) Polyglycol epoxy

*Tuliskan nota ringkas mengenai:*

- (i) *Epoksi terester*
- (ii) *Epoksi terhalogen*
- (iii) *Epoksi poliglikol*

(50 marks/markah)

**PART B****BAHAGIAN B**

2. [a] With the aid of a diagram, relate the of property changes with concentration of polyacrolonitrile, polybutadiene and polystyrene in acrolonitrile butadine styrene (ABS) polymer.

*Dengan bantuan gambarajah, hubungkan perkaitan di antara perubahan sifat polimer akrolonitril butadina styrena (ABS) dengan konsentrasi poliakrolonitril, polibutadiena dan polistirena.*

(40 marks/markah)

- [b] Recommend a suitable plastic processing method to produce egg containers. Explain the processing process and critical operational parameters which need to be controlled during the forming process.

*Cadangkan satu kaedah pemprosesan yang sesuai bagi menghasilkan bekas telur. Terangkan kaedah pemprosesan tersebut dan parameter operasi kritikal yang perlu dikawal dalam proses penghasilan tersebut.*

(60 marks/markah)

3. [a] Select 3 types of commodity thermoplastics, and compare how the structure of these materials influence their properties.

*Pilih 3 jenis termoplastik komoditi, dan bandingkan bagaimana struktur bahan-bahan ini mempengaruhi sifat-sifat.*

(40 marks/markah)

- [b] What is the effect of crosslinking on elastomer and what is the structural explanation for the effect? What would happen to the amount of stretch, hardness, strength, and creep in elastomer if the crosslinking density is increased?

*Apakah kesan sambung-silang terhadap elastomer dan berikan penerangan struktur terhadap kesan ini? Apakah yang akan berlaku terhadap jumlah regangan, kekerasan, kekuatan dan rayapan elastomer sekiranya ketumpatan sambung-silang ini meningkat?*

(40 marks/markah)

- [c] Explain what would happen to the properties of a rubber material if the carbon black is poorly mixed into the batch.

*Terangkan apakah yang akan berlaku kepada sifat-sifat getah sekiranya hitam karbon tidak tercampur secara sekata di dalam gaulan getah.*

(20 marks/markah)

4. [a] Select a suitable material to be used as non-stick coatings for cookware. Relate the structure of this material with its properties.

*Pilih satu bahan yang sesuai untuk digunakan sebagai lapisan tidak melekat bagi peralatan memasak. Kaitkan struktur bahan ini dengan sifat-sifatnya.*

(60 marks/markah)

- [b] Summarize 4 obstacles of recycling in Malaysia. Explain 3 advantages of incineration to dispose of solid waste.

*Ringkaskan 4 halangan bagi proses kitarsemula di Malaysia. Terangkan 3 kelebihan menggunakan incineration bagi melupuskan sisa buangan pepejal.*

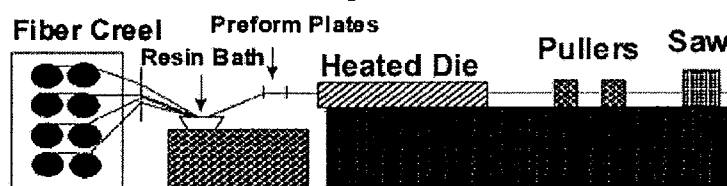
(40 marks/markah)

**PART C****BAHAGIAN C**

5. [a] Figure 1 shows a schematic diagram of a pultrusion process. Describe the process in detail by giving emphasis on the requirement of the fibre and matrix, including the advantages and limitations.

*Rajah 1 menunjukkan gambarajah skematik bagi proses pultrusi. Terangkan dengan terperinci proses pultrusi dengan memberikan penekanan terhadap keperluan gentian dan matriks serta kelebihan dan kekurangan proses tersebut.*

(40 marks/markah)



**Figure 1 - Schematic diagram of pultrusion process**

*Rajah 1 - Rajah skematik bagi proses pultrusi*

- [b] Based on information provided in Table 1, comment on how the ratio of epichlorhydrin to bisphenol A affect the properties of epoxy resin.

*Berdasarkan maklumat yang disenaraikan di dalam Jadual 1, komen bagaimana nisbah epiklorohidrin kepada bisfenol A mempengaruhi sifat-sifat resin epoksi.*

**Table 1**  
**Jadual 1**

| Molar ratio<br>epichlorhydrin:bisphenol A | Molecular<br>weight (g/mol) | Softening<br>temperature (°C) |
|---|-----------------------------|-------------------------------|
| 10.00 : 1                                 | 370                         | 9                             |
| 2.00 : 1                                  | 451                         | 43                            |
| 1.40 : 1                                  | 791                         | 84                            |
| 1.33 : 1                                  | 802                         | 90                            |
| 1.25 : 1                                  | 1133                        | 100                           |
| 1.20 : 1                                  | 1420                        | 112                           |

(40 marks/markah)

...6/-

- [c] Discuss about several advantages of using composites with respect to traditional materials (steel and concrete) for construction application.

*Bincangkan beberapa kelebihan penggunaan komposit berbanding bahan tradisional (keluli dan konkrit) untuk kegunaan pembinaan.*

(20 marks/markah)

6. [a] Describe how resol and novolak resins are produced from reaction of phenol and formaldehyde.

*Terangkan bagaimana resin resol dan novolak dihasilkan melalui tindakbalas antara phenol dan formaldehyde.*

(20 marks/markah)

- [b] Outline typical properties of cross-linked phenol-formadehyde resin.

*Senaraikan sifat-sifat tipikal resin phenol-formadehyde yang tersambung silang.*

(20 marks/markah)

- [c] Table 2 shows a typical formulation for producing unsaturated polyester resin. Describe the process of producing unsaturated polyester resin using the formulation given in Table 2.

*Jadual 2 menunjukkan formulasi tipikal untuk menghasilkan poliester tak tepu. Terangkan proses penghasilan poliester tak tepu berdasarkan formulasi yang diberikan dalam Jadual 2.*

**Table 2**  
**Jadual 2**

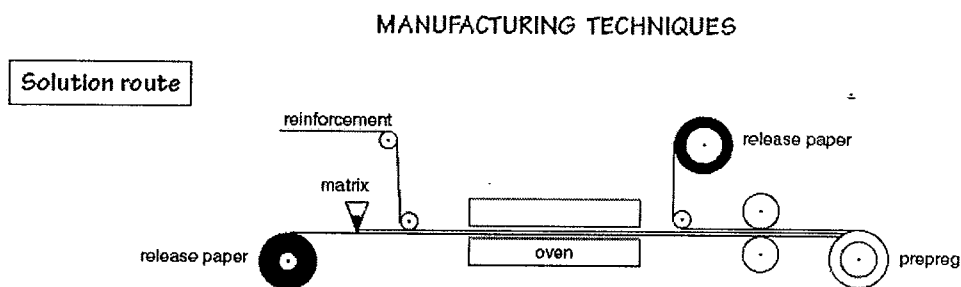
| Ingredients        | Parts by weight | Molar ratio |
|--------------------|-----------------|-------------|
| Propylene glycol   | 100             | 1.20        |
| Maleic anhydride   | 72              | 0.67        |
| Phthalic anhydride | 54              | 0.33        |

(60 marks/markah)

...7/-

7. [a] Figures 2 and 3 show two different processes of manufacturing pre-preg. Describe each of the process separately and state the advantages and limitation of each process.

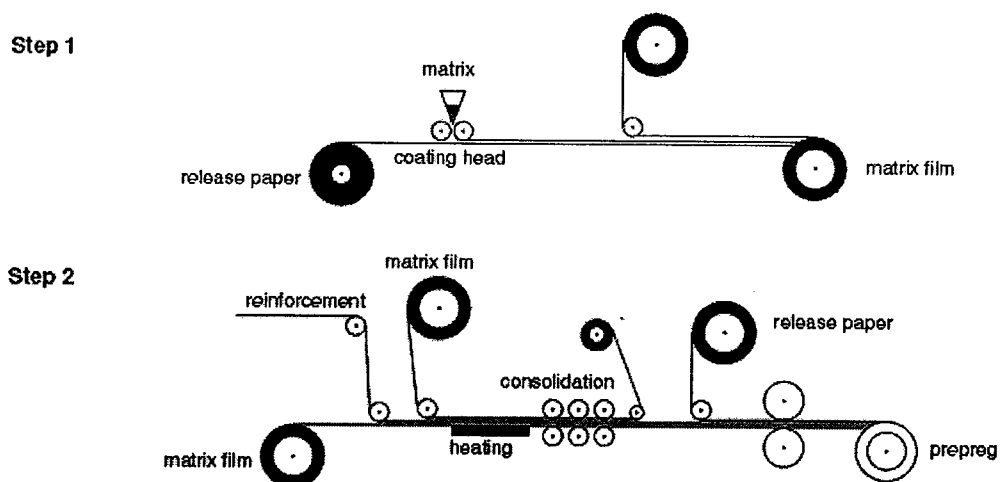
Rajah 2 dan 3 menunjukkan lakaran skematik dua proses berbeza untuk menghasilkan pra-preg. Terangkan setiap proses secara berasingan dan juga berikan kelebihan dan kekurangan untuk setiap proses tersebut.



**Figure 2 - Schematic diagram of producing pre-preg via solution route**

**Rajah 2 - Rajah skematik penghasilan pra-preg melalui kaedah larutan**

Film route : 2 steps process



**Figure 3 - Schematic diagram of producing pre-preg via two-step process**

**Rajah 3 - Rajah skematik penghasilan pra-preg melalui proses 2-langkah**

(60 marks/markah)

- [b] From Table 3, it is clear that aromatic amines provide better mechanical properties as compared to aliphatic amines curing system for bisphenol A epoxy resin. Discuss and outline reasons why these differences are exist.

*Merujuk kepada Jadual 3, aromatik amine menghasilkan resin epoksi yang mempunyai sifat-sifat mekanikal yang baik berbanding sistem awetan alifatik. Bincang dan berikan alasan-alasan kenapa ianya berlaku.*

**Table 3 - Typical values for various properties of unfilled castings prepared from liquid bisphenol A-based epoxy resin**

*Jadual 3 - Nilai-nilai tipikal sifat-sifat resin cecair epoksi berasaskan bisfenol A yang tidak terisi.*

| Properties                       | Curing agent         |                     |
|----------------------------------|----------------------|---------------------|
|                                  | Aliphatic amines (a) | Aromatic amines (b) |
| Tensile strength (MPa)           | 48-69                | 69-90               |
| Compressive strength (MPa)       | 83-100               | 120-130             |
| Flexural strength (MPa)          | 83-100               | 120                 |
| Impact strength, Izod (J/m)      | 21-27                | 27-32               |
| Heat deflection temperature (°C) | 70-110               | 145-150             |

(40 marks/markah)