UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2009/2010

April/May 2010

**ESA 382/3 – Rekabentuk Subsistem Kapal Angkasa**
*Spacecraft Subsystem Design*

Duration : 3 hours
*Masa : 3 jam*

**INSTRUCTIONS TO CANDIDATE:**
***ARAHAN KEPADA CALON:***

Please ensure that this paper contains **FIVE (5)** printed pages and **TEN (10)** questions before you begin examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **LIMA (5)** mukasurat bercetak dan **SEPULUH (10)** soalan sebelum anda memulakan peperiksaan.*

Part I: Answer **ONE (1)** questions only.
*Bahagian 1: Jawab **SATU(1)** soalan sahaja.*

Part II: Answer **ONE (1)** questions only.
*Bahagian II: Jawab **SATU(1)** soalan sahaja.*

Part III: Answer **FOUR (4)** questions only.
*Bahagian III: Jawab **EMPAT (4)** soalan sahaja.*

Student may answer the questions in English.
*Pelajar boleh menjawab soalan dalam Bahasa Inggeris.*

Each questions must begin from a new page.
*Setiap soalan mestilah dimulakan pada mukasurat yang baru.*

In the event of any discrepancies, the English version shall be used.
*Sekiranya terdapat sebarang percanggahan pada kertas soalan, versi Bahasa Inggeris hendaklah diguna pakai.*

**PART I/*BAHAGIAN I***

1. Give a brief description of the 8 major subsystems of a space vehicle and how they function.

   *Terangkan secara ringkas 8 subsistem utama kenderaan angkasa dan bagaimana ianya berfungsi.*

   **(20 marks/*markah*)**

2. List 11 types of spacecraft power sources and briefly explain how each of them works.

   *Senaraikan 11 jenis sumber kuasa kapal angkasa dan terangkan secara ringkas bagaimana ia berfungsi.*

   **(20 marks/*markah*)**

**PART II/*BAHAGIAN II***

3. Solve the problem:

   *Selesaikan masalah berikut:*

   Size an array to support a 1600-W load plus battery charge.
   *Tentukan sais array untuk menampung beban 1600W termasuk cas bateri.*

   Solar cell efficiency =11.5% at 28°C.
   *Kecekapan solar sel =11.5% pada suhu 28°C.*

   Operating temperature = 50°C.
   *Suhu operasi =50°C.*

   Degradation over lifetime = 30% (10 years).
   *Susutan jangka hayat = 30% (10 tahun).*

   Sun angle (maximum off normal) = 6 degrees.
   *Sudut matahari =6 darjah.*

   Solar intensity (1 A.U.) = 1350 W/$m^2$.
   *Keterikan matahari(1 A.U)=1350 W/ $m^2$.*

   Temperature coefficient = -0.5% per °C.
   *Pekali suhu=-0.5% per °C.*

   Packing factor = 85% (15% area loss due to cell spacing).
   *Faktor bungkusan=85% (15% kerugian kawasan disebabkan penempatan sel).*

Battery capacity = 90 Ah.
*Kapasiti bateri=90 Ah.*

For a 27.5-Volts battery array voltage = 27.5 × 1.2 = 33 Volts.
*Untuk 27.5 volt, voltan bateri =27.5 × 1.2 = 33 Volts.*

For 2 cm × 4 cm cells - $8\times10^{-4}$ $m^2$ per cell.
*Untuk 2 cm x 4 cm sel - $8\times10^{-4}$ $m^2$ setiap sel.*

**(20 marks/*markah*)**

4. Explain briefly the SV heat-balance equation:

*Terangkan secara ringkas persamaan imbangan-panas SV:*

$$Q_{sol} + Q_{ref.\ pl.} + Q_{em.\ pl} + Q_{aer} + Q_{int} - Q_{rad} = \Delta Q \text{ or}$$

$$a_1 q_{sol} S_1 + a_1 q_{ref.\ pl} S_2 + a_2 q_{em.\ pl} S_2 + q_{aer} S_{mid} + W_{int} + kW_{pil} - \varepsilon\sigma T^4 S_{rad} = cM_{SV} \frac{\Delta T}{\Delta \tau}.$$

**(20 marks/*markah*)**

## **PART III/*BAHAGIAN III***

5. Solve the problem:

*Selesaikan masalah berikut:*

A satellite is in a Very High Earth Orbit. Size a Ni-Cd battery to support a 1700-W payload. Bus voltage = 28 Volts direct current. Load duration = 1.25 hours maximum. Energy density = 14 Wh/lb for 100% discharge. Average cell voltage = 1.25 Volts. Maximum Depth of Discharge (DOD) is 70%.

*Terdapat satu satelit yang berada di Orbit bumi yang sangat tinggi. Tentukan sais Ni-Cd bateri untuk menampung 1700W beban. Diberi, Voltan bus=28V arus terus. Maksimum Jangka masa beban=1.25 jam. Ketumpatan tenaga=14Wh/lb untuk 100% nyahcas.Purata voltan sel=1.25 V. Kedalaman nyahcas maksimum(DOD) ialah 70%*

**(15 marks/*markah*)**

6. Explain in detail a passive thermal control system and describe the mechanism of louvers, which are used as a passive thermal control system.

*Terangkan secara terperinci sebuah sistem kawalan haba pasif dan beri gambaran tentang mekanisme louvers,yang digunakan sebagai sistem kawalan haba pasif.*

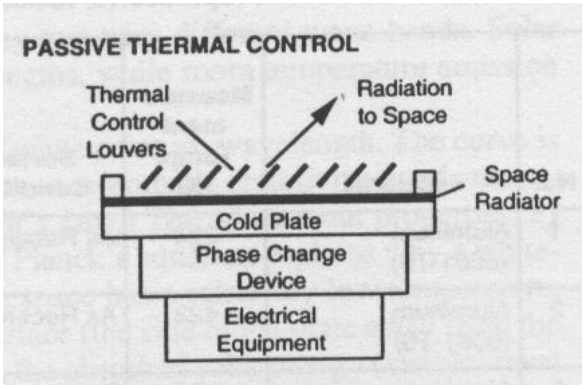


**Figure 1/*Rajah 1***

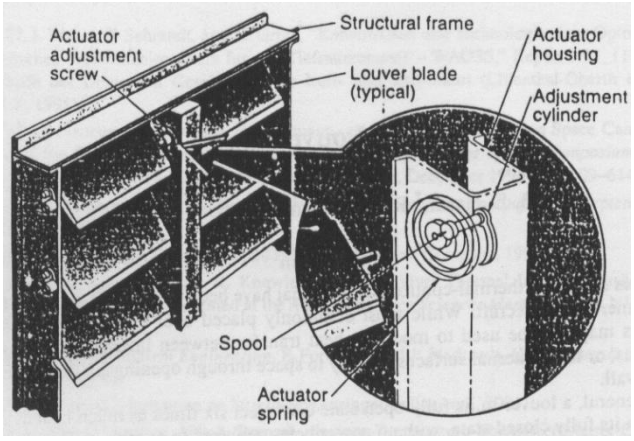


**Figure 2/*Rajah 2***

**(15 marks/*markah*)**

7. Explain in detail an active thermal control system and describe and explain heaters as an example of an active thermal control system.

*Terangkan secara terperinci sistem kawalan haba aktif dan beri gambaran dan terangkan pemanas sebagai contoh sistem kawalan haba aktif.*

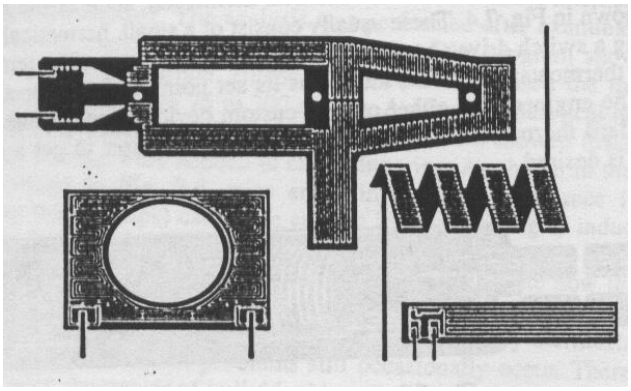

**Figure 3/*Rajah 3***

**(15 marks/*markah*)**

8. Describe the functions of Command and Data Handling System

*Terangkan fungsi-fungsi arahan dan sistem kawalan data*

**(15 marks/*markah*)**

9. Describe the functions of Structures and Mechanisms subsystem.

*Terangkan fungsi-fungsi struktur dan mekanisme subsistem*

**(15 marks/*markah*)**

10. Structures and Mechanisms subsystem: Describe Structural Design requirements in a satellite.

*Struktur dan mekanisme subsistem: Terangkan keperluan struktur rekabentuk untuk sesebuah satelit.*

**(15 marks/*markah*)**

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