UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2008/2009 Academic Session
*Peperiksaan Semester Kedua*
*Sidang Akademik 2008/2009*

April/Mei 2009

**ESA 382/3 – Spacecraft Sub-system Design**
***Rekabentuk Sub-sistem Kapal Angkasa***

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

**INSTRUCTION TO CANDIDATES**
***ARAHAN KEPADA CALON***

Please ensure that this paper contains **SEVEN (7)** printed pages and **TEN (10)** questions before you begin examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **TUJUH (7)** mukasurat bercetak dan **SEPULUH (10)** soalan sebelum anda memulakan peperiksaan.*

Part A: Answer **ONE (1)** questions only.
Part B: Answer **ONE (1)** questions only.
Part C: Answer **FOUR (4)** questions only.
*Bahagian A: Jawab **SATU (1)** soalan sahaja.*
*Bahagian B: Jawab **SATU (1)** soalan sahaja.*
*Bahagian C: 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.*

**PART A/*BAHAGIAN A***

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

   *Berikan deskripsi bagi 8 subsistem utama sesebuah kenderaan angkasa dan bagaimana ia berfungsi.*

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

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

   *Senaraikan 11 jenis punca kuasa kapal angkasa dan terangkan bagaimana ia berfungsi.*

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

**PART B/*BAHAGIAN B***

3. Size an array to support a 1700-W load plus battery charge.
*Saizkan panel untuk menyokong sebuah pengecas bateri 1700-W.*

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

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

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

Sun angle (maximum off normal) = 8 degrees.
*Sudut matahari (normal maksimum) = 8 darjah.*

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

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

Packing factor = 90% (10% area loss due to cell spacing).
*Faktor penyendatan = 90% (10% kehilangan luas disebabkan penyendatan sel).*

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

For a 27.5-Volts battery array voltage = 27.5 × 1.2 = 33 Volts.
*Bagi 27.5-Volts tatasusunan voltan bateri = 27.5 × 1.2 = 33 Volts.*

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

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

4. Explain briefly the SV heat-balance equation.

*Terangkan dengan ringkas persamaan imbangan haba SV.*

$Q_{sol} + Q_{ref.\ pl.} + Q_{em.\ pl} + Q_{aer} + Q_{int} - Q_{rad} = \Delta Q$ 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 C/*BAHAGIAN C***

5. A satellite is in a Very High Earth Orbit. Size a Ni-Cd battery to support a 1800-W payload.

*Sesebuah satelit berada pada orbit bumi tertinggi. Saizkan bateri Ni-Cd bagi menyokong beban bayar 1800W.*

Bus voltage = 28 Volts direct current. Load duration = 1.1 hours maximum. Energy density = 15 Wh/lb for 100% discharge. Average cell voltage = 1.2 Volts. Maximum Depth of Discharge (DOD) is 70%.

*Voltan bus = 28 Volts arus terus. Tempoh beban = 1.1 jam maksimum. Ketumpatan tenaga = 15 Wh/lb bagi 100% discaj. Purata voltan sel = 1.2 Volts. Maksimum discaj ukur dalam (DOD) adalah 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 dengan terperinci sistem kawalan haba pasif dan perihalkan mekanisma louvers, yang digunakan sebagai sistem kawalan haba pasif.*

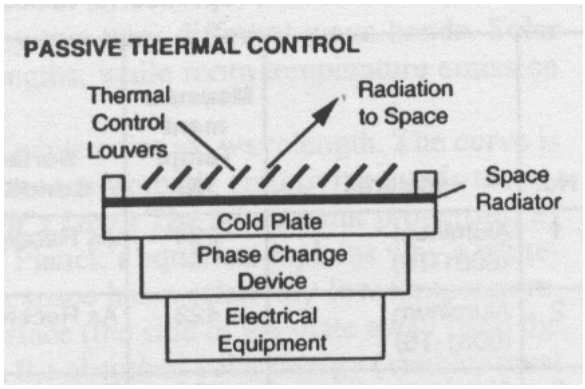


**Figure 1/*Gambarajah 1***

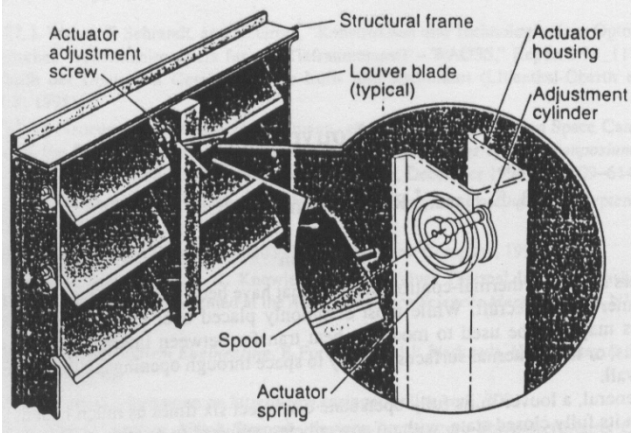


**Figure 2/*Gambarajah 2***

**(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 dengan terperinci sesebuah sistem kawalan haba aktif dan perihalkan pemanas sebagai contoh sebuah sistem kawalan haba aktif.*

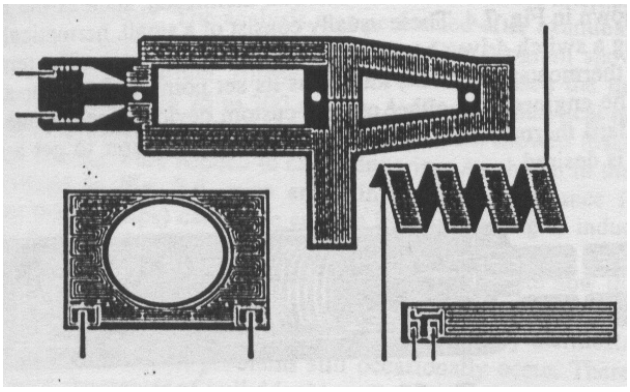

**Figure 3/*Gambarajah 3***

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

8. Describe the functions of Command and Data Handling System

*Perihalkan fungsi-fungsi Sistem Pengurusan Data dan Arahan.*

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

9. Describe the functions of Structures and Mechanisms subsystem.

*Perihalkan fungsi-fungsi subsistem Struktur dan Mekanisma*

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

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

*Subsistem Struktur dan Mekanisma : Perihalkan keperluan rekabentuk struktur dalam sesesbuah satelit.*

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

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