

UNIVERSITI SAINS MALAYSIA

First Semester Examination
2008/2009 Academic Session
*Peperiksaan Semester Pertama
Sidang Akademik 2008/2009*

November 2008
November 2008

ESA 321/3 – Aerospace Structure
Struktur Aeroangkasa

Duration : 3 hours
[Masa : 3 jam]

INSTRUCTION TO CANDIDATES
ARAHAN KEPADA CALON

Please ensure that this paper contains **FIVE (5)** printed pages and **SIX (6)** questions before you begin examination.

*Sila pastikan bahawa kertas soalan ini mengandungi **LIMA (5)** mukasurat bercetak dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan.*

Answer **ALL** questions.

*Jawab **SEMUA** soalan.*

Student may answer the questions either in English or Bahasa Malaysia.

Pelajar boleh menjawab soalan dalam Bahasa Inggeris atau Bahasa Malaysia.

Each questions must begin from a new page.

Setiap soalan mestilah dimulakan pada mukasurat yang baru.

1. Sketch and describe typical layouts of a wing structure. State the functions (types of load carried) of the structural members.

Lakarkan dan terangkan bentangan kebiasaan struktur sayap. Nyatakan fungsi (jenis beban yang ditanggung) setiap anggota struktur.

(10 Marks/Markah)

2. (a) State 4 types of equations needed to solve an elasticity problem. Write the corresponding equations for 2-dimensional problems.

Nyatakan 4 jenis persamaan-persamaan yang diperlukan untuk menyelesaikan masalah elastik. Tuliskan persamaan-persamaan tersebut untuk masalah 2-dimensi.

- (b) State and explain the assumptions used in deriving the equations of elasticity.

Nyatakan dan terangkan andaian-andaian yang digunakan untuk menerbitkan persamaan-persamaan elastik.

- (c) Explain the importance of compatibility equations in elasticity.

Terangkan kepentingan persamaan-persamaan keserasian di dalam teori elastik.

- (d) Consider the following strain fields:

Pertimbangkan medan terikan berikut:

$$\epsilon_x = a(x^2 + y^2) \quad \epsilon_y = a(x^2 + y^2) \quad \gamma_{xy} = -8axy$$

Are these strains compatible?

Adakah terikan-terikan ini serasi?

(15 Marks/Markah)

3. Determine e , the shear center of the beam cross-section shown in **Figure Q3**.

*Tentukan e , pusat ricih keratan-rentas rasuk yang ditunjukkan dalam **Rajah S3**.*

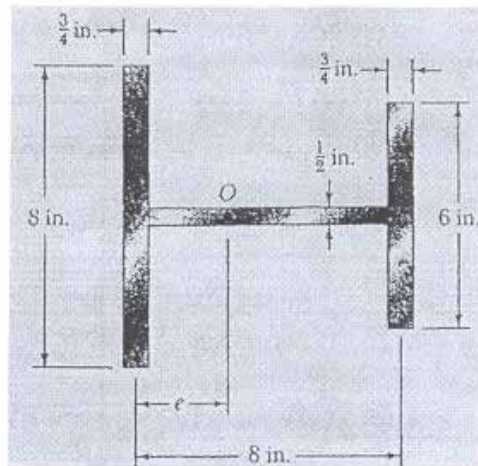


Figure Q3/Rajah S3

(15 Marks/Markah)

4. Using the wing load data shown in **Table Q4**, draw the load, shear and bending moment diagram.

*Dengan menggunakan data beban sayap dalam **Jadual S4**, lukiskan rajah beban, ricih dan momen lentur.*

x , m	1.20	2.30	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50
Distributed load, kN/m	13.7	14.1	14.2	14.6	14.9	15.2	15.1	14.8	13.7	10.6	0.0
Landing gear weight, kN		18.8									

Table Q4/Jadual S4

* Distributed load includes dynamic load, wing weight and fuel weight.

Taburan beban mengandungi beban dinamik, berat sayap dan berat bahanapi

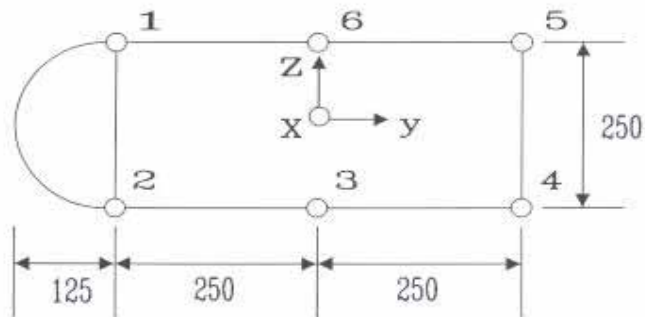
(10 Marks/Markah)

5. Bending moments of $M_y = -50 \text{ kNm}$ and $M_z = 10 \text{ kNm}$ are applied on the thin-walled 6 stringers beam section shown in **Figure Q5**.

*Momen lentur $M_y = -50 \text{ kNm}$ dan $M_z = 10 \text{ kNm}$ dikenakan ke atas keratan-rentas rasuk dinding-nipis 6 gelegar yang ditunjukkan di **Rajah S5**.*

Determine the normal stresses in all stringers.

Tentukan tegasan normal pada semua gelegar.



All dimensions in mm

Semua dimensi dalam mm

Thickness of all webs = 0.25 mm

Tebal semua web = 0.25 mm

Area of stringers, $A_1 = A_2 = 1000 \text{ mm}^2$

$A_3 = A_4 = A_5 = A_6 = 500 \text{ mm}^2$

Luas gelegar, $A_1 = A_2 = 1000 \text{ mm}^2$

$A_3 = A_4 = A_5 = A_6 = 500 \text{ mm}^2$

Figure Q5/ Rajah S5

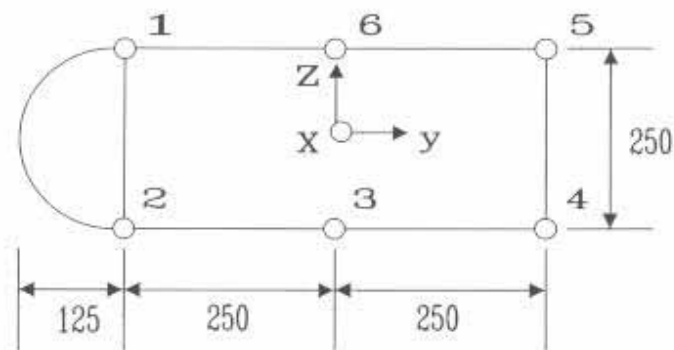
(20 Marks/Markah)

6. The thin-walled 6 stringers beam section shown in **Figure Q6** experiences a torque $M_x = -1.4$ kNm about and transverse forces $V_y = -4$ kN and $V_z = -22$ kN at its centroid.

*Keratan rasuk dinding-nipis 6 gelegar yang ditunjukkan di **Rajah S6** mengalami kilas $M_x = -1.4$ kNm dan beban lintang $V_y = -4$ kN dan $V_z = -22$ kN di sentroid.*

Determine the shear stresses in all webs.

Tentukan tegasan ricih pada semua web.



All dimensions in mm

Semua dimensi dalam mm

Thickness of all webs = 0.25 mm

Tebal semua web = 0.25 mm

Area of stringers, $A_1 = A_2 = 1000$ mm²

$A_3 = A_4 = A_5 = A_6 = 500$ mm²

Luas gelegar, $A_1 = A_2 = 1000$ mm²

$A_3 = A_4 = A_5 = A_6 = 500$ mm²

Figure Q6/Rajah S6

(30 Marks/Markah)