



## 12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

**SURNAME:** CHAPMAN

FORENAME(S): AIDAN MICHAEL  
GREETHAM

|   |                                  |                       |
|---|----------------------------------|-----------------------|
| 1 | Student Number                   | 149661                |
| 2 | Title of Examination Paper       | CAE & STRESS ANALYSIS |
| 3 | Module Code                      | M5X02064              |
| 4 | Date and Time of Examination     | 9th MAY 2019<br>12:00 |
| 5 | Examination Venue                | 1Q310                 |
| 6 | Seat Number                      | G034                  |
| 7 | Number of Answer Books handed in |                       |

| List the numbers of the questions you have attempted | Office Use |
|------------------------------------------------------|------------|
| 1                                                    | 20         |
| 2                                                    | 18         |
| 3                                                    | 10         |
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| Total                                                | 48         |

(Gweler yr ochr arall am y fersiwn Cymraeg)

80%



$$1) a) PdL = 2\sigma_H \times Lt$$

Pressure  $\times$  area = Resistive forces.

$$\frac{PdL}{2Lt} = \sigma_H$$

$$\frac{Pd}{2t} = \sigma_H$$

(4)

$$b) i) \sigma_H = 200 \times 10^6 \text{ Pa}$$

$$d = 3.5 \text{ m}$$

$$t = 0.0005 \text{ m}$$

$$P @ \text{sea level} = 101 \times 10^3 \text{ Pa}$$

$$101 \text{ kPa}$$

$$\sigma_H = \frac{Pd}{2t} \quad \therefore P = \frac{2\sigma_H t}{d}$$

$$P = \frac{2 \times 200 \times 10^6 \times 0.0005}{3.5}$$

$$P = 57142 \text{ Pa}$$

$$= 57 \text{ kPa}$$

$$101 - 57 = 44 \text{ kPa}$$

from table  $\rightarrow$  20000 ft.

$$b) ii) P @ 8000 \text{ ft} = 75.3 \text{ kPa}$$

$$75.3 - 57 = 18.3 \text{ kPa}$$

from table  $\rightarrow$  40000 ft.

c) Pressurizing the cabin allow the plane to fly at a higher altitude, where the air is thinner. Due to aerodynamic resistance, this allows for better fuel efficiency.

(4)

(3)

(2)

$$d) \frac{P \pi d^2}{4} = \sigma_H \times \pi d \times t$$

$$\frac{P \pi d^2}{4 \pi d t} = \sigma_H$$

$$\frac{P d}{4 t} = \sigma_H$$

(4)

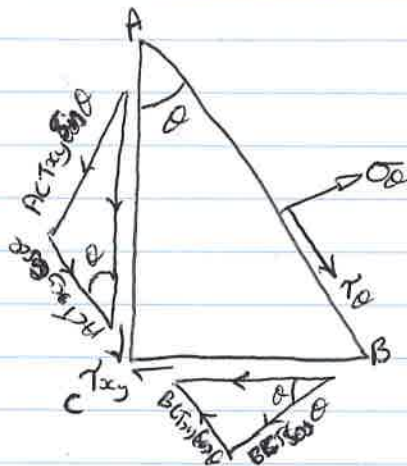
- e) Cylinders are more cost effective to produce due to footprint / storage capacity, however spheres are able to hold twice the amount of pressure for the same stress, meaning spheres are better suited to high pressure applications.

(3)

- 2) a) Principle Stress is the stress acting on an element within a system, and a principle plane is the angles at which they act. Principle Stress is the overall resulting forces acting on the element

(2)

b):

CAB  
50H

$$AB \sigma_\theta = AC \tau_{xy} \cos \theta + BC \tau_{xy} \sin \theta$$

$$AB \sigma_\theta = AC \tau_{xy} \sin \theta + BC \tau_{xy} \cos \theta$$

$$\sigma_\theta = \frac{AC}{AB} \tau_{xy} \sin \theta + \frac{BC}{AB} \tau_{xy} \cos \theta$$

$$\frac{AC}{AB} = \frac{A}{H} = \cos \theta \quad \frac{BC}{AB} = \frac{O}{H} = \sin \theta$$

$$\sigma_H = \tau_{xy} \cos \theta \sin \theta + \tau_{xy} \sin \theta \cos \theta$$

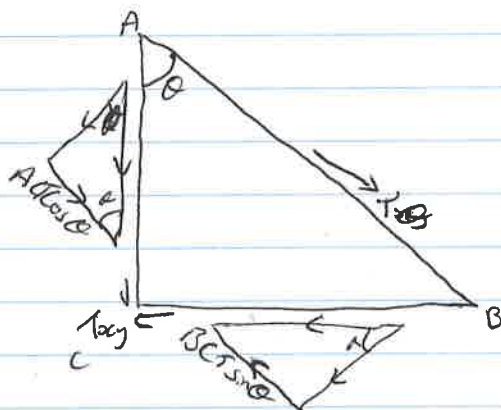
$$\sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$$

$$\sigma_H = \frac{1}{2} \tau_{xy} \sin 2\theta + \frac{1}{2} \tau_{xy} \sin 2\theta$$

$$\sigma_H = \tau_{xy} \sin 2\theta$$

(5)

ii)



$$AB \tau_\theta = BC \tau_{xy} \sin \theta - AC \tau_{xy} \cos \theta$$

$$\tau_\theta = \frac{BC}{AB} \tau_{xy} \sin \theta - \frac{AC}{AB} \tau_{xy} \cos \theta$$

$$\tau_\theta = \tau_{xy} \sin \theta \sin \theta - \tau_{xy} \cos \theta \cos \theta$$

$$\tau_\theta = \tau_{xy} \sin^2 \theta - \tau_{xy} \cos^2 \theta$$

$$\tau_\theta = \tau_{xy} [\sin^2 \theta - \cos^2 \theta]$$

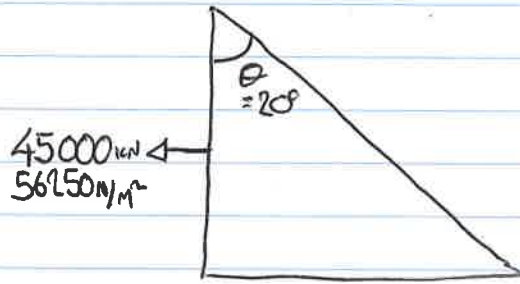
$$\tau_\theta = \tau_{xy} [-\cos 2\theta]$$

$$\tau_\theta = -\tau_{xy} \cos 2\theta$$

(5)

(5)

c)


 ~~$\sigma_x = \frac{1}{2} (56250 + 0) + \frac{1}{2} (56250 - 0) \cos 40^\circ$~~ 
 ~~$\sigma_y = \frac{1}{2} (56250 - 0) + \frac{1}{2} (56250 + 0) \cos 40^\circ$~~ 

$$\frac{\text{Force}}{\text{area}} = \frac{45000}{0.8 \times 10^{-4}} = 56250 \text{ N/m}^2$$

X

$$\sigma_x = \frac{1}{2} (56250 + 0) + \frac{1}{2} (56250 - 0) \cos 40^\circ$$

$$\sigma_x = 28125 + 28125 \cos 40^\circ$$

$$= 49669.99$$

$$= 50 \text{ kN/m}^2 \text{ (TENSILE)}$$

ECF

$$\tau_\theta = \frac{1}{2} (\sigma_x - \sigma_y) \sin 2\theta$$

$$\tau_\theta = \frac{1}{2} (56250) \sin 40^\circ$$

$$\tau_\theta = 18078.4$$

$$= 18 \text{ kN/m}^2 \text{ (down Plane)}$$

ECF

⑥

3) a) A design problem is a problem in which can have an array of potential solutions. A design problem can have multiple solutions that fit with a designated specification. Because of this, a design problem is essentially an iterative process, that continues until the most 'practical' solution is found.

However an analysis problem generally only has a single answer. Because of this, it requires a series of steps to be overcome in a certain order to generate the solution. Therefore it is a sequential process.

(3)

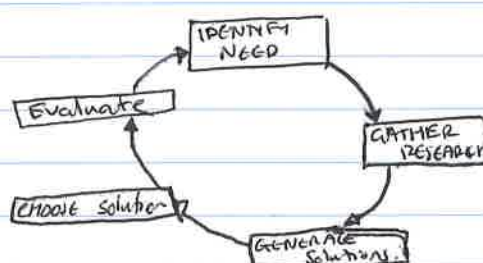
b) Design problems are iterative as there can be multiple solutions to a design problem. Therefore a solution must be generated by answering the problem multiple times (concept stage) and then choosing the best outcome to fit the specification. As an analysis problem only has one answer, the process is sequential in nature as each 'step' towards the answer must follow the previous one, in an order.

(4)



- Iterative Process.
- Time heavy.
- Optimisation of final solution

2



- Sequential Process
- Faster turnover
- Solution may not be the best fit

(3)

Question No.

Examiner Only

Arholwr yn unig

Yn y Cwestiwn



Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

Examiner Only



Question No.

Examiner Only

Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

Examiner Only



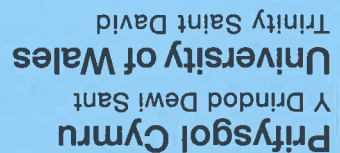
Question No.

Examiner Only

Arholwr yn unig

Arholwr yn unig





## 12 Tüdalen

3. Rhaid i'r atebion fod mewn llawysgriften ddarlennadwy. Gall yr Arholwyr naill ai anwybyddu sgrifft annarllennadwy, neu drefnu iddi gael ei threipio a chael yr ymgeisydd i dalu.

- [illegible]