



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: Anderson

FORENAME(S): Michael John Terrence

1	Student Number	151178
2	Title of Examination Paper	CAE + Stress Analysis
3	Module Code	MSX02064
4	Date and Time of Examination	9/5/19 12pm
5	Examination Venue	IQ 310
6	Seat Number	GO50
7	Number of Answer Books handed in	

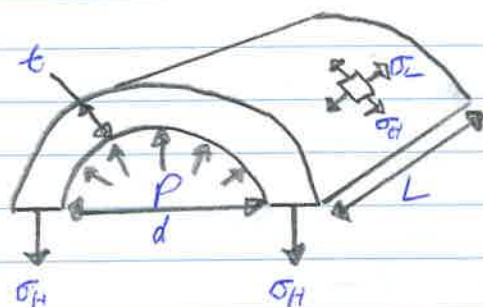
List the numbers of the questions you have attempted	Office Use
1	20
2	8
3	7
Total	35

(Gweler yr ochr arall am y fersiwn Cymraeg)

58.3 %



①



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

$$\text{Forces } \uparrow = P \times A \rightarrow A = d \times L \rightarrow \underline{P \times dL}$$

$$\text{Forces } \downarrow = 2\sigma_H t L$$

$$\text{Forces } \uparrow = \downarrow \rightarrow PdL = 2\sigma_H t L$$

$$Pd = 2\sigma_H t$$

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

b) i) Pressurised at sea level

$$\sigma_H = 200 \text{ MPa} = 200 \times 10^6 \text{ Pa}$$

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

$$t = 0.5 \text{ mm} = 0.5 \times 10^{-3} \text{ m}$$

$$\text{Ambient } P_a = 101 \text{ kPa} = 101 \times 10^3 \text{ Pa}$$

$$\frac{Pd}{2t} = \sigma_H \rightarrow P = \frac{2\sigma_H t}{d} = \frac{2 \times (200 \times 10^6) \times (0.5 \times 10^{-3})}{3.5}$$

$$P = \underline{57142.8 \text{ Pa}} \text{ or } \underline{57.14 \times 10^3 \text{ Pa}}$$

$$\text{Pressure difference} = \text{Ambient} - \text{Cabin} = 101 \times 10^3 - 57.14 \times 10^3$$

$$P = \underline{43.86 \times 10^3 \text{ Pa}}$$

$$\text{From table} \rightarrow \text{max altitude} = \underline{20000 \text{ ft}}$$

ii) Pressurised at 8000ft

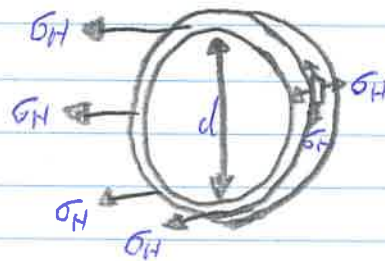
$$\text{Pressure difference} = \text{Ambient} - \text{cabin} = 75.3 \times 10^3 - 57.14 \times 10^3$$

$$P_d = \underline{18160 \text{ Pa}} \text{ or } \underline{18.16 \times 10^3 \text{ Pa}}$$

from table max altitude = 40000ft

③ Pressurising the cabin at a higher altitude enables the structure of the plane to have a lower pressure difference. This allows the plane to fly higher and save fuel due to the lower air resistance it is subjected to.

④



show $\sigma_H = \frac{Pd}{4t}$

Pressure acting on the sphere: $P \times A \rightarrow A = \frac{\pi d^2}{4} \rightarrow P \times \frac{\pi d^2}{4}$

Resistive force on the sphere = $\sigma_H \pi d \times t$

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

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

$$\frac{Pd}{4} = \sigma_H t$$

$$\frac{Pd}{4t} = \sigma_H$$

© Due to cylindrical $\sigma_H = \frac{Pd}{2t}$
and spherical $\sigma_H = \frac{Pd}{4t}$

It is clear to see that a spherical container can withstand twice the pressure exerted upon it as it is halved within the equation. This will mean that fluids stored within the sphere can be pressurised more than a cylindrical container.

A cylinder, on the other hand, can store more fluid within it, albeit at a lower pressure, due to the geometry of the shape. It could also be more effective for cost to store fluids within a cylinder, and they are easier to package and store.

3

②

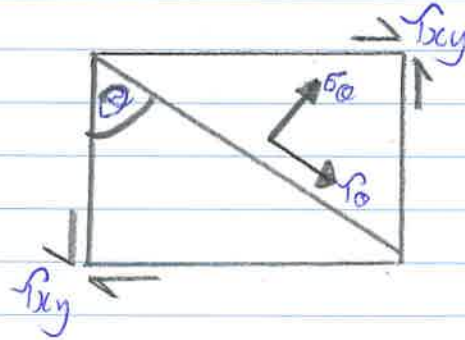
maximum and minimum

a) Principle stress are the forces acting upon the geometry of the shape, due to either internal or external forces, i.e. tensile or compression or shear.

Principle planes are the direction or surface in which these forces are acting upon with their magnitude.

③

⑥



$$\sigma_x = 0$$

$$\sigma_y = 0$$

$$i) \sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\text{since } \sigma_x + \sigma_y = 0$$

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

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

X

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

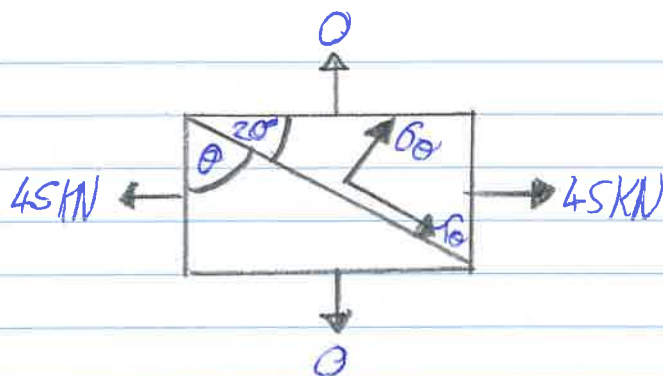
$$\text{as } \sigma_x + \sigma_y = 0$$

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

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

X

①



$$\sigma = 90 - 20 = 70^\circ$$

$$A = 800 \text{ mm}^2$$

$$800 \text{ mm}^2 \rightarrow \text{m}$$

$$= 800 \times 10^{-6} \text{ m}^2$$

$$\sigma_y = 0$$

$$\sigma_x = 45000 \text{ N} \rightarrow 45 \times 10^3 \text{ N}$$

$$\tau_{xy} = 0$$

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

$$\sigma_\theta = \frac{1}{2}(45 \times 10^3 + 0) + \frac{1}{2}(45 \times 10^3 - 0)\cos(2 \times 70) + 0 \sin(2 \times 70)$$

$$\sigma_\theta = (22500) + (-17236) + (0)$$

$$\sigma_\theta = \underline{\underline{5264 \text{ N}}}$$

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

$$\tau_{xy} = \frac{1}{2}(45 \times 10^3 - 0)\sin(2 \times 70) - 0 \cos(2 \times 70)$$

$$\tau_{xy} = (14462.72) - (0)$$

$$\tau_{xy} = \underline{\underline{14462.72 \text{ N}}}$$

⑤

③

② A design problem would be where although a design fits as required, it doesn't withstand enough stress applied to it to succeed in its application due to CAD models being developed before CAE.

An analysis problem would be where the CAE or FEA of an object or geometry shows the geometry would not withstand forces, this could need further development or analysis of the problem stated within the design brief to succeed in a FE environment.

⑥ Design problems would be encountered where a design or CAD model has been taken to prototyping or production but doesn't meet the necessary stress/strain requirements stipulated within the design brief, this would mean it would need either redesigning completely, or extra supports placed with the component's structure. This would lead to a second prototype and analysis before production could be carried forward with iterations.

An analysis problem would be a sequential process due to an FEA / CAE model being constructed, loaded and tested within a virtual environment to ensure it is designed and can withstand real life loading and use, ^{correctly} before a prototype is created, or saving costs on tooling and materials, including physical labour.

③

③ - 5 steps of the design process model - this would be advantageous to discuss and develop multiple solutions to a single problem but may incur a drawback where as multiple people are taking part, could use a lot of time arguing/discussing which solution would be best for that problem and as time is money, their wages would incur a financial loss/penalty as such.

- SIMPLE - This would help discuss and ~~and~~ analyse a solution to a problem and help develop it in a FE environment suitable for the design brief and specification. The downside is that ~~only~~ potentially only ~~1~~ solution would be analysed at one time requiring iterations if the solution isn't appropriate for use.

- CAE ^{VS} CAD - Deciding which software package would be more fit for purpose, would be advantageous in saving time within a feedback loop and therefore save money in wages ~~costs~~ outlay for production/prototypes. The drawback may be incurred if the wrong one is selected for a specific project incurring time penalties

Question No.

Examiner On

Arholwr yn unig

hif y Cwestiwn

Question No.

Examiner Only

Question No.

Examiner On

Question No.

Examiner Only

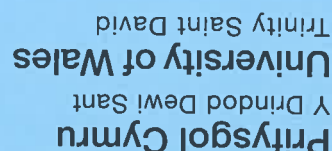
Question No.

Examiner Only

Arholwr yn unig

ff y Cwestiwn





12 Tudalen

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, pligwch et a'i seio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

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

4. Ysgriennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwneuwch unrhyw ftras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.
6. Ni ddylid rhoi unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.

7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwylwyr/gwylwyr.

8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

1	Rhif Myfyriwr	
2	Teitl y Papur	Arholiad
3	Cod y Modwl	
4	Dyddiad ac Amser yr	Archoliad
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

(See the other side for English version)

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF: