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FORENAME(S): CARL PETER

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold the flap over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners cannot ignore illegible script or have it typed and the expense of typing will be 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.**

1	Student Number	P150898
2	Title of Examination Paper	CAE & STRESS ANALYSIS
3	Module Code	M5X02064
4	Date and Time of Examination	12:00 09/05/2019
5	Examination Venue	IQ 310
6	Seat Number	G029
7	Number of Answer Books handed in	1/1

List the numbers of the questions you have attempted	Office Use
1	20
2	11
3	11
Total	42

(Gweler yr ochr arall am y fersiwn Cymraeg)

70%



Q1.

a.

$$\begin{aligned}\text{Pressure force} &= P \times A \\ &= P \times dL\end{aligned}$$

$$\text{Resistance to bursting force} = 2\sigma_H \times t \times L$$

$$\therefore PdL = 2\sigma_H tL$$

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

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

b. $\sigma_H = 200 \text{ MPa}$ $P = \rho gh$
 $d = 3.5 \text{ m}$
 $t = 0.5 \times 10^{-3} \text{ m}$

i.

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

$$Pd = 2t\sigma_H$$

$$P = \frac{2t\sigma_H}{d}$$

$$P = \frac{2(0.5 \times 10^{-3})(200 \times 10^6)}{3.5}$$

$$P = 57142.85 \text{ Pa}$$

$$P = 57.14 \text{ kPa}$$

$$\begin{aligned}\Delta P &= 101 \text{ @ sea level} - 57.14 \\ &= 43.86 \text{ kPa}\end{aligned}$$

Hence it can fly up to 20000 ft at a pressure difference of 46.6 kPa allowing for margin of safety.

ii.

if the cabin is pressurized @ 8000ft
at a pressure of 75.3 kPa the pressure
difference would be,

$$\Delta P = 75.3 - 57.14$$

$$= 18.2 \text{ kPa}$$

Allowing the airplane to reach 40000ft
@ 18.7 kPa, ~~using~~ using the lower
figure for safety.

c.

A pressurised plane cabin allows the
plane to fly higher as proven previously and
as air resistance at higher altitudes are
lower it is therefore more economical.

d.

$$\text{Pressure Force} = P \times A$$

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

$$\text{Resistance to buckling force} = \sigma_H \times \pi d t$$

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

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

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

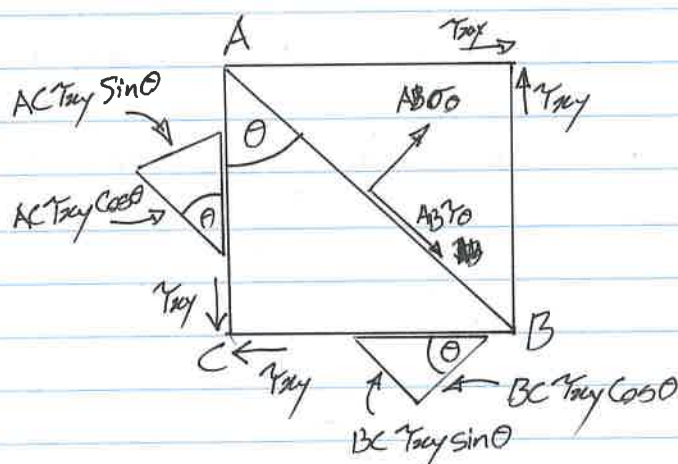
e.

Oil storage facilities will choose to store fluids at
higher pressures within spheres as it is according
~~the~~ to the equations half the hoop stress compared
to a cylinder. However it is more economical to store
fluids inside a ~~cylinder~~ cylinder as it can contain
a larger capacity of fluid compared to its footprint.

Q2

- a. Principle stress is the stress acting perpendicular to the stressed element when divided into a triangle. Perpendicular, to the principle plane which is dictated by the angle to the vertical within the stressed element.

(2)

b.
i.

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

$$\text{if } \frac{AC}{AB} = \cos\theta \quad \text{and} \quad \frac{BC}{AB} = \sin\theta$$

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

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

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

$$\therefore \sigma_{\theta} = \tau_{xy}\left(\frac{1}{2}\sin 2\theta\right) + \tau_{xy}\left(\frac{1}{2}\sin 2\theta\right)$$

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

(5)

ii.

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

Recall previous point.

$$\therefore T_{\theta} + \cos \theta T_{xy} \cos \theta = - \sin \theta T_{xy} \sin \theta$$

$$T_{\theta} =$$

$$\frac{AB}{AB} T_{\theta} + \frac{BC}{AB} T_{xy}$$

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

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

Recall previous point in bi.

$$T_{\theta} + \cos \theta T_{xy} \cos \theta = \sin \theta T_{xy} \sin \theta$$

$$T_{\theta} + \cos^2 \theta T_{xy} = T_{xy} \sin^2 \theta$$

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

$$T_{\theta} = T_{xy} (\sin^2 \theta - \cos^2 \theta)$$

$$\text{if } \sin^2 \theta - \cos^2 \theta = -\cos 2\theta$$

$$\therefore T_{\theta} = T_{xy} (-\cos 2\theta)$$

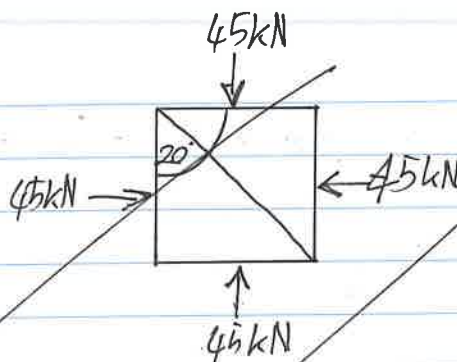
$$T_{\theta} = -T_{xy} \cos 2\theta$$

C.

$$\theta = 20^\circ$$

$$A = 0.8 \text{ m}^2$$

~~45 kN~~



$$\sigma_x = \frac{45000}{0.8} = 56250 \text{ N/m}^2$$

Note: At each end is assuming the force is acting on all sides of the bar.

$$\sigma_y = 56250 \text{ N/m}^2$$

$$\sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2(20)$$

$$\sigma_\theta = \frac{1}{2}(-56250 + 56250) + \frac{1}{2}(-56250 - 56250) \cos 2(20)$$

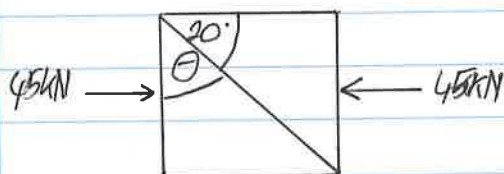
$$\sigma_\theta = -56250 \text{ N/m}^2 = -56 \text{ kN/m}^2$$

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

$$\tau_\theta = \frac{1}{2}(-56250 - 56250) \sin 2(20)$$

$$\tau_\theta = 0 \text{ kN/m}^2$$

Assuming the ^{tensile} forces are applied as in the following diagram at each end of the bar.



$$A = 0.8 \text{ m}^2$$

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

$$\sigma_x = -45 \text{ kN} / 0.8 = -36 \text{ kN/m}^2$$

$$\sigma_y = 0 \text{ kN/m}^2$$

$$\begin{aligned}\sigma_{\theta} &= \frac{1}{2} (\sigma_x + \sigma_y) + \frac{1}{2} (\sigma_x - \sigma_y) \cos 2\theta \\ \sigma_{\theta} &= \frac{1}{2} (-36 + 0) + \frac{1}{2} (-36 - 0) \cos 2(70) \\ &= \underline{\underline{-4.21 \text{ kN/m}^2}}\end{aligned}$$

$$\begin{aligned}\tau_{\theta} &= \frac{1}{2} (-36 - 0) \sin 2(70) \\ &= \underline{\underline{-11.57 \text{ kN/m}^2}}\end{aligned}$$

(4)

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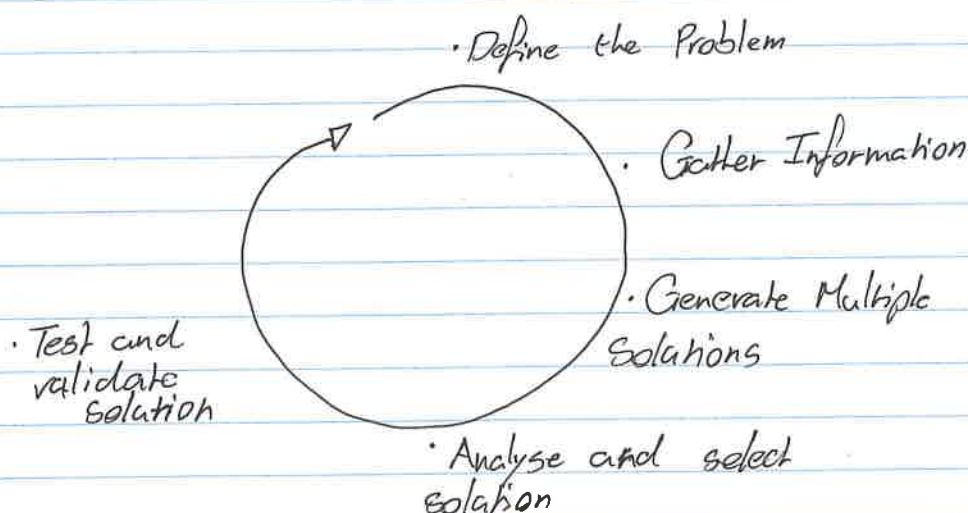
a. An analysis problem ^{usually only} has one solution and is more defined while a design problem has multiple solutions and ^{at times may} require multiple iterations.

(3)

b. A design problem is usually iterative as it is ~~is~~ subject to multiple solutions or is an area open to different approaches. Hence once a solution is found it must be deemed safe, functional and adherent to regulations and standards, if not then it will need to be redesigned. Different iterations may prove to provide improved solutions with each design hence continual efforts may be carried out until a conclusive end point is ^{reached} found. However ^{with} an analysis ~~problem~~ ^{Problem} the solution is created through a clear and defined brief with ^{set out} conditions, is tested within its ^{set} parameters, and if it is deemed right, finalised.

(5)

c. The Engineering design ^{Process} is carried out as follows,



- This process allows for ~~the~~ a creative brainstorming segment allowing for multiple solutions to be ~~also~~ considered, allowing which may lead to a effective unorthodox solution to be found.
- However this process may be extensive and lead to longer ~~processing~~ developing times than subsequent others.

(3)

Question No.

Examiner O

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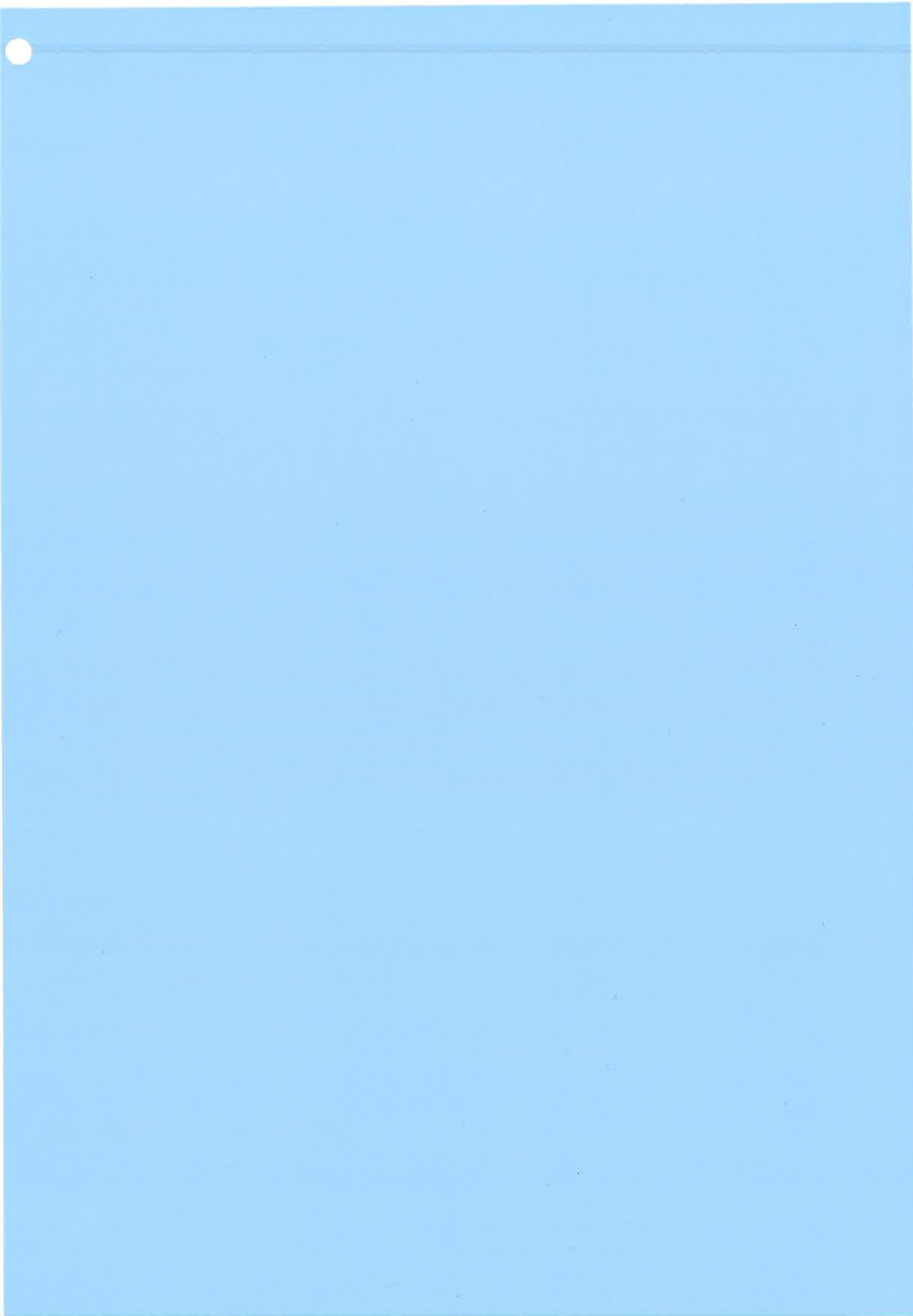
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