

**Complete, fold and seal
(see note 2 below)**

Harries

Stuart

Instructions to Candidates

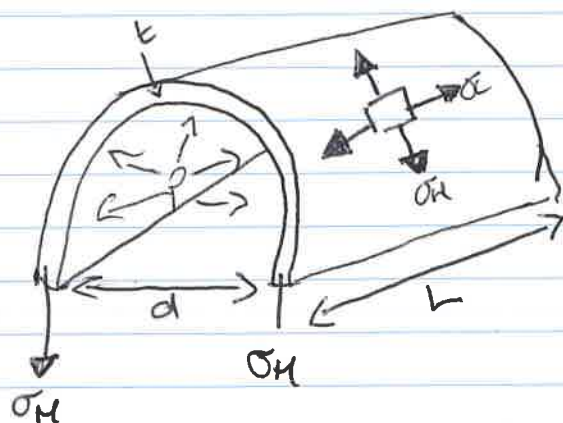
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense 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.**

1	Student Number	P150227
2	Title of Examination Paper	CAE & Stress analysis
3	Module Code	MSX02064
4	Date and Time of Examination	09/05/2019 @ 12:00pm
5	Examination Venue	IQ 302 b
6	Seat Number	1
7	Number of Answer Books handed in	1

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(Gweler yr ochr arall am y fersiwn Cymraeg)

53.3%

Q1
a)

Prove $\sigma_H = \frac{pd}{2t}$

Force $\uparrow$ = Pressure $\times$ Area

$= p \times dL$

Force $\downarrow$ = $2\sigma_H tL$

$pdL = 2\sigma_H tL$

$\therefore \sigma_H = \frac{pd}{2t}$

✓ ④

b) $\phi = 3.5m$
 $t = 0.5mm$
 ~~$p_{max} = 200 MPa$~~

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

$\sigma_H = 200 MPa$

$\frac{\sigma_H 2t}{d} = p_{max}$

$\frac{(200)(2)(\cancel{0.5} \times 10^{-4})}{3.5}$

✗

i) 101 kPa

d) Prove $\sigma_H = \frac{Pd}{4E}$

Resolve Vertically

$$\begin{aligned} \text{Force} \uparrow &= P \times \text{Area} \\ &= P \times \frac{\pi d^2}{4} \end{aligned}$$

Force $\sigma_H \pi d t$

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

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

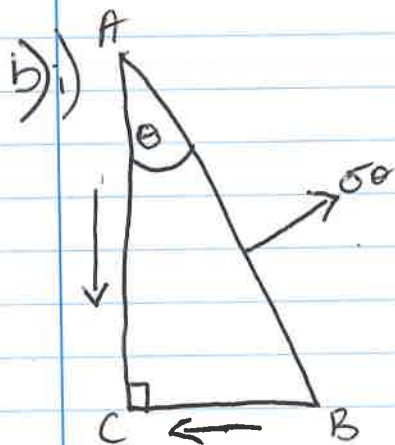
$$\therefore \frac{P d}{4} = \sigma_H t$$

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

e) Some facilities store fluids in spherical tanks as the hoop stress in double a cylindrical container. This means they can store fluids at higher pressure. The use of cylindrical storage containers is more cost effective.

Q2) Principal Stress is the Normal Stress acting on the Plane. Principle plane is the direction the Stress is acting on the plane.

(2)



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

$$\begin{aligned} \frac{SH}{AH} &= \frac{BC}{AB} \\ \frac{CH}{AH} &= \frac{AC}{AB} \\ \frac{TA}{AH} &= \frac{BC}{AB} \end{aligned}$$

Resolve τ_{xy} to AB

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

Divide by AB

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

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

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

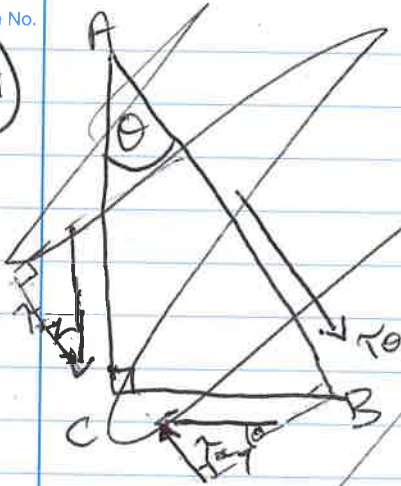
Remember $\sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$

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

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

(5)

ii)



Prove

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

Remember $\sin^2 \theta - \cos^2 \theta = -\cos 2\theta$

Resolve T_{θ} to AB

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

Divide by AB

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

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

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

Divide by AB

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

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

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

$$\sigma_{\theta} = \frac{1}{2} \left(\overset{\text{FORCE}}{45} \right) + \frac{1}{2} (-45) \cos(2 \times 20)$$

$$\sigma_{\theta} = 5.26 \text{ kN (Tensile) UNITS}$$

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

$$\tau_{\theta} = -14.46 \text{ kN (compressive)}$$

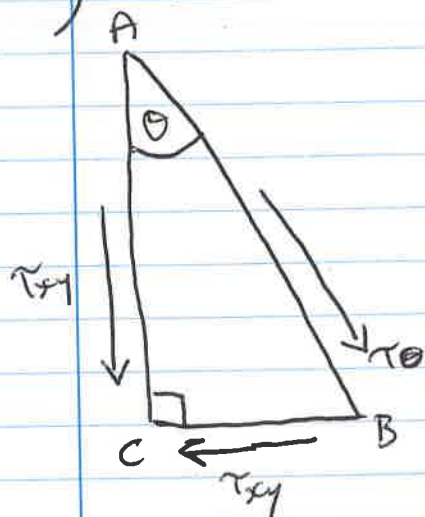
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Q2)
b)
ii)Prove $\tau_\theta = -\tau_{xy} \cos 2\theta$ Resolve τ_θ to AB

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

Divide by AB

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

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

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

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

~~xxx~~

Remember

~~$$\sin^2 \theta - \cos^2 \theta = -\cos 2\theta$$~~

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

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

(4)

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Question 2

e) Using a cylindrical storage container is the best value for money when it comes to storing fluids but as the hoop stress is half the hoop stress of the spherical tanks, they can only be stored at lower pressure.

3

Question 3

- a) The difference between a design problem and an analysis problem is that a design problem is usually vague and has more than one solution whereas, an analysis problem has only one answer and is sequential.
- b) The design problem is usually an iterative process as the solution can be continually refined up until the end of the process. Mistakes in the design process might only be picked up at the end of the process and if it is that might have to start again. This will cost time and money. The analytical problem is usually sequential as the problem only has one answer.
- c) One of the models that has been developed is the SIMPLE model. The use of this model would be involved in FEA. This would significantly reduce the need for physical prototyping as visual prototyping could be done. This would save time in the design process. A disadvantage of this would be that the results would have to be analysed by a person as the results from the computer are only approximated. Another model that has been development to help understand the design process is the five step design process. This would enable to find a possible solution quickly and it could bring different disciplines together.

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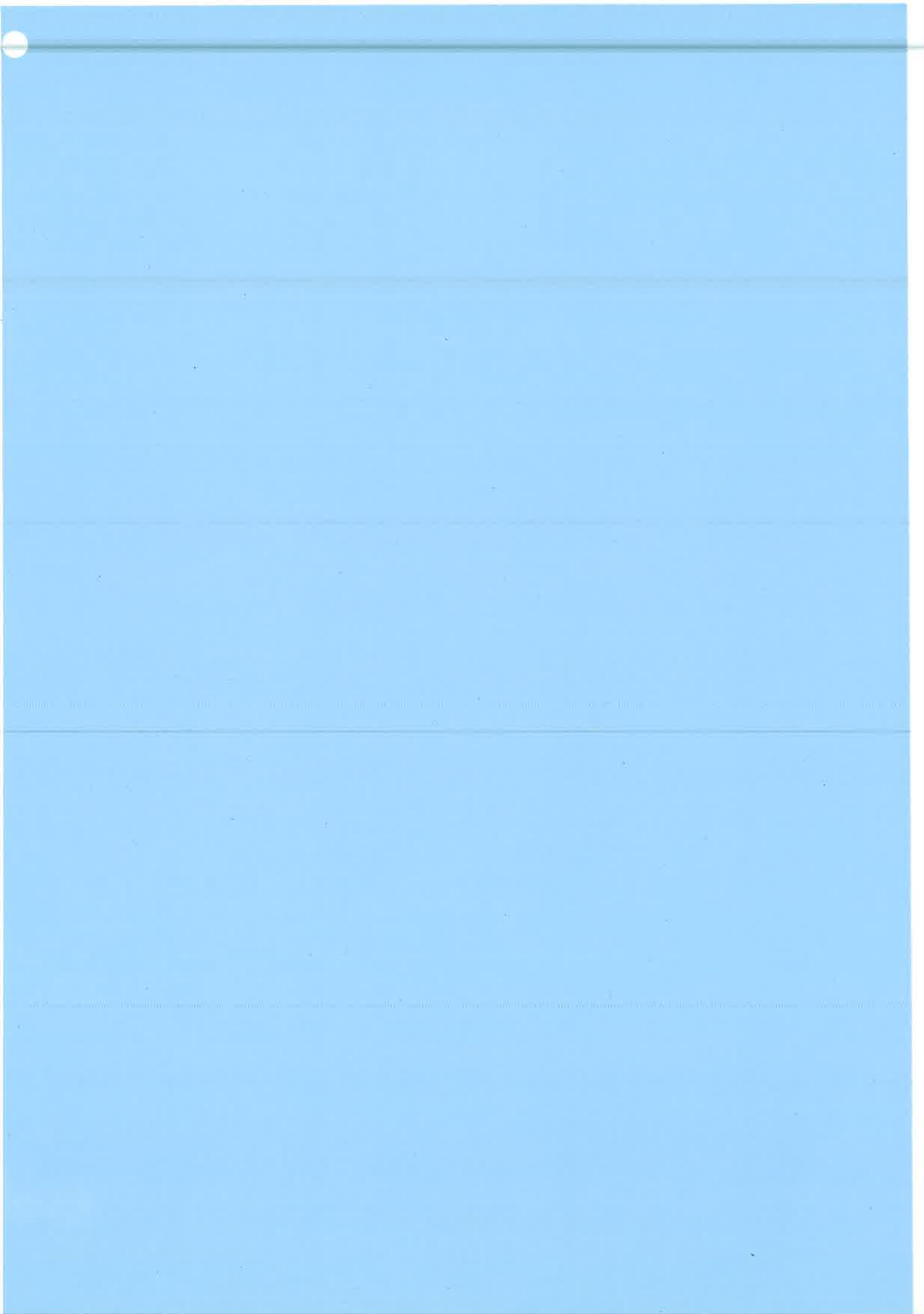
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3. Rhaid i'r atebion fod mewn llawysgrifen ddarllenadwy. Gall yr Arholwyr naill ai anwybyddu sgrïpt annarllenadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

- arholi o dan unrhyw amgylchiadau.

[illegible]