



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.**

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1	Student Number	180 5566
2	Title of Examination Paper	CAE & STRESS ANALYSIS
3	Module Code	M5X02064
4	Date and Time of Examination	12 pm 9 th of MAY
5	Examination Venue	1Q 310
6	Seat Number	6055
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	18
2	20
3	11
Total	49

(Gweler yr ochr arall am y fersiwn Cymraeg)

81.7%



QUESTION 1

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a)

$$P = \frac{F}{A} \Leftrightarrow F = P \cdot A = P \cdot d \cdot L \quad (1)$$

$$G_H = \frac{F}{A} \Leftrightarrow F = G_H \cdot A = G_H \cdot 2 \cdot t \cdot L \quad (2)$$

$$(1) = (2)$$

$$P \cdot d \cdot L = G_H \cdot 2 \cdot t \cdot L \Leftrightarrow$$

$$\Leftrightarrow P \cdot d = G_H \cdot 2 \cdot t \Leftrightarrow$$

$$\Leftrightarrow G_H = \frac{P \cdot d}{2t}$$

(4)

$$b) G_H = 200 \text{ MPa}$$

$$d = 3,5 \text{ m}$$

$$t = 0,5 \text{ mm} = 0,5 \times 10^{-3} \text{ m}$$

$$i. G_H = \frac{P d}{2t} \Leftrightarrow P = \frac{G_H \cdot 2t}{d} \Leftrightarrow$$

$$P = \frac{200 \times 10^6 \times 2 \times 0,5 \times 10^{-3}}{3,5} = 57,14 \text{ kPa}$$

$$\text{At sea level. } \text{feet} = 0 \rightarrow P_{\text{sea}} = 101 \text{ kPa}$$

$$101 - 57,14 = 43,86 \text{ kPa} \rightarrow 20000 \text{ feet}$$

(4)

• With the cabin sealed at sea level the maximum altitude that this aircraft can fly is 20000 feet.

ii)

Cabin pressure equivalent pressure of 8000 ft = 75,3 kPa

$$75,3 - 57,14 = 18,16 \text{ kPa} \rightarrow 40000 \text{ feet}$$

If the cabin is pressurized to an equivalent pressure of 8000 ft the nearest 500 ft the maximum altitude that this aircraft can fly at is ~~40000 feet~~ 40000 feet.

c. In terms of the plane structure, pressurizing plane cabins will allow the aircraft to fly much higher without suffering bigger hoop stresses. From the last examples we can say that by reducing the pressure in the cabin by 25% $((1 - 75,3/101) \times 100)$ will ~~translate in~~ allow the aircraft to fly two times higher from 20000 feet to 40000 feet. BUT WHY?

d.

$$\sigma_H = \frac{F}{A} \Leftrightarrow F = \sigma_H \cdot A \Leftrightarrow F = \sigma_H \cdot \pi d t \quad (1)$$

$$P = \frac{F}{A} \Leftrightarrow F = P \cdot A \Leftrightarrow F = P \cdot \pi \frac{d^2}{4} \quad (2)$$

$$(1) = (2)$$

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

$$\Leftrightarrow \sigma_H = P \pi \frac{d^2}{4} \frac{1}{\pi d t} \Leftrightarrow$$

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

e) Based on the equations derived in parts c and d ($\sigma_{H_{cyl}} = \frac{P d}{2 t}$ and $\sigma_{H_{sph}} = \frac{P d}{4 t}$) it's easy to understand why in oil storage facilities some fluids are stored in spherical tanks instead of cylindrical containers, because for the same Hoop Stress the spherical tanks can support twice the ~~oil~~ pressure of the cylindrical containers. Said in different words, oil can be stored with the same pressure. Cylindrical containers could be easier to manufacture and more compact but spherical containers will allow to $\rightarrow$

store ^{fluids} in higher pressures.

3

QUESTION 2

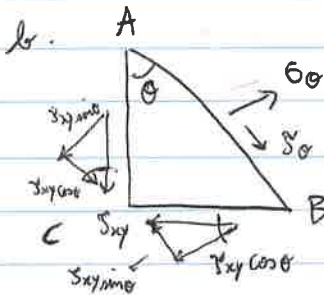
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a.

In the context of complex stress, the term 'Principal Stress' is referring to the maximum and minimum value of stress that the element will suffer when subjected to shear stress and/or normal stress with certain directions and senses. The term 'Principal Plane' is ~~referring~~ related to the 'Principal stress' because it's plane in the element (represented by an angle made with the vertical) where it suffers the maximum stress and the plane where it suffers the ~~minimum~~ minimum stress.

3



$$i) \sigma = \frac{F}{A} \Leftrightarrow F = \sigma \cdot A$$

$$\sigma_{\theta} \cdot AB \cdot 1 = AC \cdot 1 \cdot \sigma_{xy} \sin \theta + BC \cdot 1 \cdot \sigma_{xy} \cos \theta \quad (\Rightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = \frac{AC}{AB} \sigma_{xy} \sin \theta + \frac{BC}{AB} \sigma_{xy} \cos \theta \quad (\Rightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = \cos \theta \sin \theta \sigma_{xy} + \sin \theta \cos \theta \sigma_{xy} \quad (\Rightarrow)$$

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

$$\Leftrightarrow \sigma_{\theta} = \frac{1}{2} \sin 2\theta \sigma_{xy} + \frac{1}{2} \sin 2\theta \sigma_{xy} \quad (\Rightarrow)$$

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

5

$$ii) \quad \sigma_{\theta} = \frac{F}{A} \Leftrightarrow F = \sigma_{\theta} \cdot A$$

$$\sigma_{\theta} \cdot AB \cdot 1 = -AC \cdot 1 \cdot \tau_{xy} \cos \theta + BC \cdot 1 \cdot \tau_{xy} \sin \theta \quad (\Leftrightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = -\frac{AC}{AB} \tau_{xy} \cos \theta + \frac{BC}{AB} \tau_{xy} \sin \theta \quad (\Leftrightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = -\cos \theta \cdot \cos \theta \tau_{xy} + \sin \theta \cdot \sin \theta \tau_{xy} \quad (\Leftrightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = \sin^2 \theta \tau_{xy} - \cos^2 \theta \tau_{xy} \quad (\Leftrightarrow)$$

$$\Leftrightarrow \sigma_{\theta} = \cancel{\cos 2\theta} (\sin^2 \theta - \cos^2 \theta) \tau_{xy} \quad (\Leftrightarrow)$$

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

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

C.

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

$$F = 45 \text{ kN} = 45 \times 10^3 \text{ N}$$



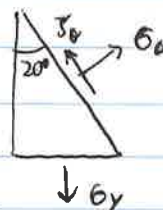
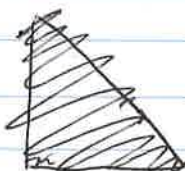
$$\sigma_y = \frac{F}{A} = \frac{45 \times 10^3}{800 \times 10^{-6}} = 56,25 \text{ MPa}$$

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

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

$$\begin{aligned} \sigma_{\theta} &= \frac{1}{2} (56,25 \times 10^6) + \frac{1}{2} (-56,25 \times 10^6) \cos (2 \times 20) = \\ &= 49,67 \text{ MPa} \end{aligned}$$

$$\tau_{\theta} = \frac{1}{2} (-56,25 \times 10^6) \sin (2 \times 20) = -18,08 \text{ MPa}$$



Representation after knowing the signs of the values for σ_{θ} and τ_{θ} .

QUESTION 3

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a.

The difference between a Design problem and an Analysis problem is that the design problem is more ambiguous. In a design problem is difficult to source the origin of the problem, while in an analysis problem due to its sequential character it is easier to source the problem, correct and get a new solution quicker.

(3)

b. The design problem is usually an iterative process, because solutions are ~~not~~ dependent on the designer experience to solve the problems. This is a time consuming process and some times while getting a new solution a new problem can show up, making this process to repeat itself. In an analysis problem because it is primarily sequential is less dependent in experience of the analyst and it is easier to identify the problems, make quick corrections and obtain new solutions in a quicker time.

/ (5)

c. One of the models ^{the '5 steps' model} that have been developed to understand how the design process would be carried out is ruled by the following steps:

5 steps model:

- Define problem
- Gather relevant information
- Generate multiple solutions
- Analyse and select solution
- Test and implement solution

One of the advantages of this model is having the work process super organized, and a disadvantage is the time that it takes since the problem is defined until the first prototype / solution.

(3)

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Question No.

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Question No.

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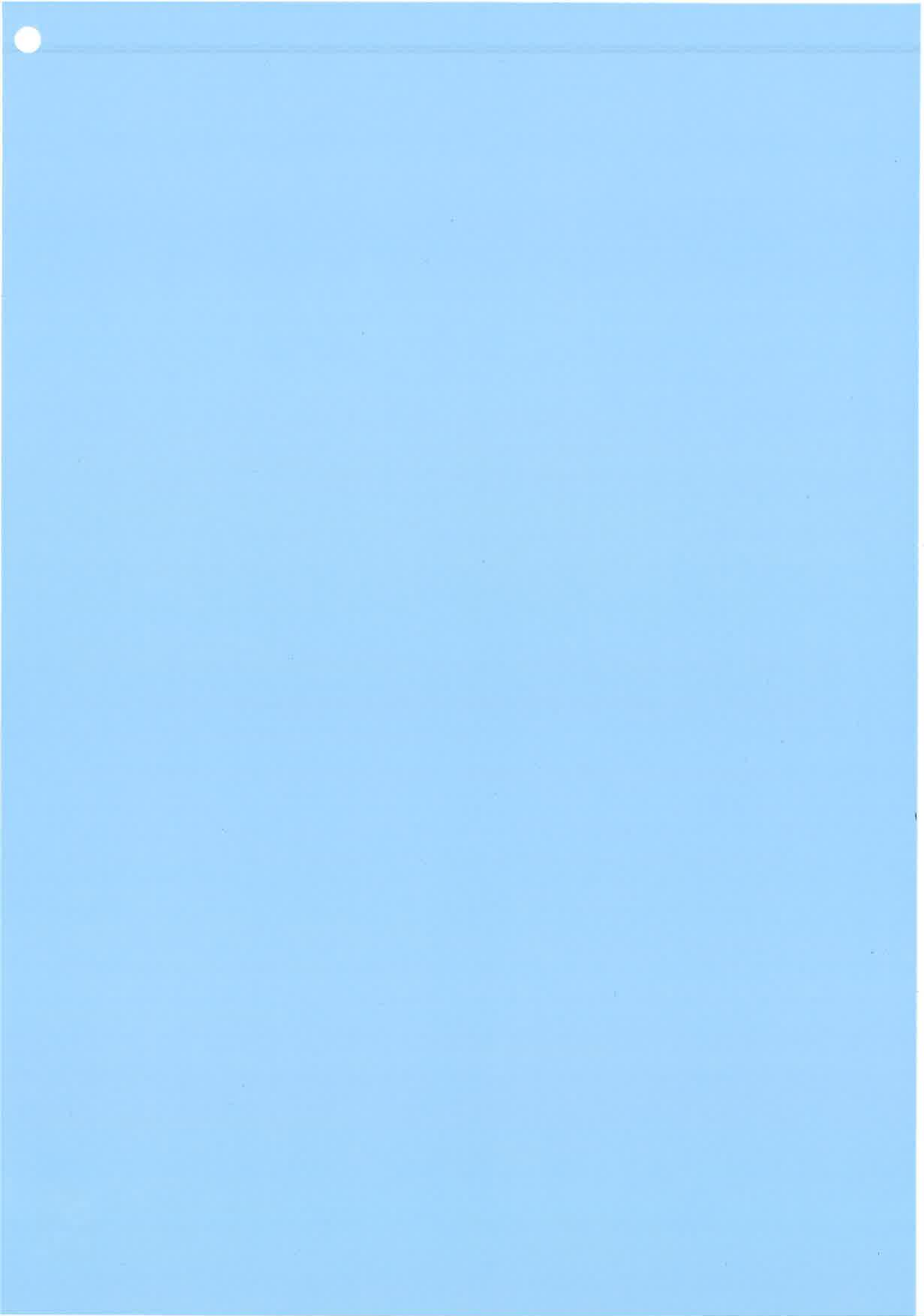
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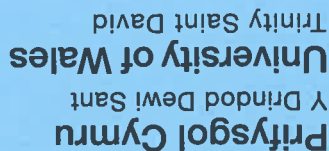
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12 Tüdalen

1. Rhowch yr holl wybodaeth y gofynnir amdani yn y blychau isod.

2. Rhwch eich enw yn lle a ddarparwyd ar y dde, plygwch ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

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

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

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

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

[illegible]

(See the other side for English version)

Llenwch, plygwrch a seliwrch
(gweler nodyn 2 isod)

CYFENW:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: