



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.**

FORENAME(S): QUAN

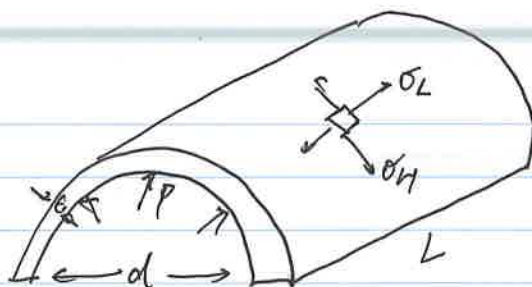
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(Gweler yr ochr arall am y fersiwn Cymraeg)

81.7%

Question 1:

(a)



Lets do the analysis for the bottom plane.
the force should be balanced:

$$\text{so } F_1 = p \cdot dL \quad (1)$$

$$F_2 = 2\sigma_H Lt \quad (2)$$

$$F_1 = F_2 \quad (3)$$

combine (1) (2) (3).

$$2\sigma_H Lt = p dL$$

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

(b) (i) At sea level: ~~$p_0 =$~~

$$\text{From (a) } \sigma_H = \frac{pd}{2t} = \frac{200 \times 10^6 \times 3.5}{2 \times 0.5 \times 10^{-3}}$$

At sea level

$$\sigma_H = \frac{pd}{2t} = \frac{101 \times 10^3 \times 3.5}{2 \times 0.5 \times 10^{-3}} = 353.5 \text{ MPa}$$

$$\sigma = \sigma_H - 200 \text{ MPa} = 153.5 \text{ MPa}$$

From the word we can get: $\sigma_H \leq 200 \text{ MPa}$.

$$\begin{aligned} \text{so } \sigma_H = \frac{pd}{2t} &\Rightarrow p = \frac{\sigma_H \cdot 2t}{d} \\ &= \frac{200 \times 10^6 \times 2 \times 0.5 \times 10^{-3}}{3.5} \\ &= 57.14 \text{ kPa} \end{aligned}$$

At sea level $P_0 = 101 \text{ kPa}$.

$$\Delta P = P_0 - P = 101 \text{ kPa} - 57.14 \text{ kPa} = 43.86 \text{ kPa}$$

From the table we find

the maximum altitude is 20000 ft.

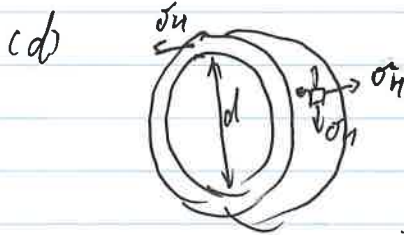
(iii) At 8000 ft $P_1 = 75.3 \text{ kPa}$

$$\Delta P = P_1 - P = 75.3 \text{ kPa} - 57.14 \text{ kPa} = 18.16 \text{ kPa}$$

From the table we find

the maximum altitude is 40000 ft.

- (c) ① pressurizing plane cabin enables the fuselage reach higher altitude when the air is dense is less
 ② thus the fuel efficiency is improved



The force is balanced at the round plane

$$\text{so } F_1 = F_2 \quad \text{①}$$

$$F_1 = P \cdot \frac{\pi d^2}{4} \quad \text{②}$$

$$F_2 = \sigma_H \cdot \pi d \cdot t \quad \text{③}$$

combine ① ② ③ $\frac{\pi d^2}{4} P = \pi d t \sigma_H$

$$\Rightarrow \sigma_H = \frac{dP}{4t}$$

(e) storing fluid in cylindrical containers are more cost effective. However, storing fluid in spherical tanks can half the hoop stress which means it has a better tolerance of high pressure. So some are stored in spherical tanks while others are stored in cylindrical containers.

(a). In fact, take an element as research object, every plane has shearing stress and normal stress. except the "principle plane". Only 2 planes don't have shearing stress, we call them "principle planes" and the normal stress of "principle planes", we call "principle stress".

(b). (i)

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

$$\Rightarrow \sigma_\theta - AC = r_{xy} AC \cdot \cos \theta \sin \theta + r_{xy} AC \cdot \sin \theta \cos \theta$$

$$\Rightarrow \sigma_{\theta} \cdot AC = 2 P_{xy} \cdot AC \cdot \sin \theta \cos \theta$$

$$\Rightarrow \sigma_0 = 2 \tau_{xy} \approx 0 \text{ MPa}$$

Remember: $2 \cos \theta \cos \phi = \cos 2\theta$

So $\sigma_0 = \tau_{xy} \sin 2\theta$

(iv) From AC direction:

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

$$\Rightarrow \rho_{\theta} AC = -\rho_{xy} AC \cdot \cos^2 \theta + \rho_{xy} AC \cdot \sin^2 \theta$$

$$\Rightarrow \cdot \varphi_{\theta} = -\varphi_{xy} \cos^2 \theta + \varphi_{xy} \sin^2 \theta$$

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

So $P_y = -P_{xy} \cos 2\theta$.

For each area

$$(L) \quad \sigma = \frac{P}{S} = \frac{45 \times 10^3}{800 \times 10^{-6}} = 56.25 \text{ MPa}$$

$$\text{So } \sigma_x = \sigma_y = 56.25 \text{ MPa}$$

$$\tau_{xy} = 0$$

From the formula sheet

$$\left\{ \begin{array}{l} \sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta \\ \tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y) \sin 2\theta \end{array} \right.$$

$$\sigma_{20} = \frac{1}{2}(56.25 + 56.25) + \frac{1}{2}(56.25 - 56.25) \cos 40^\circ$$

$$= 56.25 \text{ MPa}$$

$$\tau_{20} = \frac{1}{2}(56.25 - 56.25) \sin 40^\circ$$

$$= 0$$

For each end.. $\sigma = \frac{P}{S} = \frac{45 \times 10^3}{800 \times 10^{-6}} = 56.25 \text{ MPa}$ ✓

$$\text{So } \sigma_x = 56.25 \text{ MPa}$$

$$\sigma_y = 0$$

$$\tau_{xy} = 0$$

$$\sigma_{20} = \frac{1}{2}(56.25 + 0) + \frac{1}{2}(56.25 - 0) \cos 40^\circ$$

$$= 49.67 \text{ MPa}$$

$$\tau_{20} = \frac{1}{2}(56.25 - 0) \sin 40^\circ$$

$$= 18.08 \text{ MPa}$$

Question 3: (a) The design problem is more vaguely than the analysis problem. The analysis ~~has~~ problems have only one answer ~~while~~ whereas the design problem is a system having specified property, that is to say the ability to meet specific need. There may be many devices can meet the need.

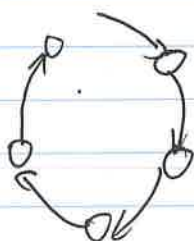
/ (3)

(b) The design problem is usually iterative, the solution to design problems ~~are~~ evolves so it may be continual refinement of the design. ~~It is that~~ It may be the case that while implementing the ~~solution~~ design, the solutions are found to be unsafe, too expensive or will not work. Hence, design ^{activities} ~~problems~~ are cyclic and iterative in nature. whereas an analysis problem has only one answer and has the sequential procedures. So an analysis problem is primarily sequential

/ (5)

~~(c)~~

(c)



There are 5 main steps to conduct design process.

1) define the problem — we should have a clear and unambiguous define of the problem. The followings may be considered:

Establish ~~that~~ customers need — what problem ^{is} the product solving?

Develop problem statement — You need to broad your problem definition especially what customers need.

Criteria for success — it involves ~~many roles~~ input from many roles such as scientists, managers, marketing and manufacturing

② gather relevant information — the followings should be considered
Is the problem real?
What's the exist solutions to the problem?
What's wrong with current solutions?
...

③ Generate multiple ^{solutions} ~~information~~ — the items following should be considered

Creative phase including brainstorm
Free the design team from taking risks
People from different principles should be involved.

④ Analysis and select one solution — the items following should be considered.

Functional Analysis
Economic and marketing analysis
Industrial Design
Safety and reliability.

⑤ Test and implementing ^{the solution} ~~under real condition~~.
Prototyping and test under real condition.
documentation
Apply patent for the design.

⑤

Question No.

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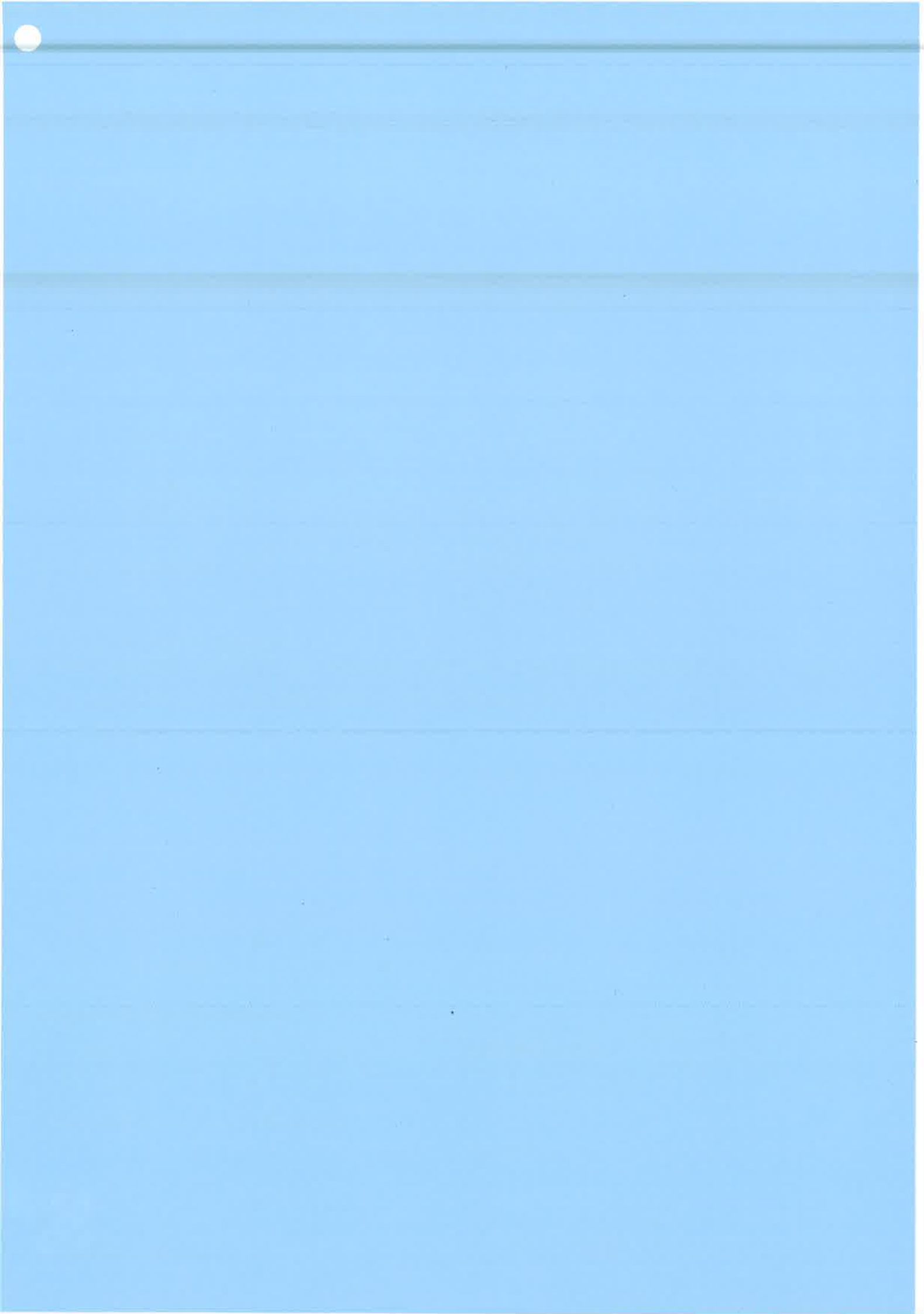
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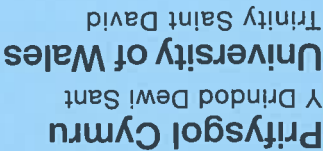
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Arholwr yn unig

f 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, plynwch et a'i seilio 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 sgript annarllennadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

4. Ysgriftennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

6. Ni ddylid rhwygo 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 gwyllwr/gwylwr.

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	Tell 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, plygwrch a seilwch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: