



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Examination Answer Books

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 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.**

Complete, fold and seal
(see note 2 below)

SURNAME:

HOPKINS

FORENAME(S):

IFAN ADAM

1	Student Number	1701085
2	Title of Examination Paper	CAE & STRESS ANALYSIS
3	Module Code	M5X02064
4	Date and Time of Examination	9/5/19 -12.00
5	Examination Venue	310
6	Seat Number	G051
7	Number of Answer Books handed in	

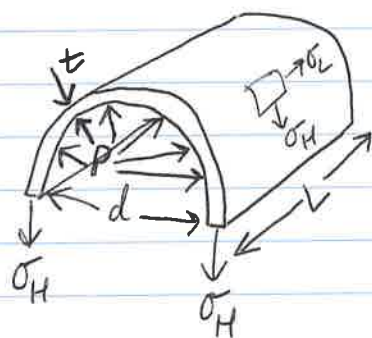
List the numbers of the questions you have attempted	Office Use
1	12
2	18
3	13
Total	43

(Gweler yr ochr arall am y fersiwn Cymraeg)

71.72



①(A)



Forces up = Forces down

Forces up due to pressure:

$$F = P \times A \\ = P \times dL$$

Forces down due to hoop stresses

$$\sigma = \frac{F}{A} \quad \therefore F = \sigma A \\ = (\sigma_H L t) 2$$

$$\therefore P dL = (\sigma_H L t) 2$$

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

①(B)(i)

$$\sigma_{H_{MAX}} = 200 \times 10^6 \text{ N/m}^2$$

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

$$t = 5 \times 10^{-4} \text{ m}$$

$$\text{Atmospheric pressure} = 101 \times 10^3 \text{ N/m}^2$$

$$P = \frac{\sigma_H 2t}{d} = \frac{(200 \times 10^6) 2 (5 \times 10^{-4})}{3.5}$$

$$\therefore P = 57.14 \text{ kN/m}^2 \quad (\text{INSIDE CABIN})$$

$$h = \frac{P}{\rho g} = \frac{57.14 \times 10^3}{1.22 \times 9.81}$$

Assuming density of air = 1.22 kg/m^3

$$\therefore h = 4,774.3 \text{ m}$$

$$\text{Therefore max altitude} = \frac{15,000}{2.0} \text{ feet}$$

①(B)(ii)

$$\text{Pressure at 8000 ft} = 75.3 \text{ kPa}$$

$$101 \times 10^3 - 75.3 \times 10^3 = 25,700 \text{ Pa}$$

$$P(-25,700) = \frac{(200 \times 10^6) 2 (5 \times 10^{-4})}{3.5}$$

$$P = 57,140 + 25,700 = 82,840 \text{ Pa}$$

$$h = \frac{P}{\rho g} = \frac{82,840}{1.22 \times 9.81}$$

$$\therefore h = 6921.7 \text{ m}$$

Max altitude = 20,000 feet

① (C)

Pressurizing the plane cabin allows the plane to fly at higher altitudes, where the air is less dense, therefore decreasing fuel consumption.

① (D)

~~* I'm assuming we are supposed to derive longitudinal stress σ_L *~~

Forces on walls due to pressure:

$$\begin{aligned} F &= P \cdot A \\ &= P \times \pi \left(\frac{d}{2}\right)^2 \\ &= P \times \pi \frac{d^2}{4} \end{aligned}$$

Forces due to hoop stress:

$$\begin{aligned} F &= \sigma \cdot A \\ &= \sigma_H \cdot \pi d t \end{aligned}$$

$$F \uparrow = F \downarrow$$

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

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

① (E)

Spherical tanks can withstand ~~more~~ greater internal pressures than cylindrical containers. Cylindrical containers can be stored more ~~* efficiently~~, therefore reducing storage costs. ~~* efficiently~~

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

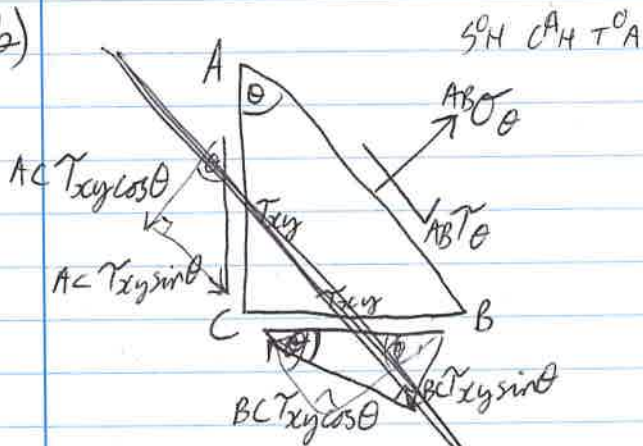
SPHERE: $\sigma_H = \frac{P d}{4 t}$

• Factor of 2 difference

- ② (a) Principal stress are the maximum and minimum stresses acting on the body. The principal plane is the plane at which these stresses act on. The two principal planes are 90° from each other.

3

② (b)

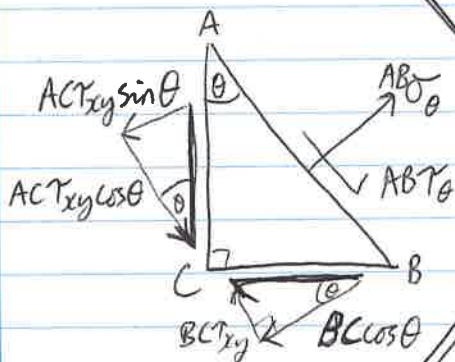


$$AB \sigma_\theta = AC \tau_{xy} \cos \theta + BC \tau_{xy} \sin \theta$$

Divide by AB

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

$$\sigma_\theta = \tau_{xy} (\cos^2 \theta + \sin^2 \theta)$$



$$\frac{AC}{AB} = \cos \theta$$

$$\frac{BC}{AB} = \sin \theta$$

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

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

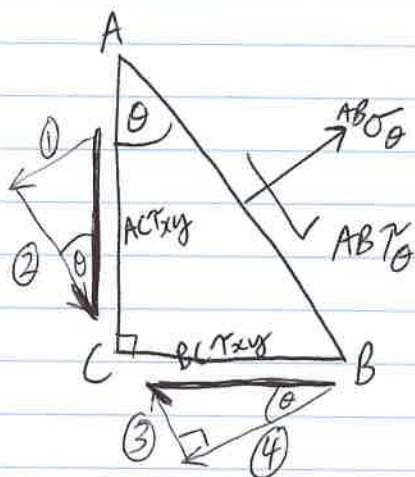
$$\therefore \sigma_\theta = \tau_{xy} \sin^2 \theta - \tau_{xy} \cos^2 \theta$$

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

$$\therefore \sigma_\theta = -\tau_{xy}$$

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

Divide by AB

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


$$\textcircled{2} = AC \tau_{xy} \cos \theta$$

$$\textcircled{3} = BC \tau_{xy} \sin \theta$$

$$\textcircled{4} = BC \gamma_{xy} \cos \theta$$

$$ABO_{\theta} = (1) + (4)$$

$$\therefore AB \sigma_\theta = AC \tau_{xy} \sin \theta + BC \tau_{xy} \cos \theta \quad (\div AB)$$

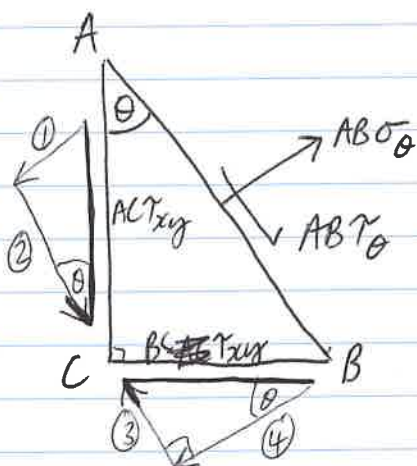
$$\therefore \sigma_{\theta} = \tau_{xy} \sin\theta \cos\theta + \tau_{xy} \cos\theta \sin\theta$$

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

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

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

(2)(B)(ii)



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

$$\begin{aligned} ① &= AC \tau_{xy} \sin \theta \\ ② &= AC \tau_{xy} \cos \theta \\ ③ &= BC \tau_{xy} \sin \theta \\ ④ &= BC \tau_{xy} \cos \theta \end{aligned}$$

$$AB \tau_{\theta} + ② = ③$$

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

$$\therefore AB \tau_{\theta} = BC \tau_{xy} \sin \theta - AC \tau_{xy} \cos \theta \quad (\div AB)$$

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

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

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

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

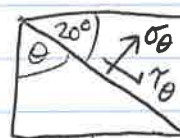
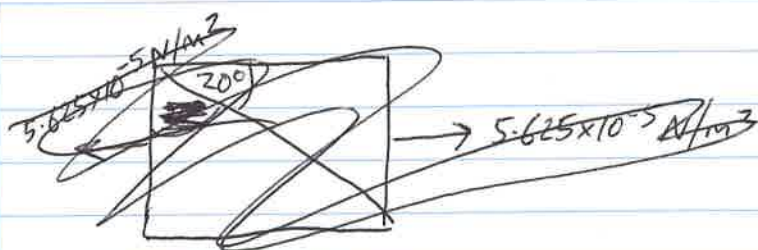
(5)

(2)(C)

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

$$F = 45 \text{ kN}$$

$$\sigma = \frac{F}{A} = \frac{45,000}{800 \times 10^{-6}} = 5.625 \times 10^{-5} \text{ N/m}^2 \quad \times$$



$$5.625 \times 10^{-5} \text{ N/m}^2$$

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

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

$$\text{Assuming } \sigma_x = 0$$

$$\sigma_{\theta} = \frac{1}{2}(5.625 \times 10^{-5}) + \frac{1}{2}(-5.625 \times 10^{-5}) \cos 140$$

$$\underline{\sigma_{\theta} = 4.97 \times 10^{-5} \text{ N/m}^2}$$

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

$$\tau_{\theta} = \frac{1}{2}(-5.625 \times 10^{-5}) \sin 140$$

$$\underline{\tau_{\theta} = -1.81 \times 10^{-5} \text{ N/m}^2}$$

X

(5)

③ (a) A design problem can have multiple different solutions, and generally the problem evolves. An analysis problem generally has less solutions, and the problem won't change as solutions are thought of. Analysis problems use specific methods to achieve, ~~whereas~~ whereas a design problem entirely depends on what design you are trying to achieve.

②

③ (b) Design problem

- Define the problem
- ~~Generate multiple solutions~~
- Gather relevant information
- Generate solutions to the problem
- Analyse the solutions
- Choose a solution and test. (Evaluate solution)

Shown above is 5 key steps to the design problem. Firstly the problem must be defined, this will include the PDS - product design specification. Relevant information must be gathered and questions like "Is there already a solution to the problem?" are asked.

Once this information has been collected, solutions to the problem are generated. The design problem is usually described as an iterative process as new information is found whilst generating solutions, therefore the previous steps are sometimes modified.

Analysis problems are primarily sequential as once the PDS has been created, specific analysis

solutions are used in order to deem whether the product is successful. Sometimes certain points on the PDS are more important than others, therefore a way of analysis must be created.

③ (c)

- British standard 7000 (based on Plank...)
- Plank and (1996)

One of the models emphasizes the use of human interaction with the product, early on in development (and throughout the design process). This can be costly since various prototypes need to be created in order for humans to test the product. It does however mean that feedback will be received early on in the design stage, allowing for various improved designs.

~~Plank and ... model emphasizes~~

One of the design problems focused on an iterative design process, with various iterations of the product created (I believe this was Plank and...). This would mean that there are various different solutions. An advantage of this would be the fact that there would

be many different designs to choose from, and likely mean a better product would be formed. A disadvantage of this is that the analysis step of the design process:

- Define the problem
- Generate solutions to the problem
- Evaluate solutions
- Gather relevant information
- Analyse solutions

... is that the analysis step would be long and costly.

A model based on sustainability has also been developed. A disadvantage of this is it can be more costly, and a longer process than some of the other methods.

On the other hand sustainability is very important in the design process, and a huge advantage of this method is the fact that you can reduce the environmental effect of a design.

I also remember of a Japanese method for the design process but do not remember the name.

(6)

Question No.

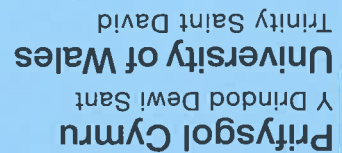
Examiner Only

Question No.

Examiner Only

Question No.

Examiner Only



12 Tüdalen

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y 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 llawysgriften ddarlennadwy. Gall yr Arholwyr naill ai anwybyddu sgrïpt annarllennadwy, 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 fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

6. Ni ddylid rhwgo 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 gwylwlr/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.

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	Tell y Papur Arholiad	
1	Rhif Myfyriwr	

Rhestrwch nffau'r cwestiynau a ymgeisiwyd gennych	
	At Ddibenion y Swyddfa

(See the other side for English version)

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: