



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: Martin

FORENAME(S): Ainsley Sam

1	Student Number	P149894
2	Title of Examination Paper	CAE & Stress analysis
3	Module Code	~~MSE~~ M5202064
4	Date and Time of Examination	09/05/17 12:00pm
5	Examination Venue	IQ
6	Seat Number	G039
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	18
2	17
3	~~10~~ 13
Total	48

(Gweler yr ochr arall am y fersiwn Cymraeg)

807



1
a) Forces $\uparrow$ = Forces $\downarrow$

$$\text{Forces } \uparrow = \text{Pressure} \times \text{Area} \quad P \times A$$

$$\text{Area} = d \times L \quad P \times dL = P dL$$

$$\text{Forces } \downarrow = 2\sigma_H \times t \times L$$

$$\therefore P dL = 2\sigma_H \times t \times L$$

L Cancel out

$$P d = 2\sigma_H \times t$$

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

b) i) $\sigma_H \text{ max} = 200 \text{ MPa} \quad d = 3.5 \text{ m} \quad t = 0.5 \text{ mm}$

$$P_{\text{max}} = \frac{\sigma_H \times 2 \times t}{d} = \frac{200 \times 10^6 \times 2 \times 0.5 \times 10^{-3}}{3.5} = 57.14 \times 10^3 \text{ Pa}$$

$$P \text{ at Sea level} = 101 \times 10^3 \text{ Pa}$$

$\therefore$ If the Cabin is pressurised at Sea level

$$101 \times 10^3 - 57.14 \times 10^3 = 43.86 \times 10^3 \text{ Pa}$$

From the table the highest the plane can fly is ~~25,000~~ ^{20,000} ft

ii) At 20000 ft $P = 75.3 \times 10^3 \text{ Pa}$

$$75.3 \times 10^3 - 57.14 \times 10^3 = 18.16 \times 10^3 \text{ Pa}$$

From the table the highest the plane can fly is ~~45000~~ ^{40,000} ft

(4)

(3)

(2)

- c) By matching the pressure of the plane cabin to the outside pressure the plane can fly higher as the forces inside are matching the forces outside. This stops the cabin from compressing or expanding to dangerous levels.
An advantage of this is there is better fuel economy if the plane can fly higher as there is less dense air, therefore there is less drag acting on the plane.

- d) Forces = Forces

$$PA = \sigma_H \times d \times \pi \times t$$

$$PR \text{ Area} = \frac{\pi d^2}{4}$$

$$\therefore \frac{Pd \pi}{4} = \sigma_H \cdot d \cdot t \cdot \pi$$

π Cancels out

d Cancels the square from d^2

$$\frac{Pd}{4} = \sigma_H t$$

$$\therefore \sigma_H = \frac{Pd}{4t}$$

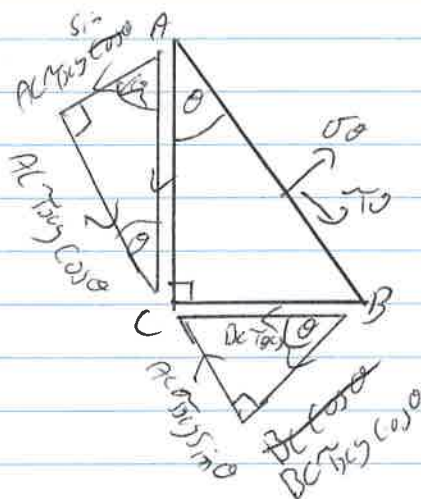
- e) A sphere is able to withstand more pressure which can be seen as when both the equations are rearranged for pressure.
Sphere $P = \frac{\sigma_H \times 4 \times t}{d}$ Cylinder $P = \frac{\sigma_H \times 2 \times t}{d}$

Therefore if both can take the same hoop stress and have the same thickness and diameter then a sphere can take 2x more pressure.

A cylinder is able to hold more volume than a sphere.

If the high volume low pressure is what is wanted then a cylinder should be used. If high pressure is required then a sphere should be used as it can withstand more pressure.

25i)



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

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

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

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

$$\frac{CB}{AC} = \tan \theta$$

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

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

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

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

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

$$\sigma_{\theta} = \tau_{xy} 2 \times \frac{1}{2} \sin 2\theta$$

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

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

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

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

$$\tau_{\theta} =$$

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

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

a

→
Next Page (Continue)

τ_{xy}

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

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

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

$$\sin \theta \times \sin \theta = \sin^2 \theta$$

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

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

 $\therefore \tau_{\theta} =$

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

Q) 800 mm^2 (SA) ten force 45 kN 20°

We know

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

and

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

$$\text{Area} = \frac{\pi d^2}{4}$$

 $d =$

$$\sigma_{\theta} = \frac{1}{2} (45 \times 10^3) + \frac{1}{2} (45 \times 10^3) \cos 2(20)$$

$$= 39.74 \times 10^3 \text{ N/m}^2$$

$$\tau_{\theta} = \frac{1}{2} (45 \times 10^3) \sin(40)$$

$$= 14.46 \times 10^3 \text{ N/m}^2$$



2a) $\tan \theta = \left(\frac{\sigma_p + \sigma_x}{\sigma_y} \right)$ $\sigma_p = \text{Principle Stress}$

Principle Plane is the plane where the principle stress is acting

2

Principle Stress is the stress acting in the principle plane.

3a) A design problem is a problem that arises during the design stage. There are many solutions to the same problem. Design problems are solved ~~itself~~ in iterations.

An analysis problem typically only has one solution and are solved sequentially.

✓ (3)

b) A design problem is usually iterative as there are many possible solutions to the same problem. This means one idea can be tested and after each test changes big or small can be made to improve the way the problem is being solved. The problem can be looked at in different ways from different angles.

An analysis problem is usually sequential as there is typically only 1 solution to the problem there is no need to do multiple iterations. The analysis has been done to find the best solution.

✓ (4)

c) ~~The Five~~ The Five Step Process

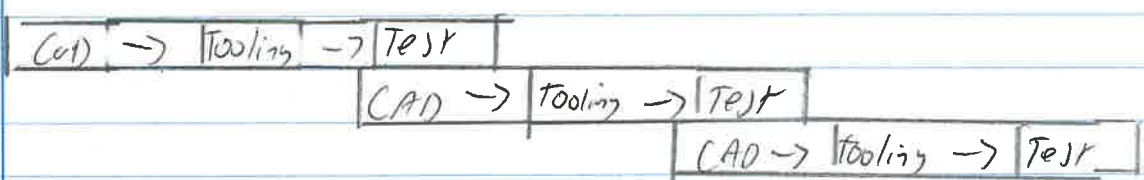
One advantage of the five step process is there is a constant design loop ~~until~~ until the design is completed which in theory should result in a more refined product.

One disadvantage is that it can be a long process overall and time can be wasted.

- 1) Identify the problem
 - What does the customer want
 - What is the end goal
- 2) Conduct research
 - What have other companies done
 - What was good/bad about previous solutions
 - Does the problem need to be solved
- 3) Create multiple solutions
 - Work with all areas of the team to create a variety of solutions
- 4) Select and analyse solutions
 - Look at all the available solutions
 - Analyse the safety, ergonomics, efficiency of the product
- 5) test and implement solution
 - Test the solution under real world conditions
 - File for patents to protect the products integrity

3

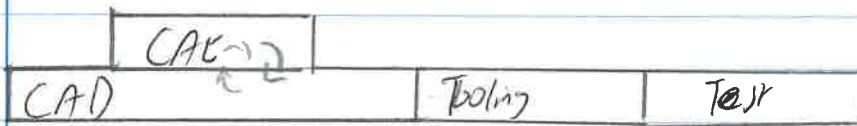
CAD lead design



time →

A CAD lead design is when a CAD model is produced, a prototype is made then it is tested.
one advantage of this is accurate data can be gathered from the real life testing
one disadvantage is it can be expensive especially if lots of prototypes have to be produced.

CAE lead



CAE lead is when a CAD model is produced and a virtual prototype is made in CAE. This has a feed back loop until both engineers are happy and a physical prototype is made.

one advantage is many designs can be made but since they don't have to be manufactured it reduces the price.

one disadvantage is if the CAE is not validated the results can be inaccurate.

CAE Lead (Early)



When CAE is introduced earlier it can reduce the overall time of the project and typically reduce the overall cost.

one advantage is the project can be completed in a shorter time which means a company can take on more projects.

one disadvantage is the customer might not like the design produced in CAE and want to see a CAD model first.



Question No.

Examiner Only

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Arholwr yn unig

Rhif y Cwestiwn



Question No.

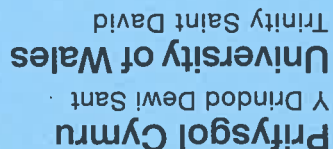
Examiner Only

Question No.

Examiner Only

Arholwr yn unig

hif y Cwestiwn



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 ddarllenadwy. Gall yr Arholwyr naill ai anwybyddu sgrifft annarllenadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

4. Ysgriennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw tras 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 gwyliwr/gwyliwyr.

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 unthwy amgylchiadau.

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

[illegible]

(See the other side for English version)

Llenwch, plygwrch a seilwch
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: