



SURNAME: Farnhill

FORENAME(S): Herry

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.**

1	Student Number	148876
2	Title of Examination Paper	LAE and stress analysis
3	Module Code	MSX02064
4	Date and Time of Examination	4/5/19
5	Examination Venue	IQ building room 310
6	Seat Number	6052
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	(7)
2	17
3	13
Total	37

(Gweler yr ochr arall am y fersiwn Cymraeg)

6177



1) $pdl : \sigma_H$ $pdl : 2\sigma_H$

$$\frac{pdl}{2H} = \sigma_H \quad \frac{pdl}{2H} = \sigma_H$$

b) $\sigma_H = 200 \times 10^3$
 $d = 3.5$
 $f = 0.5 \times 10^3$

$$\frac{pdl}{2H} = \sigma_H$$

$$\frac{2\sigma_H}{d} = p$$

$$\frac{15,000 \text{ feet}}{20,000 \text{ feet}} = \frac{2 \times 0.5 \times 10^3 \times 200 \times 10^3}{3.5} = 57.14 \text{ MPa}$$

at sea level = $2 \times 0.5 \times 10^3$

$$\frac{57.14}{101 \times 10^3} = 5.64 \times 10^{-4}$$

$$= 56.57 \text{ mm}^2$$

$p = 101 \times 10^3$
 $d = 3.5$
 $f = 0.5 \times 10^3$

$$\frac{pdl}{2H} = \sigma_H = \frac{101 \times 10^3 \times 3.5}{2 \times 0.5 \times 10^3}$$

$p = 101 \times 10^3$ $p = \frac{101 \times 10^3 \times 4.81}{0.56 \times 4.81} = 18385 \text{ feet}$

$p = p_{gh}$

$p = 101 \times 10^3$ $p = \frac{101 \times 10^3}{0.56 \times 4.81} = 4995.7 \text{ MPa}$

$p = 0.768 \times 4.81 \times 8000 = 30,000 \text{ feet} = 25,000 \text{ feet}$

ii) $\frac{75.3 \times 10^3 \times 3.5}{2 \times 0.5 \times 10^3} = 26$

$\sigma_H = \frac{pdl}{2H}$

$\frac{57.14}{75.3 \times 10^3} = 7.58 \times 10^{-4} (100) = 75.8 \text{ cm}$

$\frac{p}{p_{xy}} = \frac{75.3 \times 10^3}{0.75 \times 4.81}$

$= 10.239 \text{ m}$

$= 33,000 \text{ feet}$

d) $\frac{\rho d^2}{4} = \sigma_H \rho_{at}$

$$\frac{\rho d^2}{4} = 0.1$$

$$\frac{\rho d}{4} = 0.1$$

c) The plane can fly higher with the passengers been at a comfortable ambient pressure in the plane

e) depending on the fluid

Sphere

$$\sigma_H = \frac{2 \times 3}{4 \times 0.5 \times 10^3}$$

$$= 3 \text{ MPa}$$

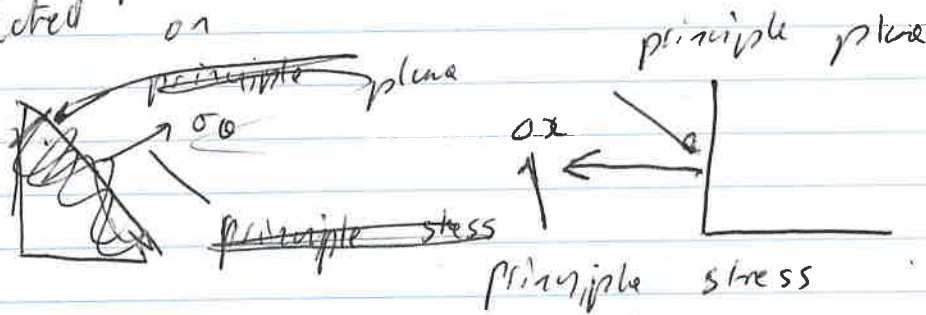
Cylinder

$$\sigma_H = \frac{2 \times 3}{2 \times 0.5 \times 10^3}$$

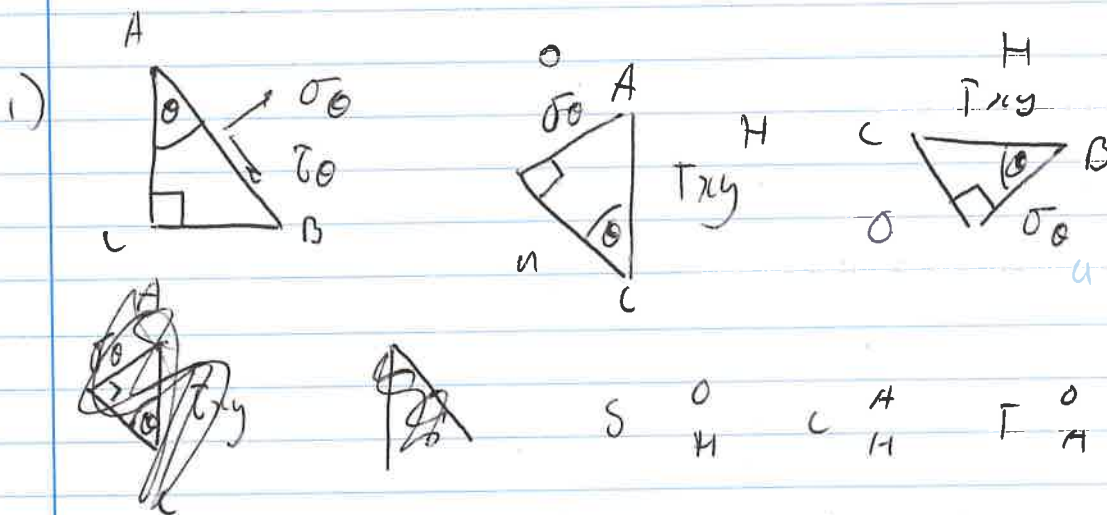
$$= 6 \text{ MPa}$$

A cylinder tank can store more liquid at the same pressure as a sphere tank so would depend on the viscosity and density of the liquid. For a higher viscosity liquid one would store in a cylinder tank compared to a low viscosity liquid.

- 2) principle stress is the force that is acting on
away from a plane
principle plane is where the force has
acted on



(2)



$$AC \tau_{xy} \sin \theta \quad BC \tau_{xy} \cos \theta$$

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

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

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

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

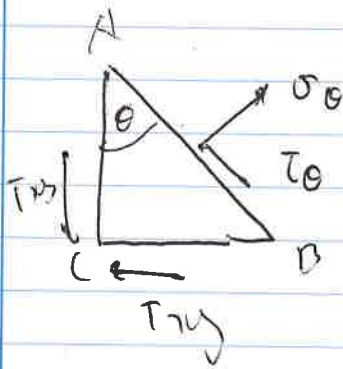
$$\sigma_{\theta} = 2 \tau_{xy} \cos \theta \sin \theta$$

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

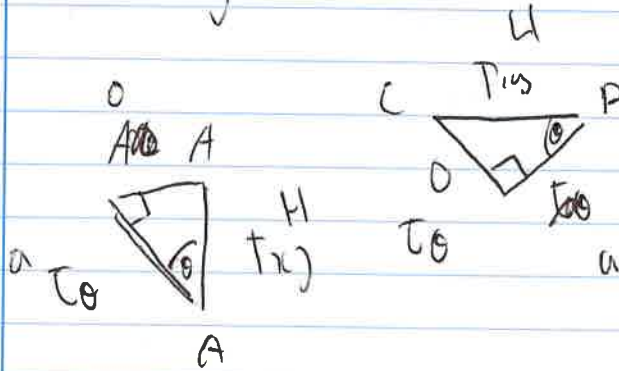
$$\sigma_{\theta} = \tau_{xy} \sin 2\theta$$

(5)

ii



$$S \quad \begin{matrix} 0 \\ 1 \end{matrix} \quad \begin{matrix} A \\ H \end{matrix} \quad \begin{matrix} 0 \\ 1 \end{matrix} \quad A$$



cos

sin

cos theta

sin theta

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

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

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

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

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

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

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

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

(K)

e)

$$\frac{800 \times 10^3}{45 \times 10^3}$$

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

$$= \frac{40 \times 10^3}{800 \times 10^3}$$

$$= 50 \text{ MPa}$$



$$\begin{aligned}\sigma_y &= 50 \times 10^3 \\ \sigma_x &= 0 \\ \tau_{xy} &= 0\end{aligned}$$

$$\begin{aligned}\sigma_\theta &= \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta \\ &= \frac{1}{2}(50 \times 10^3) + \frac{1}{2}(-50 \times 10^3) \cos 2 \times 20 \\ &= 5.848 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\tau_\theta &= \frac{1}{2}(\sigma_x - \sigma_y) \sin 2\theta \\ &= \frac{1}{2}(-50 \times 10^3) \sin 2 \times 20 \\ &= -16 \text{ MPa}\end{aligned}$$

ECF

⑥

3) • a design problem is a vague broad problem that will take a long time to fix - a design specification will be made to fix the problem

• An analysis problem is a very specific problem that will need a lot of time investigating a very specific issue with the component. For example bolt heads shearing under high load - analysis problem to solve

b)

A design problem will be an iterative process as there will be lots of different ideas to look at the solutions. For example a mountain bike uses all of its suspension travel damping the shock absorber ~~and not~~ ~~minimising~~. The ways to solve this would be

- Change spring rate
- alter weight distribution
- increase suspension travel
- alter frame geometry
- ~~change~~ reduce frame mass.

These are all very ~~iterative~~ iterative ideas with lots of different ways to solve the problem, there isn't necessarily one correct solution. Could be a variation or range of ideas.

An analysis problem is usually sequential because the engineer will look over the previous steps to see where the problem occurred to find the solution and really understand the problem.

(2)

for example a mountain biker snaps his frame. The engineer will look at:

- where was the snap snap
- ~~forces~~ and dir direction and forces acting on the frame
- condition of the frame
- geometry of the frame
- FEA or ~~analysis~~ frame

all of these steps will be step by step process to find exactly where the problem is. This could go back and forth a lot depending on the problem. for example

look at the direction and force of the snap, input this into the FEA, prototype the model. if the snap still occurred return back to the FEA

- (c) ~~one solution~~ one of the models to find a ^{solution} design problem is a step by step guide

define the problem

- Vague statement about problem
- fill a design specification for the problem
- success criteria that needs to be achieved
- budget and timescale of the solution

relevant information

- find kind specific areas that need to be improved
- what people will need to be involved in the process
- appoint people from various areas to find the solution

multiple Solution

- a creative brainstorm from lots of different engineers to solve the problem
- figure out which the best idea will be from a various range of ideas
- how much does each solution meet the success criteria and specification
- find cost and timescale of each solution to find the most efficient solution

Evaluate Solution

- How close does it meet the success criteria
- ^{timescale} ~~budget~~ and cost of the solution
- does it cause the component to be massively redesigned

Test the Solution

- does it meet the required standards
- does it have the mechanical strength
- does it meet regulation standards
- does it match the ~~the~~ design specifications
- ~~it~~ could the customer be inclined to buy it
- does it have a unique selling point

The advantages of studying this method is that the problem is being solved 1 step at a time and not missing any vital areas of information. It allows time for people to solve a big issue without being rushed.

A disadvantage is that this can be a very long process to solve a small issue. In the criteria is set very vague when the problem hasn't really been solved. These advantages and disadvantages are about all the steps above.

Another way of solving problems is through FEA

Simple

Split

- Split the geometry down into finite elements
- ~~At the~~ p is the element is 1D, 2D or 3D
- ~~can~~ the model be meshed correctly enough for accuracy

Interpret the geometry

can the model be solved in a reasonable amount of time for a reasonable level of accuracy.

Very complex small ~~mesh~~ nodes that increase solving time but have a very insignificant effect can be ignored

Material

~~can the~~ ~~is~~ is the material loaded into the FEA model to determine whether it is linear or non linear.

If the incorrect material is loaded then it could lead to poor correlation

physical property

if the element is 1D or 2D the ~~correct~~ material the geometry wrongly selected to the model. if the model is 3D is the is correct geometry and thickness

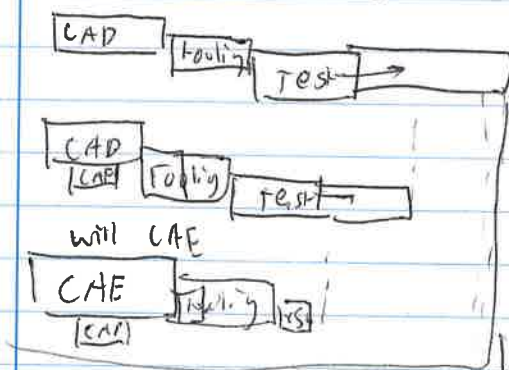
loading

- is the model being loaded in the correct direction and correct forces acting on the model.
- are the boundary conditions known

evaluate

How many significant figures is accurate, its only an approximation without prototyping garbage in = garbage out.

or below is a CAE diagram without CAE



Before CAE very the process would take a lot

longer as there would need to be a lot more manufacturing and generating CAD models.

more CAE reduces costs and generates the prototype faster, the customer and supplier can know the performance

CAN lead to poor correlation from too much CAE and not enough prototyping.

The advantages and disadvantages have been described
by the design process and CAE.

3



Question No.

Examiner Only

Arholwr yn unig

Ynif y Cwestiwn

12 Tüdalen

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

[illegible]

(See the other side for English version)

CYFENW:

ENW(AU) CYNTAF: