



12 Pages

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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.
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5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
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SURNAME:

Dougha)

FORENAME(S):

Dimitris

List the numbers of the questions you have attempted	Office Use
1	20
2	18
3	$8\frac{1}{2}$
Total	$46\frac{1}{2}$

77.5%



1)

a. Forces applied in half of the cylinder = pressure $\times$ Projected Area
 $= p \times dL$

Resistan Force $= 2 \times \text{hoop stress} \times \text{thickness} \times \text{length}$
 $= 2\sigma_H tL$

Therefore $p dL = 2\sigma_H tL$

Therefore the hoop stress :

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

/ (4)

b.

$$\sigma_H = 200 \times 10^6 \text{ Pa}$$

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

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

$$\sigma_H = \frac{pd}{2t} \quad (\Rightarrow) \quad p = \frac{\sigma_H \times 2t}{d}$$

$$p = \frac{200 \times 10^6 \times 2 \times 0,5 \times 10^{-3}}{3,5}$$

$$p = 57,14 \text{ kPa}$$

/

i) Maximum altitude $101 - 57,14 = 43,86 \text{ kPa}$

This pressure is at 25,000 feet.

/ (4)

ii) If the cabin pressurized at 8000 ft

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

So the maximum altitude will be at 40,000 feet

/ (3)

c. The advantage of pressurizing plane cabins
 it allows the airplane to fly higher
 where there is less air resistance therefore
 it is saving fuel.

/ (2)

d.

$$\text{Force applied on sphere} = \text{Pressure} \times \text{projected Area} \\ = p \frac{\pi d^2}{4}$$

$$\text{resistance force} = \text{thickness} \times \pi d \times \sigma_y$$

$$\text{Therefore } \sigma_H \pi d t = \frac{p \pi d^2}{4}$$

$$\text{Therefore } \underline{\sigma_H = \frac{pd}{4t}}$$

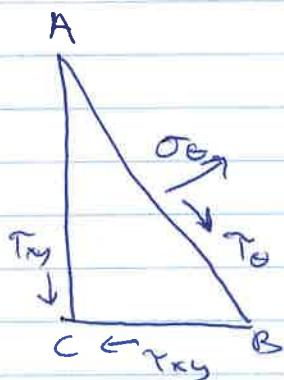
e) In the cylindrical containers you can have more quantity ~~more~~ stored compare to the spherical tanks. On the other ~~side~~ side in the spherical tanks you can store oil having higher pressure.

a. Principal Stresses are the minimum and maximum values a complex stress material can have.

Principal Plane are the point at which principal stress acts on.

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b.



We can say that

$$AB \sigma_\theta$$

$$AB T_\theta$$

$$BC T_{xy} \cos \theta$$

$$AC T_{xy} \sin \theta$$

We take the forces parallel

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

Divide by AB

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

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

but $BC = AB \sin \theta$ and $AC = AB \cos \theta$

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

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

So $\sigma_\theta + T_{xy} \cos \theta \sin \theta = T_{xy} \sin \theta \cos \theta$

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

$$\sigma_\theta = 2 T_{xy} \sin \theta \cos \theta \quad \text{but} \quad \sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$$

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

$$\underline{\sigma_\theta = T_{xy} \sin 2\theta}$$

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

Divide by AB

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

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

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

Divide by AB

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

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

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

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

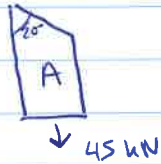
$$T_{\theta} = T_{xy} (\sin^2 \theta - \cos^2 \theta)$$

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

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

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C.



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

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

$$\sigma_y = \frac{F}{A} \Rightarrow \sigma = \frac{45 \times 10^3}{800 \times 10^{-6}}$$

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

For the normal stress

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

$\sigma_x = 0$

$$\sigma_\theta = \frac{1}{2} \sigma_y + \frac{1}{2} \sigma_y \cos 2\theta$$

$$\sigma_\theta = \frac{1}{2} 56,25 + \frac{1}{2} 56,25 \times \cos 2 \times 20^\circ$$

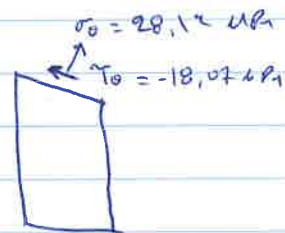
$$\sigma_\theta = 28,12 \text{ MPa}$$

For the shear stress

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

$$\tau_\theta = - \frac{56,25 \times 10^6}{2} \sin 40^\circ$$

$$\tau_\theta = -18,07 \text{ MPa}$$



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a. At an analysis problem there can be only one solution whereas in the Design Problem there can be a multiple solutions. The design problem is a long process that there can be a solution to a specific problem but there are parameters that we have to consider like the cost, time, performance. That is why a design problem is an iterative process.

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b. On a design problem there are a lot of different options on how to approach the problem and see how these options can affect the results and if the results are the one an engineer desire. There are also others in the line that have to interfere with the project like marketing, management.

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c. The design process should be carried out by

1) Define the problem

- why do we need to find a solution?
- how do we need to find the solution?

2) Gather information

- Do a research about the problem
- Market research and needs
- Collect all the data from similar projects

3) Generate a solution

- After we defined the problem we have to find the solution

- Think all the parameter of the solution
- include different ideas and new ideas

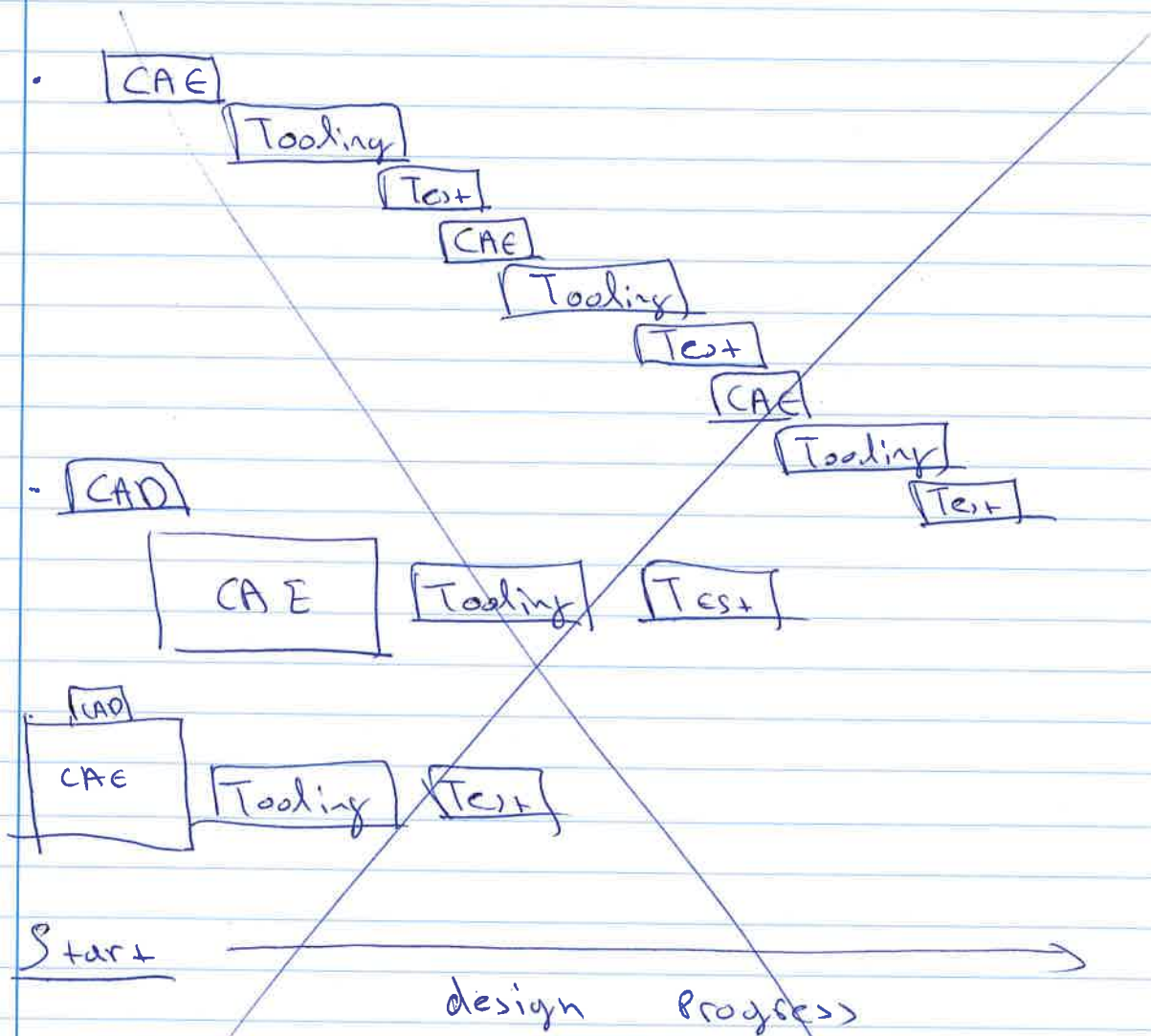
4) Analyse and choose a solution

- how it affect the industry
- Manufacturing
- Building it
- Safety consideration
- Environmental affect
- Specifications and Regulations

5) Test and Implementation

- Build a prototype
- Test before proceed to release

(3)



From the diagram above we can see how with the use of CAE we can have results much faster than choosing any other way. That save a lot of time and reduces the cost significantly.

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Question No.

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i)

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

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

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

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

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

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

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

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



$$-w_x$$

$$-\frac{wx^2}{2}$$

$$\frac{wLx}{2} - \frac{wx^2}{2}$$

$$\frac{wL^2}{4} - \frac{wx}{2}$$

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

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

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

$$\sigma_H t = Pd$$

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

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

$$P = 57,14 \text{ kPa}$$

See lead

$$101 - 57,14 = 43,86 \text{ kPa} \quad 25.000 \text{ Pa}$$

~~101~~ -

$$75,3 - 57,14$$

$$\sigma_H \pi d t = \rho \pi d^2$$

$$\sigma_H = \frac{\rho d}{4t}$$



$$AB \sigma_\theta = AC \cos \theta + BC \cos \theta$$

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

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

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

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

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

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

