

MATEUSZ DAMIEL SKOCZYLAS (1704045)
CAE and stress analysis exam (MSX02064)
02/05/2020, 1PM-3PM

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Q2) a)

process
(A)

Define the problem → user/customer requirements (problem plan)
→ feedback to use as criteria for making a successful outcome (e.g. input from manufacturing, marketing, management and scientists/engineers)

→ make up problem statement - address and indentify needs, but not detailed enough to preclude possible solutions

process

14 (B)

Gather relevant information

→ is the problem realistic? is the initial statement defined correctly / accurate?

→ ~~Inde~~ Research existing solutions to see if the problem has already been solved or not, if not then new solution is required

↳ If ~~exi~~ solutions already exist, analyse what is wrong with them / what can be improved, and what is being done correctly

→ Look at the industry side of things, to see what companies manufacture existing solution

→ Analyse the financial side of things to find out what economic factors govern the ~~the~~ solution to problem

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Q2) a) (CONTINUED)

→ Analyse target market (find out how much customers are willing to pay ~~and~~ research safety, environmental ~~is~~ issues, ~~ergonomics~~ and aesthetics).

③ Generate multi

process

③ Generate multiple ideas/solutions

→ during this creative brainstorming process, allows for choosing the best solution

→ Design The process of design ~~sho~~ should allow for ~~risk taking~~ ~~the~~ risk taking designs

→ use the process of synthesis of new ideas to solve the design problem

→ people from all range of departments/disciplines should be involved to allow for creating the best possible solution.

process

④

Analyse and select solution

There are a range of different analysis that can be carried out, including;

- Manufacturing / testability
- Product safety
- Reliability analysis
- Regulations / standards
- Market / economic analysis
- Functional analysis
- Industrial design and ergonomics
- Electrical / electromagnetic analysis
- Mechanical / strength analysis

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Q2)a) (CONTINUED)

process

(E) Test and implement solution

- Prototype the solution and test under real life conditions. This can be used to correlate the analytical work in process D to make sure the solution is meeting requirements/needs. Rapid and contemporary manufacturing techniques such as 3D printing can be used.
- ~~Do~~ Produce documentation. This might be needed if legislative testing is needed or audit is carried out, to prove the testing done.
- ~~File~~ applications for patents to protect the design.

Q2)b)

~~FEA can~~ by integrating FEA into the design process. The FEA process can be integrated into process D (analyse and select solution).

By carrying out FEA during this process, the solution can be ensured to meet safety standards through stress analysis / ~~max~~ factor of safety requirements. This also allows for simulating fatigue (reability), mechanical strength. The FEA process should be used alongside models made in CAD.

FEA to some extent can also be used in process C (generating multiple ideas/solutions) combined with CAD modelling using an iterative process to come up with most optimised solution. This makes the process quicker / more efficient.

40 min per question

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Q1)a) Upwards force:

$$F = P \times A$$

$$F = P \times dL$$

Downwards force:

$$F = 2 \sigma_H \times tL$$

thus

$$2 \sigma_H tL = PdL$$

$$2 \sigma_H t = Pd$$

thus

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

Q1)b)

hoop stress is twice as large as longitudinal stress, thus it is the limiting factor. the following can be seen;

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

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

Q1)c)

$$1.0255 \text{ kg/m}^3$$

Q1)d)

$$P = \rho gh$$

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

$$h?$$

thin cylinder

$$t = 5 \text{ mm}$$

$$F_s = 2.1$$

$$\text{yield } P_{\max} = 200 \text{ MPa}$$

$$P_i = 0$$

$$\frac{P}{\rho g} = h$$

$$\frac{400000 \times 10^3}{1.0255 \times 9.81} = 39760.82 \text{ m}$$

$$P_{\max} = \frac{2 \sigma_H t}{d}$$

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

$$= 400000 \text{ kPa}$$

hoop stress

1.0255

Q1) e) $P = 200 \text{ MPa} - 0.1 \text{ MPa} = 199.9 \text{ MPa}$ *

↑
new effective
pressure difference

not in order
↘

Q1) f) ~~The~~ The ~~si~~ real submarine is not an ideal thin walled cylinder. It contains much more complexity. ~~(extra components etc structural)~~
e.g. extra moulding ~~foraging~~ seams which impact structural integrity, furthermore, thin wall cylinder theory is only an approximation.

Q1) f) $P = 200 \text{ MPa} - (0.1 \times 2) = 199.8 \text{ MPa}$

Q1) g) The values are ideal not realistic

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~~Q4) a)~~ Q4) a)

$$\left[\begin{array}{l} \cos \theta \sin \theta = \frac{1}{2} \sin 2\theta \\ \sin \theta \cos \theta = T_{xy} \sin 2\theta \end{array} \right]$$

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

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

$$AB \cos \theta = AC$$

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

$$AB \sin \theta = BC$$

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

$$\begin{aligned} \sigma_{\theta} &= T_{xy} \sin \theta \cos \theta + T_{yx} \sin \theta \cos \theta \\ &= 2 T_{xy} \sin \theta \cos \theta \end{aligned}$$

Q4) b)

$$\tau_{\theta} = 84 \text{ MPa}$$

direct stress

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

$$\cos$$

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

$$\sigma_{\theta} = (84 \times 10^6) \sin (2 \times 59) = 74167597.8 \text{ N/m}^2$$

Q4 d) When load is applied exactly at 45°

Q4 e) this is unlikely to happen as typically the force is not applied directly at 45° especially in a real world situation