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

LOCATION: SWANSEA | **LLEOLIAD: ABERTAWE**

LEVEL 5 | **LEFEL 5**

EXAMINATION PERIOD | **CYFNOD ARHOLIADAU**
MAY 2020 | **MAI 2020**

MODULE CODE:
M5X02064: CAE & Stress analysis

TIME: 2 HOURS

ANSWER THREE OUT OF FOUR QUESTIONS

Equipment or materials required – None

Adnoddau neu ddefnyddiau sydd eu hangen – Dim

A formula sheet is provided for reference.

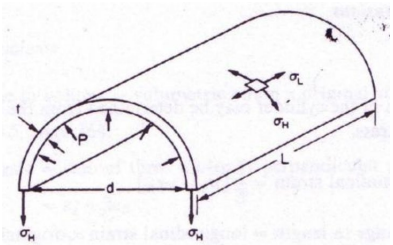
University approved calculators are permitted.

Assume 'g' = 9.81 m/s^2.

Question 1

a) Given the diagram below, prove that the hoop stress in a thin cylinder is given by $\sigma_h = \frac{Pd}{2t}$

[3 marks]

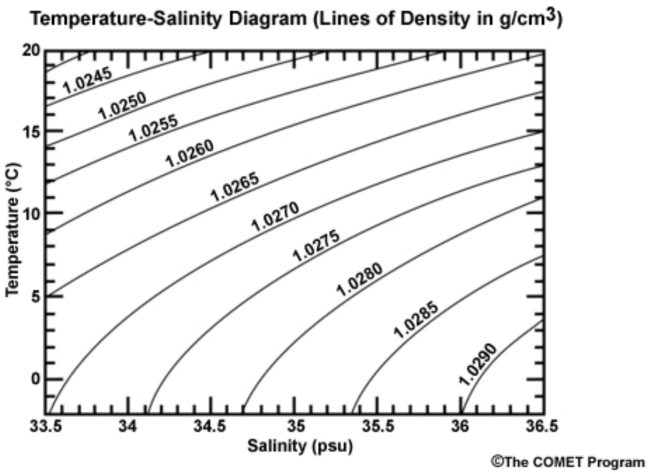


b) Explain why for a thin cylinder that this is the limiting factor. Relate this to the longitudinal stress seen in such structures.

[2 marks]

c) In an ocean where the salinity is 33.5psu and the temperature is 5^0C, using the below graph, find the density of the sea water in m^3/Kg to the nearest increment shown.

[1 mark]



d) Given $P=\rho gh$ were P is pressure, ρ = density and h = height (or depth). In a submarine that can be considered to be a thin cylinder, 4.4m in diameter with a wall thickness of the outer skin of 4.4mm, find the depth that this submarine can dive to without exceeding the yield stress of the skin with a factor of safety of 2.1, (assume that the Yield stress of this material is 200MPa), in the ocean considered in (c). Assume that there is zero pressure inside the submarine.

[3 marks]

e) What depth does this increase to if the submarine is sealed with atmospheric pressure inside. (Assume that atmospheric pressure is 0.1MPa.

[2 marks]

f) If the inside of the submarine could be pressured to twice atmospheric pressure, what depth could the sub now dive to without exceeding the yield stress of the skin of the submarine?

[2 marks]

g) Comment on the values obtained in (d) (e) and (f).

[2 marks]

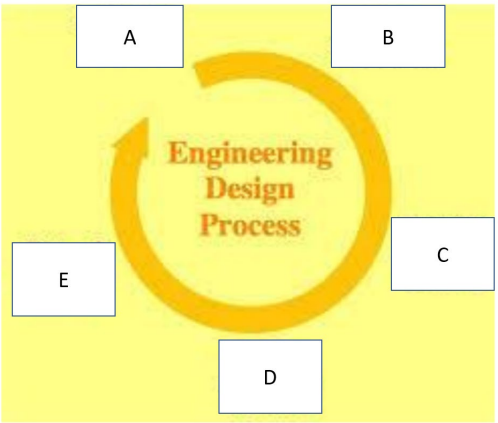
f) Discuss why the results considered in this question may differ to the real scenario.

[5 marks]

Question 2

a) The design process can be split down into 5 tasks as shown in the below diagram. Identify and discuss each of these tasks

[15 marks]



b) Discuss which of these steps could benefit from FEA and how these may be influenced by integrating this.

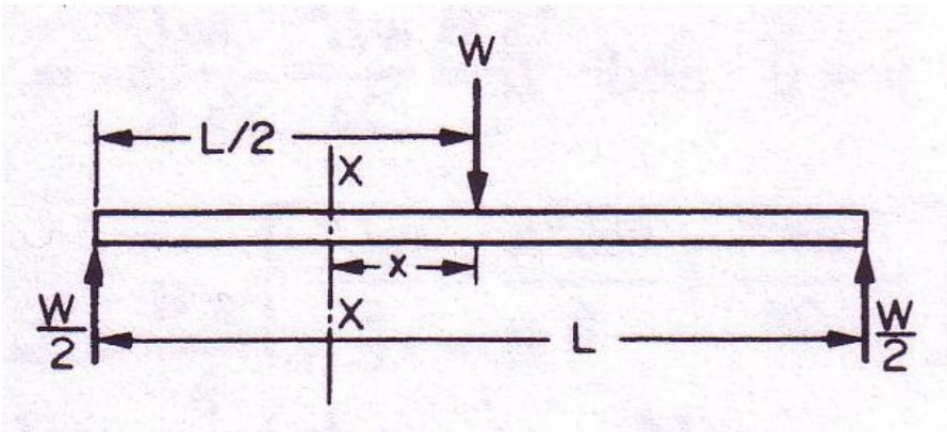
[5 marks]

Question 3

a) Given the below diagram and the standard relationship for slope and deflections of beams of $M_{xx} = \frac{EId^2y}{dx^2}$, prove that the deflection anywhere on the beam, y, may be given by the following relationship

$$y = \frac{1}{EI}\left[\frac{WLx^2}{8} - \frac{Wx^3}{12} - \frac{WL^3}{48}\right]$$

[8 marks]

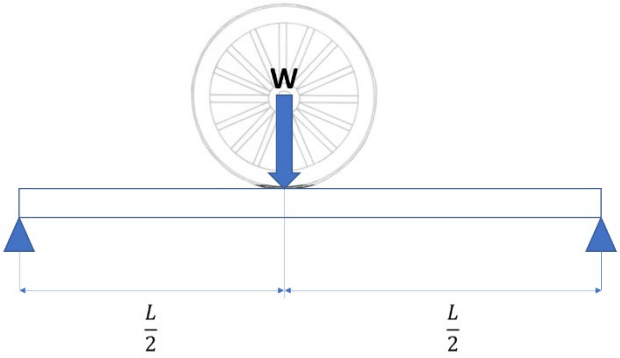


b) Hence prove that the maximum deflection is given by $y_{max} = \frac{-WL^3}{48EI}$

[2 marks]

c) Consider the below section of damaged railway track. In order to ensure that a train may pass safely over this without derailment, the centre deflection must not exceed 10.5mm. The track may be considered to be simply supported at each end and the load (W=45kN) from the train wheel on each track may be considered as shown in the below figure. If the track is made from steel (E=223GPa) and the second moment of area of the track (I) is $68 \times 10^{-6} m^4$, what is the maximum safe span for the unsupported section of track?

[3 marks]



d) Discuss why the results considered in this question may differ to the real scenario.

[6 marks]

e) What else should be considered during analysis such as this?

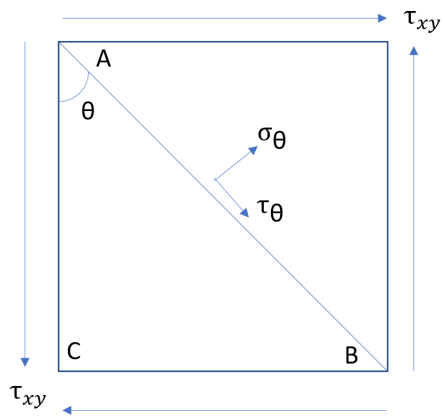
[1 mark]

Question 4

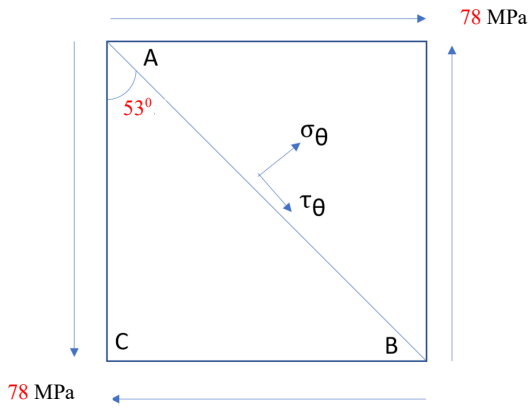
a) By considering the element shown below that is subjected to shear stress only, prove that the direct stress (σ_θ) is given by the following expression given the relationship cosθ sinθ = $\frac{1}{2} sin2\theta$

$$\sigma_\theta = \tau_{xy} sin2\theta$$

[10 marks]



b) Given the below situation where an element is subjected to a shear stress of 78MPa on the planes shown, calculate the direct stress seen on the plane AB.



[3 marks]

c) Given the relationship $\tau_\theta = -\tau_{xy}\ cos2\theta$ calculate the shear stress on the plane AB.

[2 marks]

d) Describe a situation where a piece of material may be assumed to be subjected to a shear stress only.

[2 marks]

e) Discuss why this is unlikely to happen.

[3 marks]

Diwedd/End