UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	AIRCRAFT STRUCTURE
COURSE CODE	:	BDU 20103
PROGRAMME	:	BDC/BDM
EXAMINATION DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Briefly explain about plane strain and plane stress.

(4 marks)

(b) The 60° strain rosette is mounted on the aircraft A380 vertical stabilizer as shown in **Figure Q1(b)**. Due to the loadings during flight test, the readings from the gauges give $\varepsilon_a = 60(10^{-6})$, $\varepsilon_b = 135(10^{-6})$ and $\varepsilon_c = 264(10^{-6})$. Determine.

(i) The average normal strain.

(ii) The in plane principal strains and the directions in which they act. Sketch the deformed element for principal strains.

(iii) The maximum and minimum in-plane shear strains.

(iv) The principal stresses at that point.

(16 marks)

Q2 (a) (i) State the two disadvantages of the Integration Method in solving complex beam deflection problems.

(ii) Define the elastic curve.

(6 marks)

(b) The wing spar of Pilatus PC-12 is subjected to a triangular distributed loading as shown in **Figure Q2(b)**. Determine:

(i) Reactions at the supports and sketch the Free Body Diagram of the spar.

(ii) The equations of the elastic curve for $0 \leq x \leq L/2$ (in terms of EI).

(iii) The slope at A and the maximum deflection (in terms of EI).

(14 marks)

Q3 (a) Explain buckling of column phenomenon and state the assumption made in applying Euler's formula to determine critical load.

(4 marks)

(b) Define the column and critical load.

(4 marks)

(c) The crane is used to hoist a 500 kg Sabrewing cargo drone as shown in **Figure Q3(c)**. Determine:

(i) Axial force in rod AB, F_{AB} and sketch the force equilibrium at point A.

(ii) The required minimum diameter of the solid L2-steel (E = 200 GPa, σ_Y = 703 MPa) rod AB (to the nearest mm) so that it will not buckle. Use F.S = 2 against buckling.

(12 marks)

Q4 (a) Briefly explain the strain energy.

(6 marks)

(b) A half wing spar of ATR 42 aircraft can be modeled as cantilever beam subjected to a linear distributed load shown in **Figure Q4(b)**. If the beam is made of A36 steel (E = 200 GPa, I = 99.2 (106) mm^4), determine the bending strain energy in the beam

(14 marks)

Q5 (a) Discuss the characteristics of thick cylinders. Explain the main difference between thick and thin cylinders.

(4 marks)

(b) **Figure Q5(b)** shows a cross section of flap/slat compound tube used in Airbus 330 actuator system. It is formed by shrinking a tube of 250 mm internal diameter and 25 mm wall thickness onto another tube of 250 mm external diameter and 25 mm wall thickness. Both tubes are made of the same material. The stress set up at the junction owing to shrinkage is 10 MPa. The compound tube is then subjected to an internal pressure of 80 MPa. Determine the final stress setup across the section.

(16 marks)

Q6 (a) Explain about the following failure modes; yielding, fracture, and buckling.

(6 marks)

(b) State two elastic failure theories.

(2 marks)

(b) The state of plane stress shown occurs at a critical point of Cessna 172 landing gear is shown in **Figure Q6(c)** where σ_x = 85 MPa, σ_y = -45 MPa τ_{xy} = 25 MPa. As a result of several tensile tests, it has been found that the tensile yield strength is σ_Y = 250 MPa for the grade of steel used. Determine:

(i) Principle stresses and maximum shear stress.

(ii) The factor of safety with respect to yield, using the maximum shearing stress theory and the maximum distortion energy theory

(12 marks)

- END OF QUESTION -

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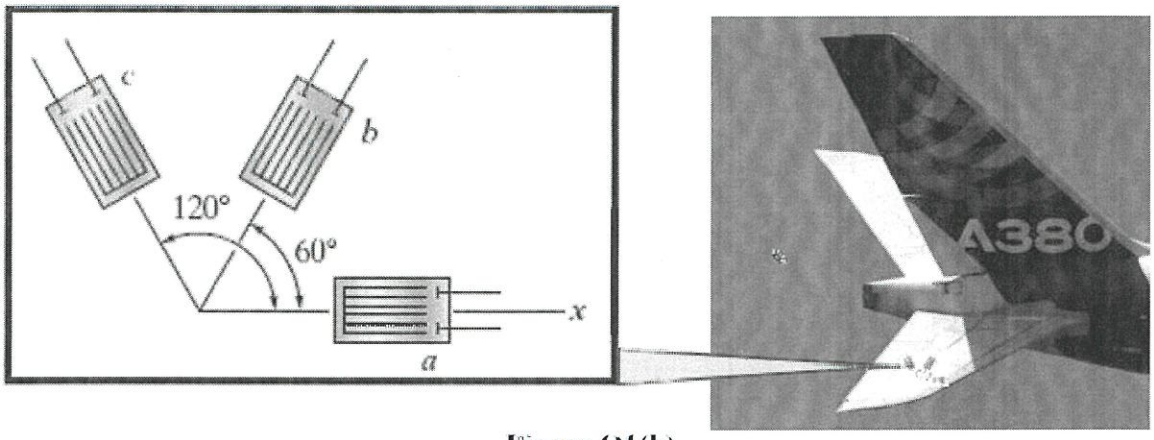

Figure Q1(b)

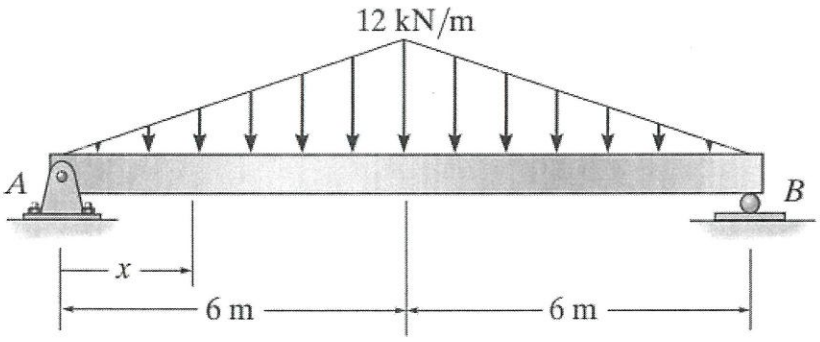

Figure Q2(b)

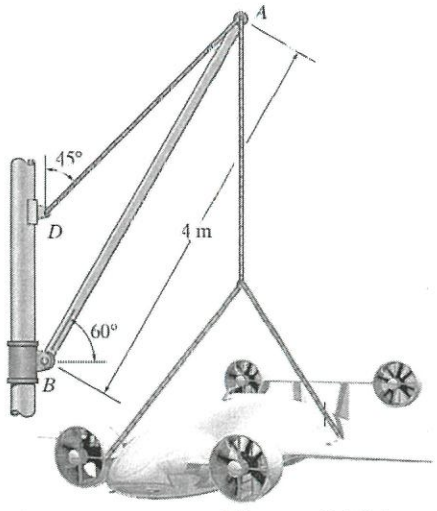

Figure Q3(b)

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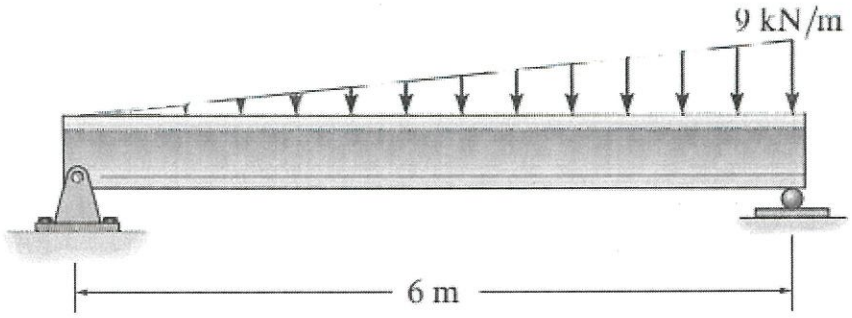

Figure Q4(b)

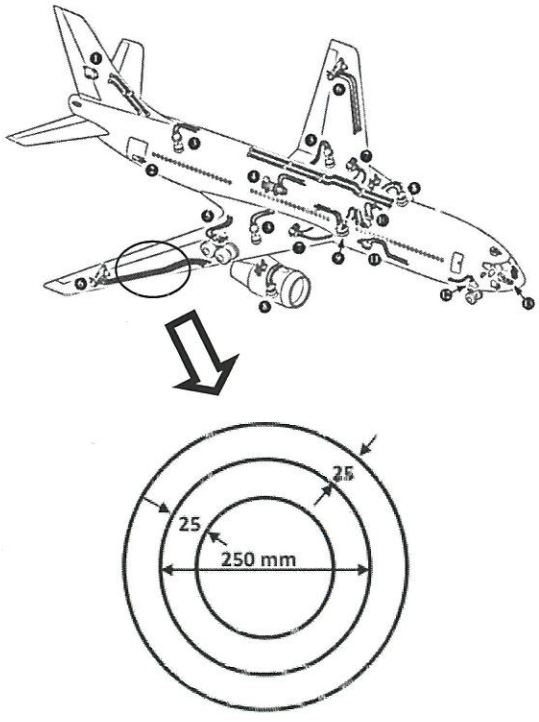

Figure Q5(b)

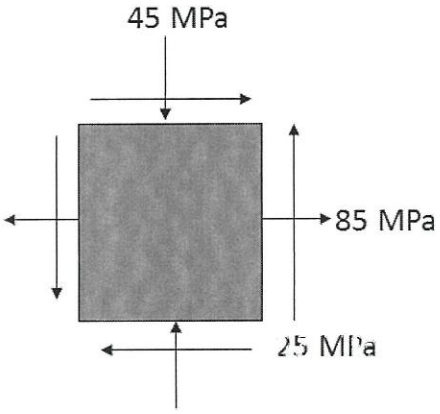

Figure Q6(c)