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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017**

TERBUKA

COURSE NAME : AIRCRAFT STRUCTURE
COURSE CODE : BDU 20103
PROGRAMME : 2 BDC / 2 BDM
EXAMINATION DATE : DECEMBER 2016 / JANUARY 2017
DURATION : 3 HOURS
INSTRUCTION : ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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Q1 (a) Briefly explain about biplane aircraft. State two (2) advantages and disadvantages of biplane aircraft compared to monoplane aircraft. (8 marks)

(b) Two plates of 4 mm thick are connected by means of rivet joint. The rivets used have a diameter of 4 mm. It is known that the failure strength of the rivet in shear and the ultimate tensile strength of the plate are 355 N/mm^2 and 445 N/mm^2 , respectively.

(i) If the technician decided to set rivet spacing, b as 8 mm, determine either single riveted lap joint or single butt joint should be chose so that the failure will not occur. Note that the joint is designed so that failure due to shear in rivet and failure due to tension in plate will occur simultaneously.

(ii) Determine the maximum rivet spacing, b if the plates are connected by single riveted lap joint.

(iii) Calculate the joint efficiency for single riveted lap joint for the case stated in (ii).

(iv) Calculate the diameter of the rivet and thickness of the plate that should be used if the edge load, P applied is 800 N/mm for the case of single riveted lap joint. The rivet spacing is maintained as obtained in (ii).

(17 marks)

Q2 (a) Consider the two element system as shown in Figure **Q2(a)** where Node 1 is attached to a fixed support, yielding the displacement constraint $U_1=0$, $k_1=9 \text{ kN/m}$, $k_2=13 \text{ kN/m}$. Applied forces, $F_2=F_3=333 \text{ N}$. For these conditions;

(i) sketch Free Body Diagram for the system.

(ii) determine nodal displacements U_2 and U_3 .

(8 marks)

(b) The doubly symmetrical fuselage section shown in Figure **Q2(b)** has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels. The boom area is 150 mm^2 each. When the section is subjected to shear loads of 50 kN and a bending moment of 100 kNm , calculate;

(i) the direct stresses in the booms

(ii) the shear flows in the panels.

(17 marks)

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- Q3** (a) The study of aeroelasticity may be broadly classified into two fields i.e. static aeroelasticity and dynamic aeroelasticity. Describe these two classes of aeroelasticity and explain flutter and buffeting phenomena in aircraft structure. (10 marks)
- (b) Figure **Q3(b)** shows an aircraft having a total weight of 45 kN lands on the deck of an aircraft carrier. It is brought to rest by means of a cable engaged by an arrester hook. If the deceleration induced by the cable is 3g, determine;
- (i) the tension of the cable, T.
 - (ii) the load on an undercarriage strut.
 - (iii) the shear and axial loads in the fuselage at the section A-A (the weight of the aircraft aft of A-A is 40 kN).
 - (iv) the length of deck covered by the aircraft before it is brought to rest if the touch-down speed is 25 m/s.
- (15 marks)
- Q4** (a) Briefly explain Finite Element Method (FEM). Give four (4) advantages of the FEM over a conventional approach. (7 marks)
- (b) The cross section of a wing's stringer shown in Figure **Q4(b)** is subjected to a bending moment of 1500 Nm and -1000 Nm acting in the vertical and horizontal planes, respectively.
- (i) Determine the location of neutral axis of the stringer.
 - (ii) Calculate the maximum direct stress due to bending moment.
 - (iii) State the point/line where the maximum direct stress acts.
- (18 marks)
- Q5** (a) A buckling test is conducted on A-36 steel ($E=200$ GPa) rod AB as shown in Figure **Q1(a)**. The rod has a diameter of 32mm and connected by pin at its ends.
- (i) Determine the maximum force P that can be applied to the handle so that the rod AB does not buckle.
 - (ii) Calculate the critical stress, σ_{cr} experienced by rod AB.
 - (iii) If the force P of 70 kN is applied, calculate the factor of safety for rod AB with respect to buckling.
- (8 marks)

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- (b) Figure Q5(b) shows the front view of a wing spar for an aircraft which carries a non-uniform load distribution. Each flange has a cross section of 500 mm^2 with top flange being horizontal.
- (i) If the flanges are assumed to resist all direct loads while the spar web is effective only in shear, determine the flange loads and the shear flows in the web at sections 2.
- (ii) If the web in the wing spar has a thickness of 2 mm and is fully effective in resisting direct stresses, calculate the maximum value of shear flow in the web at a section 2.

(17 marks)

- END OF QUESTION -

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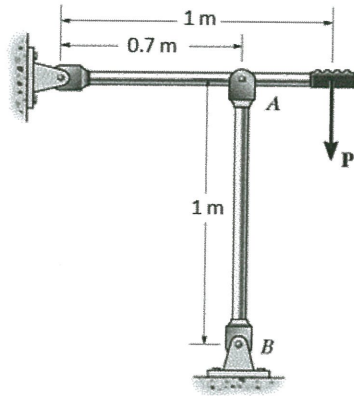


FIGURE Q1(a)

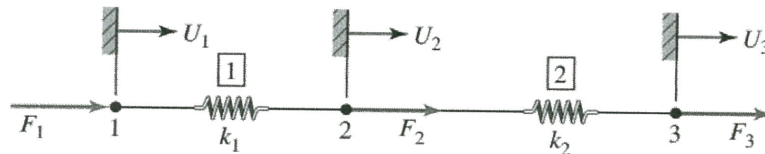


FIGURE Q2(a)

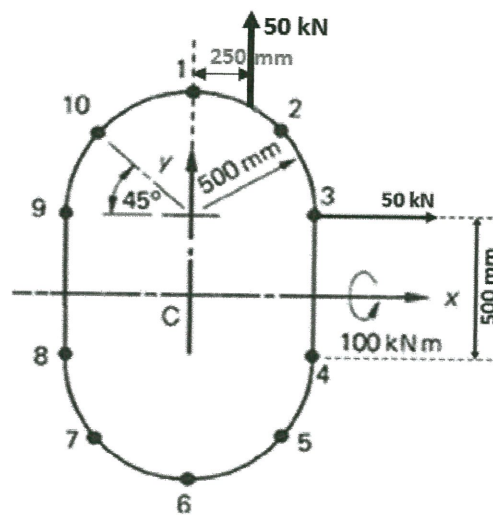


FIGURE Q2(b)

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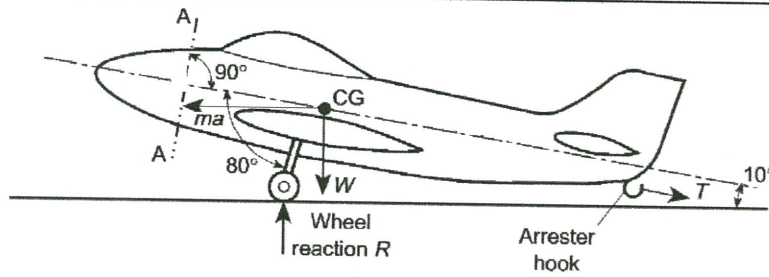


FIGURE Q3(b)

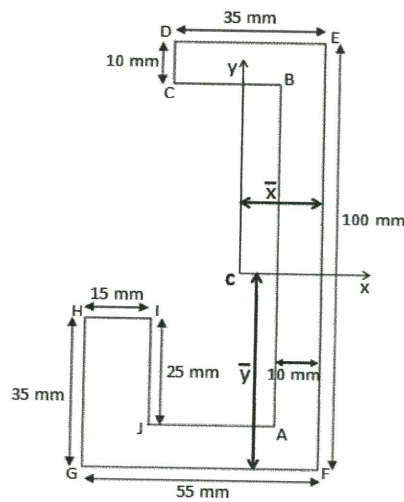


FIGURE Q4(b)

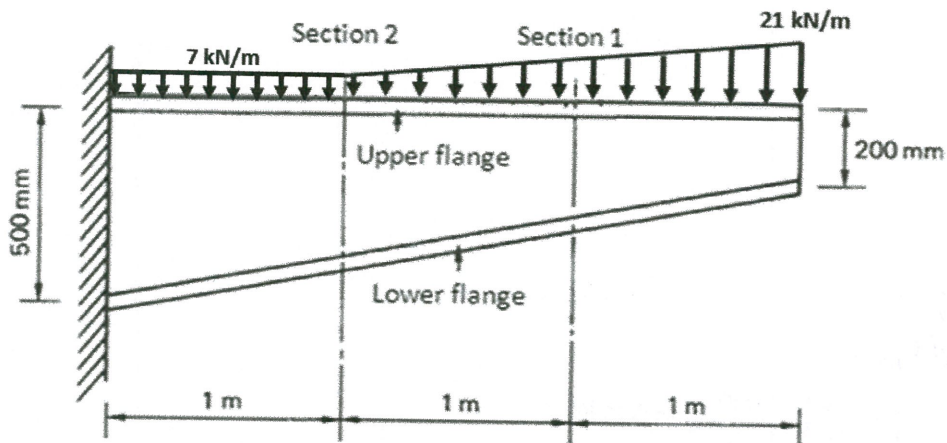


FIGURE Q5(b)

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