| Reg. No. | | | | | | | | | |
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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*(A constituent unit of MAHE, Manipal)*

## IV SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

## END SEMESTER EXAMINATIONS, MAY 2024

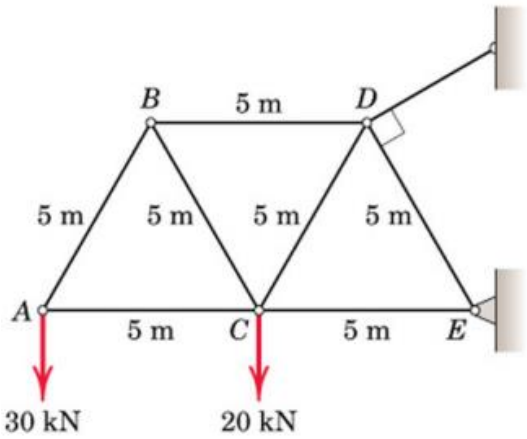
## ADVANCED AIRCRAFT STRUCTURES [AAE-2225]

REVISED CREDIT SYSTEM

**Time: 3 Hours** **Date: 03 MAY 2024** **Max. Marks: 50**

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

| Q.NO | Questions | *Marks* | *CO* | *BTL* |
|---|---|---|---|---|
| **1A.** | Explain the concepts of statically determinate and indeterminate structures in structural engineering with neat sketches. | ***02*** | ***01*** | ***04*** |
| **1B.** | Discuss the key design considerations for creating a monocoque structure. What factors influence the choice between a monocoque and semi-monocoque design for a given application? | ***04*** | ***01*** | ***02*** |
| **1C.** | Evaluate the internal forces in the members AB, AC, BC, BD and CD of the truss structure shown in figure 1.   Figure: 1 | ***04*** | ***01*** | ***05*** |
| **2A.** | Discuss the importance of Breadth -Batho theory of torsion in structural analysis and how does it contribute to the understanding and design of engineering structures. | ***02*** | ***02*** | ***02*** |
| **2B.** | An aircraft having a total weight of 45 kN lands on the deck of an aircraft carrier and is brought to rest by means of a cable engaged by an arrester hook, as shown in figure 2. If the deceleration induced by the cable is 3 g, determine (i) the tension, T, in the cable, (ii) the load on an undercarriage strut (Assuming two | ***04*** | ***02*** | ***03*** |

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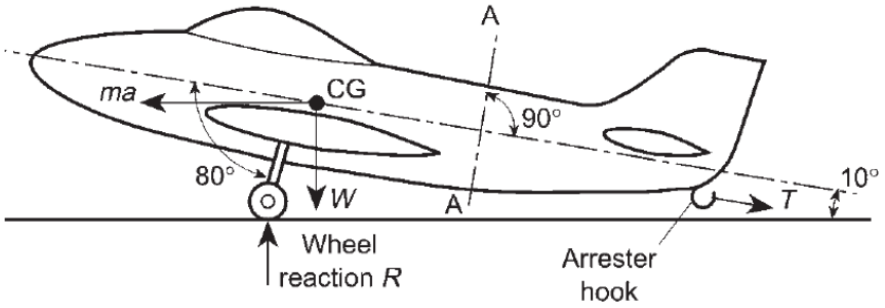
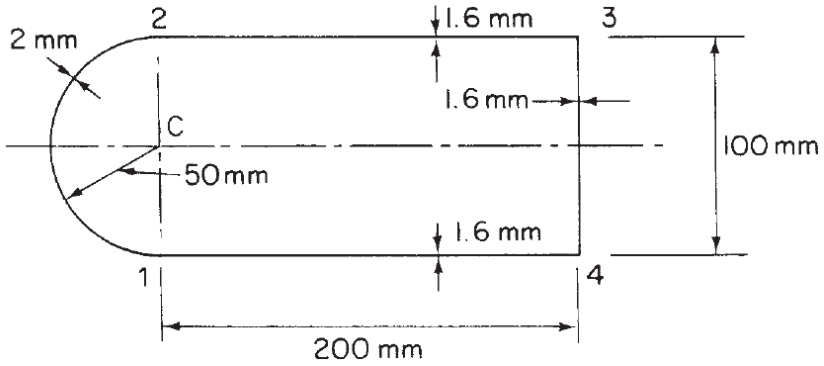
| | undercarriage struts) (iii) the shear and axial loads in the fuselage at the section AA; the weight of the aircraft aft of AA is 4.5 kN. (iv) also evaluate the length of deck covered by the aircraft before it is brought to rest if the touch-down speed is 25 m/s.<br>  <br><br>Figure: 2 | | | |
| **2C.** | A uniform closed section beam, of the thin-walled section shown in Figure 3, is subjected to a twisting couple of 4500 Nm. The beam is constrained to twist about a longitudinal axis through the centre C of the semicircular arc 12. For the curved wall 1-2 the thickness is 2 mm, and the shear modulus is 22000N/mm$^2$. For the plane walls 2-3, 3-4 and 4-1, the corresponding thickness and shear modulus are 1.6 mm and 27500N/mm$^2$ (*Note*: *Gt* =constant.). Determine the rate of twist in rad/mm.<br>  <br><br>Figure: 3 | ***04*** | ***02*** | ***03*** |
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| **3A.** | Differentiate between the multiple/bogie type and tandem type landing gear arrangement of an aircraft. | ***02*** | ***03*** | ***02*** |
| **3B.** | The landing gear as illustrated in figure 4 is representative of a main landing gear. The oleo strut OE has a sliding attachment at E, which prevents any vertical load to be taken by member AB at E. The brace struts GD, FD and CD are pinned at each end and will be assumed as 2 force members. Draw the space force diagram. | ***04*** | ***03*** | ***03*** |

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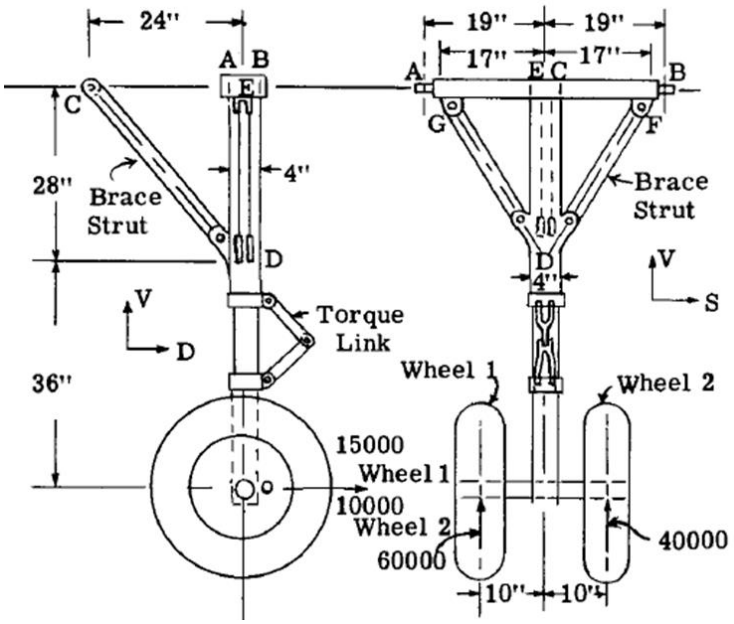
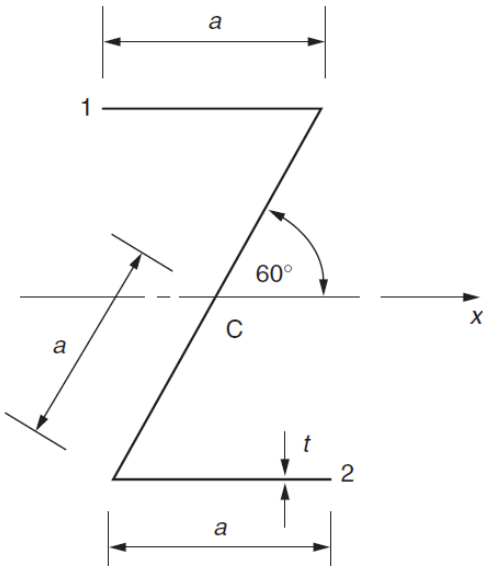
| |  <br>Figure: 4 | | | |
| **3C.** | For the above example 3B, Determine the reaction forces at points A, B and C assuming no side forces. | ***04*** | ***03*** | ***03*** |
| | | | | |
| **4A.** | Explain why determining shear centre is important in structural analysis. | ***02*** | ***04*** | ***04*** |
| **4B.** | Determine the moment of inertia $I_{xx}$ of the thin-walled section shown in figure 5.<br>  <br>Figure: 5 | ***04*** | ***04*** | ***03*** |
| **4C.** | A beam having the cross-section shown in figure 6 is subjected to a bending moment of 1500 Nm in a vertical plane. Evaluate the maximum direct stress due to bending stating the point at which it acts. | ***04*** | ***04*** | ***05*** |

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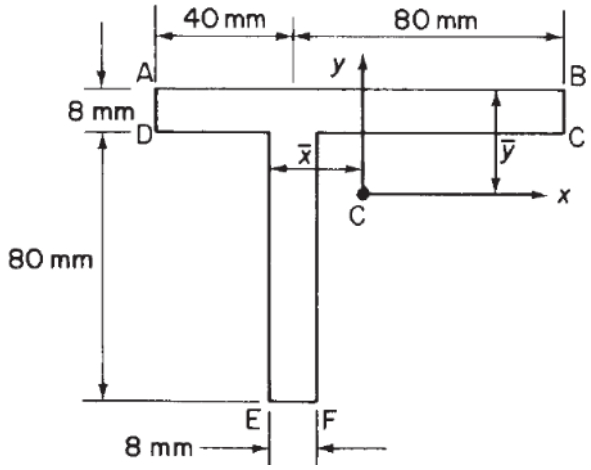
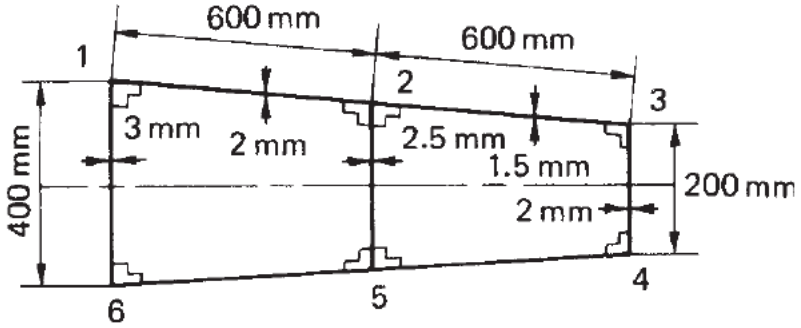
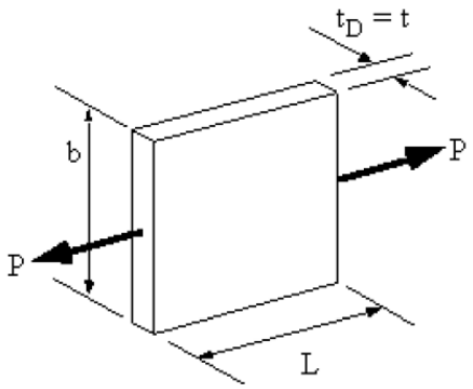
| |  <br>Figure: 6 | | | |
| **5A.** | Describe the significance of structural idealisation in the design and analysis of aircraft. | ***02*** | ***05*** | ***02*** |
| **5B.** | Part of a wing section is in the form of the two-cell box shown in figure 7. in which the vertical spars are connected to the wing skin through angle sections all having a cross sectional area of 300mm$^2$. Idealize the section into an arrangement of direct stress carrying booms and shear stress only carrying panels suitable for resisting bending moments in a vertical plane. Position the booms at the spar/skin junctions.<br>  <br>Figure: 7 | ***04*** | ***05*** | ***04*** |
| **5C.** | The figure 8 shows an aircraft panel supporting tensile load P. Idealise the given panel into an arrangement of booms carrying direct stresses and skin carrying only shear stress. Furthermore, determine the boom area.<br>  <br>Figure: 8 | ***04*** | ***05*** | ***03*** |