Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEB07

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

B.Tech IV Semester End Examinations (Regular), MAY – 2020

Regulations: IARE - R18

AEROSPACE STRUCTURES

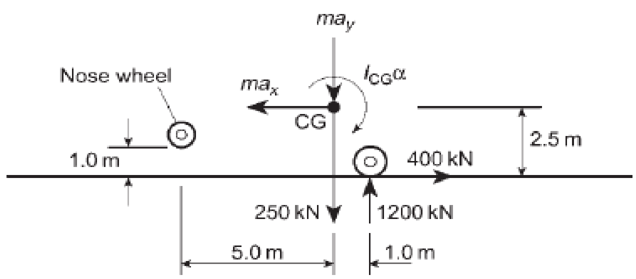
(AERONAUTICAL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

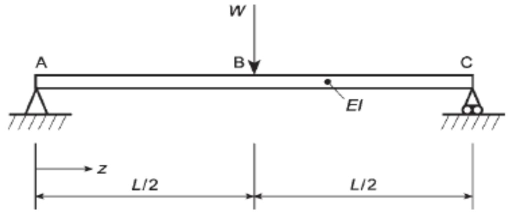
1. a) An aircraft having a weight of 250 kN and a tricycle undercarriage lands at a vertical velocity of 3.7 m/s, such that the vertical and horizontal reactions on the main wheels are 1200 kN and 400 kN respectively; at this instant the nose wheel is 1.0m from the ground, as shown in Fig. below. If the moment of inertia of the aircraft about its CG is 5.65×10^{8} Ns^{2} mm determine the inertia forces on the aircraft, the time taken for its vertical velocity to become zero and its angular velocity at this instant. **[7M]**



b) Calculate the vertical displacements atone fourth and mid-span of the simply supported beam of length L, having udl throughout the beam and flexural rigidity EI by using energy Method. **[7M]**

2. a) The aircraft for which the stalling speed Vs in level flight is 46.5 m/s has a maximum allowable manoeuvre load factor $n_1$of 4.0. In assessing gyroscopic effects on the engine mounting the following two cases are to be considered: **[7M]**
i) Pull-out at maximum permissible rate from a dive in symmetric flight, the angle of the flight path to the horizontal being limited to 60^0 for this aircraft.
ii) Steady, correctly banked turn at the maximum permissible rate in horizontal flight.
Find the corresponding maximum angular velocities in yaw and pitch.

b) Determine the deflection of the mid-span point of the linearly elastic, simply supported beam shown in Fig. below; the flexural rigidity of the beam is EI. By using total potential energy method. **[7M]**



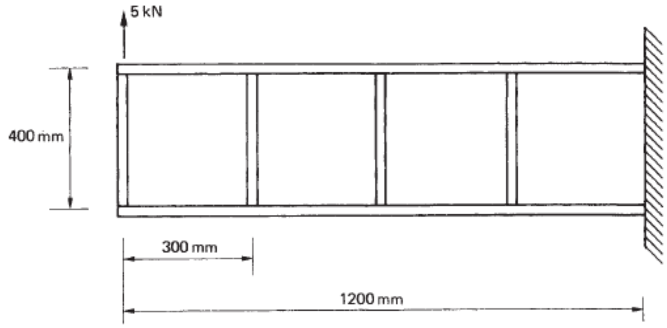
UNIT – II

3. a) **Explain** the basic theory of thin plates? **[7M]**

b) **Derive** the equation $(1/\rho) = M / [D(1+\upsilon)]$ of thin plate subjected to pure bending. **[7M]**

4. a) A thin rectangular plate a×b is simply supported along its edges and carries a uniformly distributed load of intensity q_0. **Determine** the deflected form of the plate and the distribution of bending moment. **[7M]**

b) The beam shown in is assumed to have a complete tension field web. If the cross-sectional areas of the flanges and stiffeners are, respectively, 350mm^2 and 300mm^2 and the elastic section modulus of each flange is 750mm^3, **determine** the maximum stress in a flange and also whether or not the stiffeners will buckle. The thickness of the web is 2mm and the second moment of area of a stiffener about an axis in the plane of the web is 2000mm^4; E =70 000 N/mm^2. **[7M]**



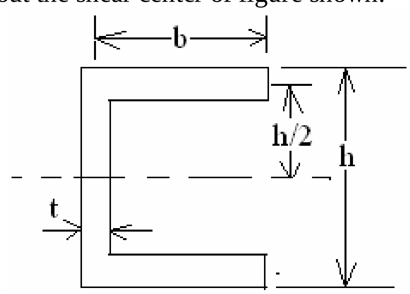
UNIT – III

5. a) **Write** short notes on the following: **[7M]**
   i. Symmetrical bending
   ii. Unsymmetrical bending

b) **Derive** $(\sigma_z) = [(M_y I_{xx} - M_x I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)]\, x + [(M_x I_{yy} - M_y I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)]\, y$ **[7M]**

6. a) **Derive** the Bredt-Batho formula for thin walled closed section beams with the help of neat sketch. **[7M]**

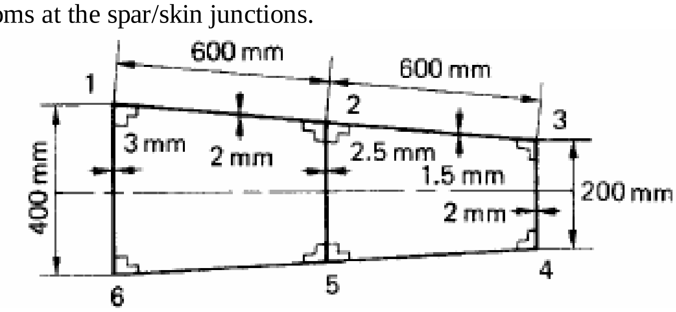
b) **Derive** the equation to find out the shear center of figure shown. **[7M]**



UNIT – IV

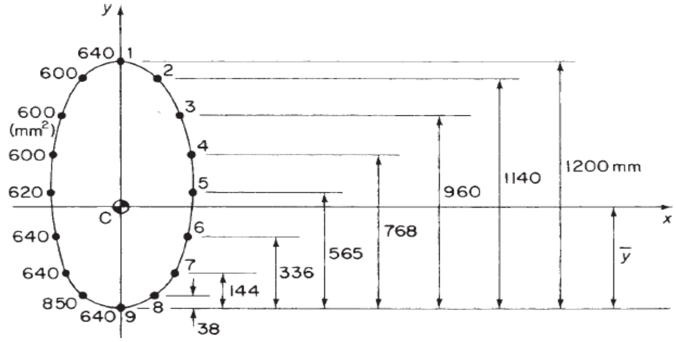
7. a) Derive the equation to find out the bending stress of idealized panel. **[7M]**

b) Part of a wing section is in the form of the two-cell box shown in Figure in which the vertical spars are connected to the wing skin through angle sections, all having a cross-sectional area of 300 mm^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. **[7M]**



8. a) Draw the neat sketches of idealized simple wing section. Derive bending stress and shear flow distribution. **[7M]**

b) The fuselage section shown in Fig. 20.5 is subjected to a bending moment of 100 kNm applied in the vertical plane of symmetry. If the section has been completely idealized into a combination of direct stress carrying booms and shear stress only carrying panels, **determine** the direct stress in each boom. **[7M]**



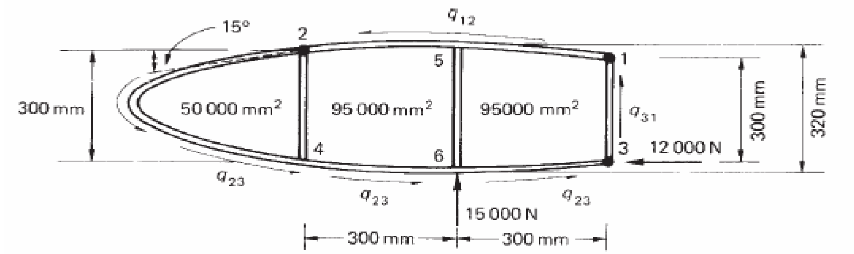
UNIT – V

9. a) **Write** a detailed note on the following **[7M]**

   i. Fuselage frames

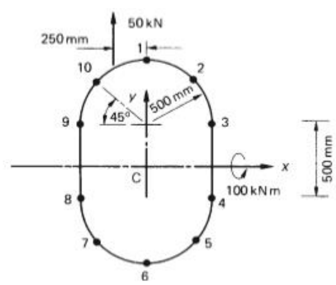
   ii. Wing ribs

   b) **Calculate** the shear flows in the web panels and the axial loads in the flanges of the wing rib shown in Figure. Assume that the web of the rib is effective only in shear while the resistance of the wing to bending moments is provided entirely by the three flanges 1, 2 and 3. **[7M]**



10. a) Explain direct stress distribution on wing section with neat sketch. **[7M]**

   b) The doubly symmetrical fuselage section shown in Fig. P.22.1 has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels; theboomareasareall150mm^2. Calculate the direct stresses in the booms and the shear flow in the panels when the section is subjected to a shear load of 50kN and a bending moment of 100kNm. **[7M]**



INSTITUTE OF AERONAUTICAL ENGINEERING
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COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the aircraft structural components and its behavior under different loading conditions
II	Obtain knowledge in plate buckling and structural instability of stiffened panels for airframe structural analysis.
IV	Explain the thin walled section and structural idealization of panels and differentiate from the type of loads carried.
IV	Solve for stresses and deflection in aircraft structures like fuselage, wing and landing gear.

COURSE OUTCOMES (COs)

CO 1	Describe the concept of Structural components, structural joints, Monocoque and semi monocoque structures and also energy methods and principles.
CO 2	Describe the concept of thin plates subject to different types of loads and also buckling phenomena of thin plates, local instability and instability of stiffened panels.
CO 3	Understand the concept of symmetric and un-symmetric bending of beams shear stresses and shear flow distribution of thin walled sections and Torsion phenomenon.
CO 4	Explore the concept of Structural idealization and stress distribution of idealized thin walled sections.
CO 5	Discuss the concept of idealized thin walled sections, fuselage, Wing spar and box beams.

COURSE LEARNING OUTCOMES (CLOs)

Students, who complete the course, will be able to demonstrate the ability to do the following:

AAEB07.01	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.
AAEB07.02	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetric maneuver loads, gust loads on the joints.
AAEB07.03	Differentiate Monocoque and semi monocoque structures and analyze stresses in thin and thick shells.
AAEB07.04	Explain energy principles and its application in the analysis of structural components of Aircraft.
AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.
AAEB07.06	Describe Buckling phenomena of thin plates and derive Elastic, inelastic, experimental determination of critical load for a flat plate.
AAEB07.07	Calculate the local instability, instability of stiffened panels, failure stresses in plates and stiffened panels.
AAEB07.08	Discuss critical buckling load for flat plate with various loading and end conditions
AAEB07.09	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions
AAEB07.10	Solve for deflections of beams under loading with various approaches

AAEB07.11	Calculate the shear stresses and shear flow distribution of thin walled sections subjected to shear loads.
AAEB07.12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.
AAEB07.13	Explain the theory of Structural idealization
AAEB07.14	Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.
AAEB07.15	Solve for stress distribution of idealized thin walled sections subjected to bending.
AAEB07.16	Solve for stress distribution of idealized thin walled sections subjected to, shear and torsion.
AAEB07.17	Calculate and analysis of idealized thin walled sections subjected to bending
AAEB07.18	Calculate and analysis of idealized thin walled sections subjected to shear and torsion.
AAEB07.19	Analyze fuselage of variable stringer areas subjected to transverse and shear loads.
AAEB07.20	Analyze Wing spar and box beams of variable stringer areas subjected to transverse and shear loads.

MAPPING G OF SEMESTER END EXAMINATION - COURSE LEARNING OUTCOMES

SEE Question No.		Course Learning Outcomes		CO	Blooms Taxonomy Level
1	a	AAEB07.01	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.	CO 1	Understand
	b	AAEB07.01	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.	CO 1	Understand
2	a	AAEB07.02	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetric manoeuvre loads, gust loads on the joints.	CO 1	Understand
	b	AAEB07.03	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetric manoeuvre loads, gust loads on the joints.	CO 1	Understand
3	a	AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	CO 2	Remember
	b	AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	CO 2	Understand
4	a	AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	CO 2	Remember
	b	AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.	CO 2	Remember
5	a	AAEB07.09	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions Solve for deflections of beams under loading with various approaches	CO 3	Remember
	b	AAEB07.09	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions Solve for	CO 3	Remember

			deflections of beams under loading with various approaches		
6	a	AAEB07.12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.	CO 3	Remember
	b	AAEB07.12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.	CO 3	Understand
7	a	AAEB07.14	Explain the theory of Structural idealization and Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.	CO 4	Remember
	b	AAEB07.15	Solve for stress distribution of idealized thin walled sections subjected to bending, shear and torsion.	CO 4	Remember
8	a	AAEB07.16	Explain the theory of Structural idealization and Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.	CO 4	Remember
	b	AAEB07.16	Solve for stress distribution of idealized thin walled sections subjected to bending, shear and torsion.	CO 4	Remember
9	a	AAEB07.18	Analyze fuselage of variable stringer areas subjected to transverse and shear loads.	CO 5	Understand
	b	AAEB07.18	Wing spar and box beams of variable stringer areas subjected to transverse loads.	CO 5	Remember
10	a	AAEB07.19	Analyze fuselage, Wing spar and box beams of variable stringer areas subjected to transverse and shear loads.	CO 5	Understand
	b	AAEB07.20	Analyze fuselage, Wing spar and box beams of variable stringer areas subjected to shear loads.	CO 5	Remember

Signature of Course Coordinator **HOD, AE**