BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

B.E. Fifth-Semester (AE) Final Examination, 2012

Subject: Aerospace Structure II **Subject Code: AE-502**

Full Marks: 70 **Time : 3hours**

(Answer any five questions)

(All questions are having same marks)

1. Write down the relationship of bending moments (M_x & M_y) and twisting moments (M_{xy}) with the small deflection (w) of a thin rectangular plate subjected to bending and twisting properly explaining the different terms. A 3 mm thick rectangular plate is subjected to uniformly distributed bending moments M_x = 30 N-m/mm and M_y = 20 N-m/mm along with a uniformly distributed twisting moments M_{xy} = 20 N-m/mm along each edge. Determine the principal moments in the plate, the planes on which they acts and the corresponding principal stresses.

2. a) Write down the generalized governing differential equation of equilibrium for a rectangular thin plate subjected to a generalized transverse load q per unit area. b) Deduce the expression of boundary conditions for a thin rectangular loaded plate which is having its edges i) clamped, ii) simply supported and iii) free.

3. A thin plate of dimension a x b is subjected to an in-plane compressive load N_x per unit length in x direction applied on edges having length b. Deduce the expression for total potential energy V_x of the plate for the in-plane compressive load N_x. Also write down the expression for total potential energy V, if the plate is also subjected to another in-plane compressive load N_y per unit length in y direction and in-plane shear load N_{xy} per unit length along all four edges in addition to in-plane compressive load N_x per unit length in x direction.

4. Part of a compression panel of internal construction is shown in Fig. Q.4. The equivalent pin-centre length of the panel is 600 mm. The material has a Young's modulus of 70 000 N/mm^2 and its elasticity may be taken as falling catastrophically when a compressive stress of 350 N/mm^2 is reached. Taking coefficients of 3.62 for buckling of a plate with simply supported sides and of 0.385 with one side simply supported and one free, determine (a) the load per mm width of panel when initial buckling may be expected and (b) the load per mm for ultimate failure. Treat the material as thin for calculating section constants and assume that after initial buckling the stress in the plate increases parabolically from its critical value in the centre of sections.

5. An aircraft having a total weight of 40 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 Fig. Q.5. If the deceleration induced by the cable is 2.5 g determine the tension, T, in the cable, the load on an undercarriage strut and the shear and axial loads in the fuselage at the section AA; the weight of the aircraft aft of AA is 4 kN. Calculate also the length of deck covered by the aircraft before it is brought to rest if the touch-down speed is 22 m/s.

6. An aircraft weighing 240 kN has wings 89m^2 in area for which ~~CD~~ C_D =0.0075+0.045C_L^2 . The extra-to-wing drag coefficient based on wing area is 0.0127 and the pitching moment coefficient for all parts excluding the tailplane about an axis through the CG is given by CM_c=(0.428C_L −0.061)m. The radius from the CG to the line of action of the tail lift may be taken as constant at 12.2 m. The moment of inertia of the aircraft for pitching is 206 000 kgm^2. During a pull-out from a dive with zero thrust at 220 m/s EAS when the flight path is at 45° to the horizontal with a radius of curvature of 1600 m, the angular velocity of pitch is checked by applying a retardation of 0.25 rad/s2. Calculate the manoeuvre load factor both at the CG and at the tailplane CP, the forward inertia coefficient and the tail lift.

See the reverse page

7. An aircraft flies at sea level in a correctly banked turn of radius 600m at a speed of 160 m/s. Figure Q.7 shows the relative positions of the CG, aerodynamic centre of the complete aircraft less tailplane and the tailplane centre of pressure for the aircraft at zero lift incidence. Calculate the tail load necessary for equilibrium in the turn. The necessary data are given in the usual notation as follows:

Weight W =135 kN,	$dC_L/d\alpha$=4.5/rad	
Wing area S =46.5m^2	C_D =0.01 + 0.05C_L	
Wing mean chord = 3.0m	$C_{M,0}$=−0.03	Density of Air 1.223 kg/M^3.

8. A beam having the cross-section shown in Fig. Q.8 is subjected to a bending moment of 1400Nm in a vertical plane. Calculate the maximum direct stress due to bending stating the point at which it acts.

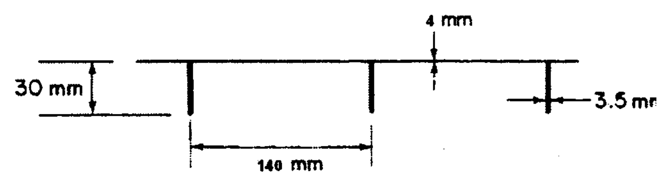

Fig. Q.4

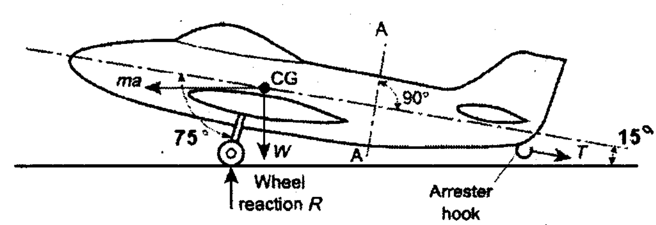

Fig. Q.5

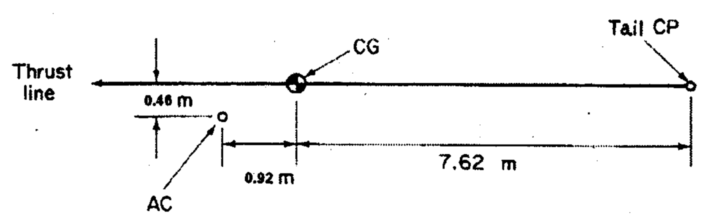

Fig. Q.7

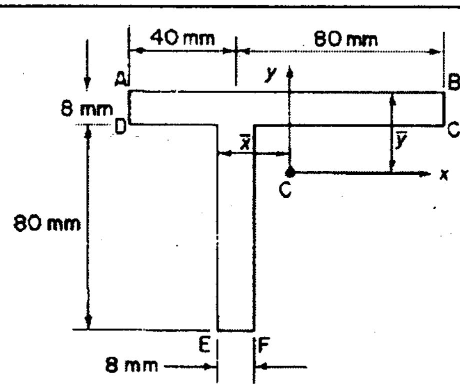

Fig. Q.8