Quiz 1

AE220 Aerospace Structural Mechanics
Date: February 3, 2014
Name: **Roll No:**

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1. An aircraft is flying with a lift, L, equal to the weight of the aircraft, W when a gust with lift $\Delta L = 1.5W$ strikes the aircraft. The resultant of this gust produced lift is 90 inches aft of the C.G. I_{pitch} for the entire plane is 2.25×10^7 lb-in-sec^2 computed about the aircraft C.G.

   Before the gust strikes, a load sensor located on the boom attachment point senses a shear force V of 1000 lb. The weight of the boom is 1000 lb. Its pitch mass moment of inertia about its own G.G. is 3000,000 lb-in-sec^2.

   (a) Compute the aircraft load factor, n_z.

   (b) Compute the value of V (and direction) at the sensor when the gust strikes.

   (c) Compute the bending moment, M, (and direction) at the sensor when the gust strikes.

   Marks 12

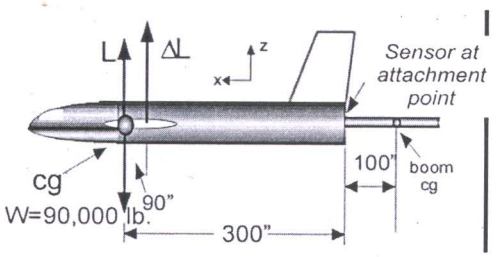


Figure 1:

(a) Load factor = n_z = $\frac{\sum F_{external} \leftarrow \text{(excluding reaction force)}}{W}$ = $\frac{L + \Delta L}{W}$ = $\frac{W + 1.5W}{W}$

= 2.5 — (1)

(b) Unbalance moment about c.g. due to gust = $\Delta L \times 90'' = 1.5 \times 90W$ lb-in

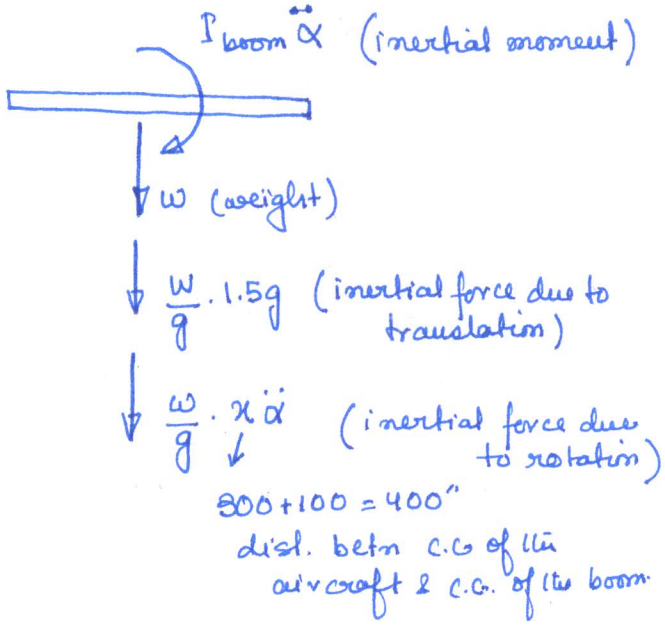
Angular acceler about GG due to the gust = $\frac{1.5 \times 90 \times W}{I_{pitch}}$

= $\frac{1.5 \times 90 \times 90000}{2.25 \times 10^7}$ = 0.54 rad/s^2 — (1)

Translational acceler. due to the gust = $\frac{\Delta L g}{W}$ = 1.5g in/sec^2. — (1)

Weight of the boom = Shear force when the gust is not acting = W = 1000 lb — (1)

Free body diagram of the boom



Shear force at the sensor after the gust strikes $= w + \frac{w}{g} \times 1.5g + \frac{w}{g} \times 400\ddot{\alpha}$

$= 1000 + 1.5 \times 1000 + \frac{1000}{32.2 \times 12} \times 400 \times 0.54$

$= 2500 + 559$ lb

$= 3059$ lb ——— (4)

(c) Bending moment at the sensor

$= 3059 \times 100 + I_{boom}\ddot{\alpha}$

$= 305900 + 3 \times 10^6 \times 0.54$ lb-in

$= 467900$ lb-in

——— (4)

3. Write (maximum two sentences each) the main structural function of (i) *skin*, (ii) *stringers*, and (iii) *ribs*. No marks will be given for answers longer than two sentences. **Marks 4**

Skin: resist shear stress due to torsion — (1)

Stringers: resist normal stress due to bending — (1)

Ribs: Reduces effective length of the panels, increasing buckling ~~shear~~ resistance. Resists hoop stress — (2)