quizz 7, ME 240 Dynamics, Fall 2017

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0.1 Problem 1

Question 1 1 pts

The drone hovers for 41 seconds at a height of 40 meters above the ground while taking a picture of a crowd.

What is the vertical impulse by the lift force (combined force of the four rotors) during this time (in Newton-seconds)?

Report your answer to the nearest whole number

$$\begin{aligned} I &= \int_0^t F dt \\ &= \int_0^t mg dt \\ &= mgt \\ &= (1)(9.81)(41) \\ &= 402.21 \text{ N-s} \end{aligned}$$

0.2 Problem 2

Question 2 1 pts

A sudden gust of wind propels the drone against the side of a nearby building at 4.48 m/s. Inertial sensors onboard the drone determine that it bounces back from the building with a speed of 1.10 m/s. Assume this event is a direct central impact.

What is the coefficient of restitution between the drone and the building during this collision?

Report your answer to three decimal places.

$$-e = \frac{V_B^+ - V_A^+}{V_B^- - V_A^-}$$

Where B is the wall. Hence $V_B^+ = V_B^- = 0$ since wall do not move. Therefore

$$\begin{aligned} -e &= \frac{-V_A^+}{-V_A^-} \\ &= \frac{-(-1.10)}{-(+4.48)} \\ &= \frac{1.10}{-4.48} \\ &= -0.24554 \end{aligned}$$

Hence

$$e = 0.245\,54$$

0.3 Problem 3

Question 3 1 pts

Another gust of wind blows the drone against the building a second time. This time, the impact speed is 5.13 m/s and the rebound speed is 1.47 m/s. It collision takes 0.29 seconds to complete.

What is the magnitude of the average force applied by the building to the drone during this collision (in Newtons)?

Report your answer to one decimal place.

$$mv_A^- + \int_0^{0.29} F_{av}dt = mv_A^+$$

But $m = 1$ then

$$\begin{aligned} \int_0^{0.29} F_{av}dt &= v_A^+ - v_A^- \\ &= -1.47 - 5.13 \\ &= -6.6 \end{aligned}$$

Hence

$$\begin{aligned} F_{av}(0.29) &= -6.6 \\ F_{av} &= -\frac{6.6}{0.29} \\ &= -22.759 \end{aligned}$$

The magnitude is 22.759 N. The negative sign, since force is in negative x direction.

0.4 Problem 4

Question 4 1 pts

A third gust of wind blows the drone against the building a third time. This time the impact speed is 6.4 m/s and the rebound speed is 0.12 m/s.

What is the magnitude of the energy dissipated in this collision (in Joules)?

Report your answer to one decimal place.

Energy lost is

$$\begin{aligned}\Delta &= \frac{1}{2}m\left(v_A^-\right)^2 - \frac{1}{2}m\left(v_A^+\right)^2 \\ &= \frac{1}{2}(6.4)^2 - \frac{1}{2}(0.12)^2 \\ &= 20.473\,\text{J}\end{aligned}$$

0.5 Problem 5

When blown against the building repeatedly, the drone came dangerously close to a nest of peregrine falcons. It therefore drew the attention of the mother falcon, with mass 1.023 kg, circling above. The falcon, diving at 107 m/s straight down, collides with the drone, which is hovering at a stationary position prior to impact. After they collide the falcon becomes entangled with the drone.

What is the post-impact speed of the drone-plus-falcon system (in m/s)?

Report your answer to one decimal place.

Let A be the fallcon and B be the drone. Hence

$$\begin{aligned}m_A v_A^- + m_B v_B^- &= (m_A + m_B)\,v^+ \\ (1.023)\,(107) + 0 &= (1.023 + 1)\,v^+ \\ v^+ &= \frac{(1.023)\,(107)}{2.023} \\ &= 54.108\ \text{m/s}\end{aligned}$$