EECS 725 – Introduction to Radar

Homework Assignment #1 (50 points)

An aircraft flies a straight and level path at a 1000-m height above the ground with a 90 m/s ground speed, as illustrated in Figure 1. A target with a 1-m^2 radar cross-section lies on the ground offset 2 km from the aircraft's ground track. The radar on the aircraft has a 1-GHz operating frequency. It has a 10-cm x 50-cm antenna (height 10 cm, length 50 cm) is mounted on the aircraft's fuselage with the long dimension parallel to the fuselage axis and inclined 45° below the horizon (see Figure 2).

In addressing the problems listed below, consider the interval when the aircraft's x position goes from -2000 m to + 2000 m. Assume that only echoes from the target are observed and ignore the curvature of the Earth (i.e., assume a flat Earth).

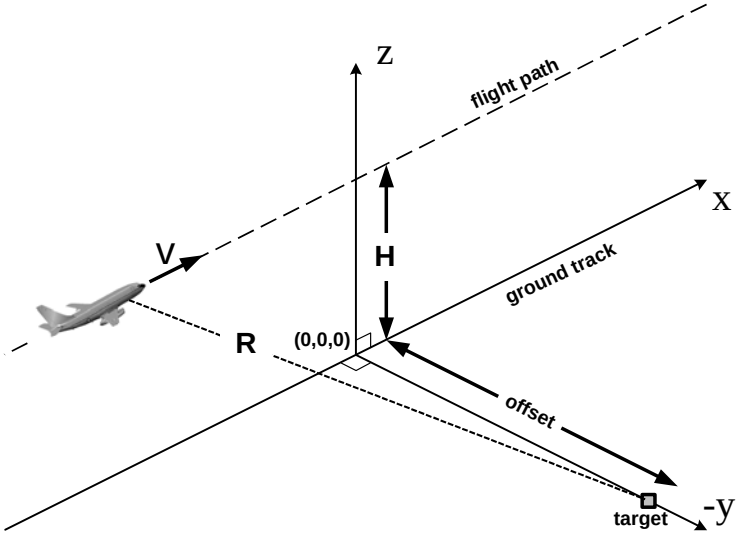

FIGURE 1. Scene geometry

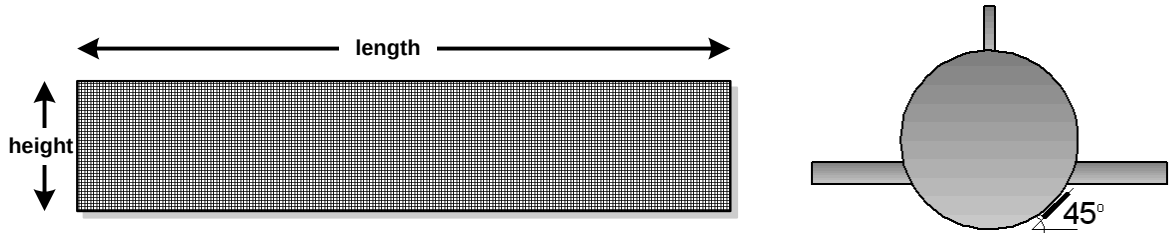

FIGURE 2. Antenna dimensions (left). Antenna mounting detail (right)

Problem 1. Plot the range (R expressed in meters) to the target versus aircraft position x.

Problem 2. Plot the angle (expressed in degrees) between the aircraft's velocity vector and the range vector versus aircraft position x.

Problem 3. Plot the antenna gain (on a decibel scale) in the direction of the range vector versus aircraft position x. [use the sin(x)/x antenna radiation pattern model]

Problem 4. Plot (on a decibel scale) the ratio of P_r/P_t versus the aircraft position x.

Problem 5. Plot the Doppler shift (expressed in Hertz) of the target's echo versus aircraft position x.