EECS 725 – Introduction to Radar

Homework Assignment #2 (30 points)
A side-looking, pulse-Doppler radar is carried on a satellite that orbits the Earth. The system has the following parameters:

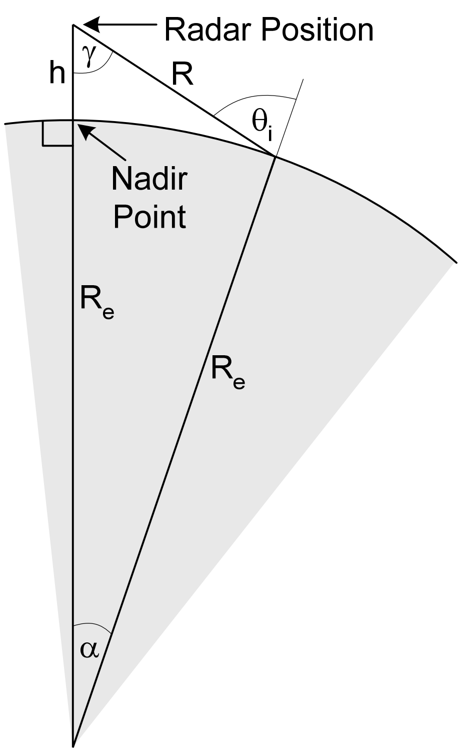
Orbit altitude	330 km (above the sea level)
Radar frequency	1 GHz
Along-track antenna dimension	5 m
Transmitted pulse duration	50 μs
Illuminated swath width	50 km
Mid-swath incidence angle	37°

In addressing the problems listed below, assume that only echoes from the illuminated swath are observed. You must consider the curvature of the Earth (i.e., involves spherical geometry).

Problem 1. Find the range of available PRF values assuming it is permissible to have multiple pulses in the air.

Problem 2. If all the system parameters remain constant (including the illuminated swath width) except for the radar's frequency, how would the range of available PRF values change? Explain.

Problem 3. For the given system parameters, what is the maximum possible swath width? That is, how large might the swath width become before no valid PRF values are available?



Spherical Earth geometry

Problem parameters

R_e	Earth's average radius (6378.145 km)
h	orbit altitude above sea level (km)
α	core angle
R	radar range
γ	look angle
θ_i	incidence angle
v	satellite velocity (km/s)
v_g	satellite ground velocity (km/s)
μ	standard gravitational parameter (398,600 km^3/s^2 for Earth)

Spherical Earth geometry calculations

$$\gamma + \alpha = \theta_i$$

$$\frac{R_e + h}{\sin \theta_i} = \frac{R_e}{\sin \gamma} = \frac{R}{\sin \alpha}$$

$$R^2 = R_e^2 + (R_e + h)^2 - 2\, R_e\, (R_e + h) \cos \alpha$$

Satellite velocity calculations

$$v = \sqrt{\mu / (R_e + h)}, \text{ km/s}$$

$$v_g = v\, R_e / (R_e + h)$$