Serial #
0
- 1 points for not writing your serial number

King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE418: Satellite Communications (101)

Quiz 2: Orbital Mechanics (Doppler Effects)

Name: KEY

A satellite, in a 500 km high circular orbit, carries a 3 GHz transmitter. Determine: $v = \sqrt{\frac{\mu}{r}}$

a) The orbital velocity.
b) The orbital period.
c) The orbital angular velocity in radians per second;
d) If an earth station on the surface of the earth at mean sea level, 6,370 km from the center of the earth, can receive the transmissions down to an elevation angle of 0°, calculate the maximum Doppler shift that this station will observe. Note: include the earth's rotation and be sure you consider the *maximum possible* Doppler shift (i.e. 2Δf).

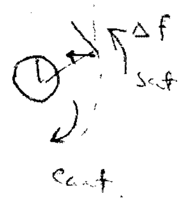
Note: assume the average radius of the earth is 6,370 km and Kepler's constant has the value $3.986004418 \times 10^5\ km^3/s^2$.

a) $v = \sqrt{\frac{\mu}{r}} = 7.6171$ Km/sec (1)

b) $T = \frac{2\pi r}{v} = 5.667 \times 10^3$ sec (2)

c) $V_{angular} = \frac{2\pi}{T} = 0.0011$ rad/sec. (2)

d) $v_{on\ direction} = v * \frac{r_e}{r_e + h} = 7.0626$ Km/sec. (2) Δf↓



Max when earth rotate in the opposite direction

Earth rotation (angular) $= \frac{2\pi}{\text{sidereal day}} \simeq \frac{2\pi}{24 * 60 * 60} =$ (1)

speed on Earth surface $= \frac{2\pi}{\simeq 24 * 60 * 60} * r_e$

Total speed $= 7062.6 + 463.23 = 7.526$ km/sec

$\Delta f = \frac{V_T}{\lambda}$ (1)

$2\Delta f = 150.5196$ kHz (1)

↳ Because max increase is Δf & max decrease is Δf.

Good Luck, **Dr. Ali Muqaibel**

without Earth Station
$2\Delta f = 141.25$ KHz