Jordan University of Science and Technology
Department of Electrical Engineering
Satellite Communication Systems (EE558) 1st Exam

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Q1 A satellite is placed in a circular orbit with an orbital period of two hours. Calculate the height of the satellite above sea level and it's velocity in Km/hr.

Q2

a- What are three types of satellite orbits according to their heights?
b- What are three types of satellite orbits according to their inclination?
c- Define: apogee, inclination, ascending node, and retrograde orbit.
d- What are the six keplerian orbital elements?

Q3 An earth station is located in Amman with a latitude of 32° N and a longitude of 36° E. Calculate the antenna look angles for an Arabsat at 26° E.

Q4 A 6 meters paraboloidal antenna has an illumination efficiency of 60 percent. Calculate the effective aperture, the power gain, and the half power beamwidth at 12 GHz.

Q5

a- What are the three types of losses suffered by a satellite signal when it passes through earth atmosphere?
b- What are the different types of polarization?
c- What are the two types of double reflector antennas (draw)?
d- Define: the polarization loss, offset feed, isotropic antenna, and cross polarization discrimination.

$$a^3 = \frac{\mu}{n^2}, \quad P = \frac{2\pi}{n}, \quad \mu = 3.986 \times 10^{14}\ m^3/s^2$$

$$B = \phi_E - \phi_{ss}, \quad b = \arccos(\cos B \cos \lambda_E)$$

$$A = \arcsin\left(\frac{\sin|B|}{\sin b}\right) \qquad R = 6370\ Km$$

$$El = \arccos\left(\frac{a_{GSO}}{d} \sin b\right) \qquad a_{GSO} = 42164\ Km$$

$$d = \sqrt{R^2 + a_{GSO}^2 - 2 R a_{GSO} \cos b}$$

$$A_{eff} = \eta A_{physical}, \quad G = \frac{4\pi A_{eff}}{\lambda^2}$$

$$G(dish) = \eta \left(\frac{\pi D}{\lambda}\right)^2, \quad HPBW = 70 \frac{\lambda}{D}°$$

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Q1 $P = 2h$

$$a^3 = \mu \left(\frac{P}{2\pi}\right)^2$$

$$a^3 = 3.986 \times 10^{14} \left(\frac{2 \times 60 \times 60}{2\pi}\right)^2 = 5.234 \times 10^{20}$$

20

$$a = 8.06 \times 10^6 \text{ m} = 8059 \text{ km}.$$

$$h = a - R = 8059 - 6370 = \boxed{1689 \text{ km}}$$

$$n = \frac{2\pi a}{P} = \frac{2\pi (8059 \text{ km})}{2 \text{ hr}} = \boxed{25.318 \times 10^3 \text{ km/hr}}$$

Q2

ⓐ 1. low earth orbits (LEO)
2. Medium earth orbits (MEO).
3. Geostationary orbit.

5

ⓑ 1. equatorial orbit.
2. polar orbit.
3. inclined orbit.

5

ⓒ apogee: is the farthest point of the satellite path according to earth's equatorial plane.

5

inclination: is the angle measured east ward, in the earth's equatorial plane at the ascending node form east to north.

ascending node: ~~the point lies in the equatorial plane, measured~~

the point of the satellite plane that lies in the equatorial plane measured when the sat goes from ~~north to east~~ south to north.

retrograde orbit: the orbits which rotate in a direction opposite to the earth rotation direction (Inclination angle $90 \leq i \leq 180$).

(d) (a) semimajor axis, (e) eccentricity, (i) inclination, pergee

right asention of the ascending node, true anomaly

Q3

$\lambda_E = 32$

$\phi_E = 36$ $\qquad \phi_{ss} = 26°$

soln.

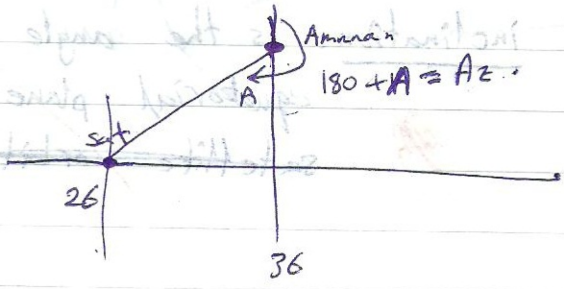
$B = \phi_E - \phi_{ss} = 36 - 26 = 10°$

$b = \arccos(\cos 10 \cos 32) = 33.37°$

$A = \arcsin\left(\frac{\sin(10)}{\sin(33.37)}\right) = 18.4°$

$$Az = 180 + A = 198.4°$$

λ_E	B	Az
<0	<0	A
<0	>0	360−A
>0	<0	180−A
>0	>0	180+A



3

$$d = \sqrt{R^2 + a_{GSO}^2 - 2 R a_{GSO} \cos b}$$

R = 6370, a_{GSO} = 42164, b = 33.37°

$d = 37010.4$ km > 36000 km!!

$$E_l = \arccos\left(\frac{a_{GSO}}{d} \sin b\right) = 51.2^\circ$$

Q4 $D = 6$ m $\eta = 0.6$

$$A_{physical} = \frac{\pi D^2}{4} = 9\pi = 28.274 \text{ m}^2$$

$$A_{effective} = \eta A_{physical} = 0.6 * 28.274 = 16.965 \text{ m}^2$$ #

$$G = \frac{4\pi A_{eff}}{\lambda^2}, \quad \lambda = \frac{c}{f} = \frac{3\times10^8}{12\times10^9} = 0.025 \text{ m}$$

$$G = 341.1 \times 10^3$$

$$HPBW = 70 \frac{\lambda}{D} = 0.2917^\circ$$

Q5 (19)

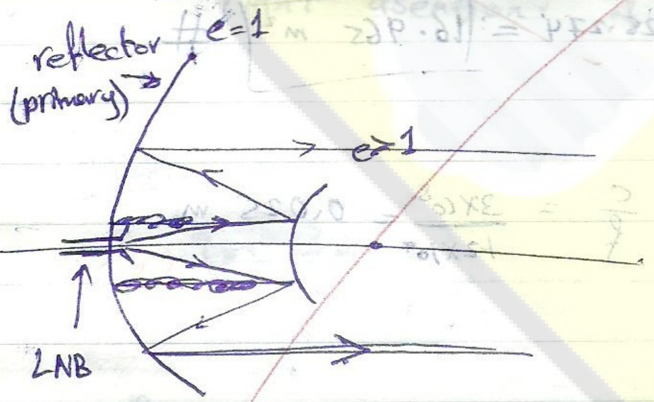
ⓐ 1. atmosphere losses.
2. Ionosphere losses.
~~3. rain losses.~~
~~heavy~~
~~4. ice & snow losses.~~
3. heavy rain, ice & snow losses.
~~4. sky~~

(5)

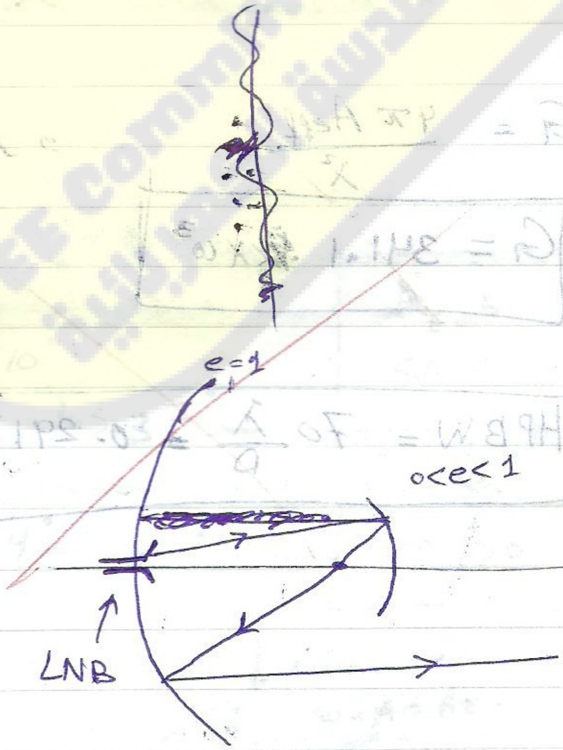
ⓑ
1. Linear polarization.
2. Elliptical polarization (3 circular polarization).

(3)

ⓒ
1- Cassagerain.



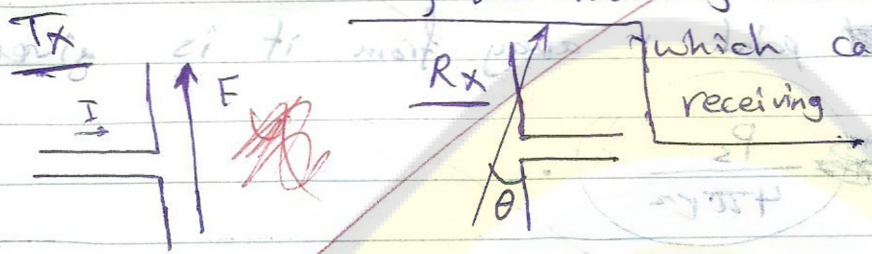
2. Gregorian



(5)

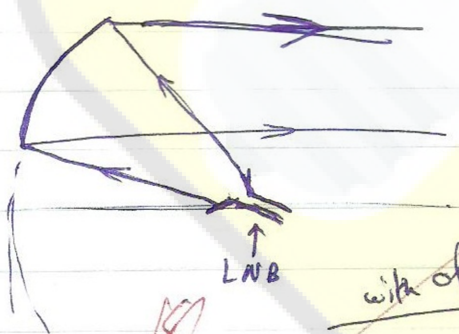
(d) **polarization loss :** The polarization type of the transmitting & the receiving antenna not the same which cause loss in the receiving power signal!!

ex1 :



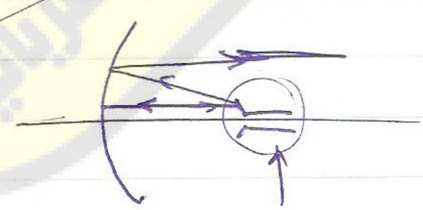
ex2 : One antenna RHC polarized & the other is LHC polarized.

offset feed :



with offset

the advantage is there is no blockage wave.



block about 10% of the wave.

Isotropic antenna: An antenna that radiate the wave equally in all directions. & its power at a point r away from it is given by:

$$\frac{P_s}{4\pi r^2}.$$

$$XPD = 20 \log \frac{E_{11}}{E_{12}} \text{ dB}$$

which can be determined by θ_F : faraday's angle.