

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF ELECTRICAL ENGINEERING

EE 672 SATELLITE COMMUNICATIONS
EXAMINATION II

21 May, 2007

NAME :	
I.D. # :	

PROBLEM #	Q. 1	Q.2	Q.3	Q.4	TOTAL
Marks					
Maximum	30	20	30	20	100

Q.1 The normalized far field radiation intensity of an antenna is given by:

$$U(\theta, \phi) = \begin{cases} \sin \theta \cos^2 \phi & 0 \leq \theta \leq \pi \text{ and } 0 \leq \phi \leq \pi/2, 3\pi/2 \leq \phi \leq 2\pi \\ 0 & \text{elsewhere} \end{cases}$$

- Sketch the 3-D radiation pattern and determine the direction of maximum radiation.
- Calculate the maximum directivity.
- Calculate the half-power beam-width in the azimuth plane (x-y plane).
- Calculate the half-power beam-width in the elevation plane (x-z plane).
- Calculate the approximate directivity using the approximate formula $D_o = 4\pi / (\theta_{1r} \theta_{2r})$ and determine the percentage error.
- Sketch the 2-D radiation pattern (rectangular form) in the azimuth plane.

Q.2 A low earth orbit (LEO) satellite system transmits 1 W at 1.62 GHz using a 29 dB gain antenna with spot beam directed towards users on the earth that are a maximum of 1500 Km away. Calculate:

- The received power, if the user antenna has a 1 dB gain when directed towards the satellite.
- The required satellite EIRP (Effective Isotropically Radiated Power) in dBm, in order for the received power to be at least -90 dBm.

Q.3 A DBS TV system operates at $f = 12$ GHz and has the following specifications:
 Output transmitter power per channel = 250 W, Transmitter antenna gain = 40 dB,
 Nominal path length to the receiving earth station = 37750 km,
 Clear air atmospheric loss = 1 dB,
 Receiving antenna diameter = 0.6 m., its efficiency = 65%, and $T_A = 50$ K
 Polarization loss in receiving antenna = 0.7 dB
 Pointing error in receiving antenna = 0.6 dB, Waveguide loss before LNA = 2 dB
 LNA gain = 30 dB and its noise figure = 2 dB, mixer noise temperature = 500 K,
 IF amplifier gain = 20 dB and its noise temperature = 700 K.
 Calculate the following:

- The system noise temperature referred to the input terminals of the LNA,
- The received signal power in dBW
- The receiver noise power in dBW
- The downlink C/N
- The available margin over 9 dB (C/N) threshold
- The earth station G/T ratio.

Taking into consideration that the earth station is located at the edge of the coverage zone where the received power is -3 dB relative to the center of the coverage zone. The channel bandwidth is 27 MHz and the ambient noise temperature is 290 K.

(Boltzman's constant = -228.6 dBW/K/Hz)

Q.4

- Represent BPSK and QPSK signals in the I-Q plane.
- Choose the most suitable modulation scheme among the following types, to use in the listed satellite services.

AM, DSBSC, SSB, FM, PM, ASK, BPSK, QPSK, 8-ary PSK, 16-ary PSK.

Satellite service:

- FSS, analog multiplexed telephony
- FSS, digital data
- DBS, analog tv programs
- MSS, analog telephony
- MSS, digital data.
