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:

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

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

1. The received power, if the user antenna has a 1 dB gain when directed towards the satellite.
2. 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:

a. The system noise temperature referred to the input terminals of the LNA,
b. The received signal power in dBW
c. The receiver noise power in dBW
d. The downlink C/N
e. The available margin over 9 dB (C/N) threshold
f. 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

1. Represent BPSK and QPSK signals in the I-Q plane.
2. 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:

a. FSS, analog multiplexed telephony
b. FSS, digital data
c. DBS, analog tv programs
d. MSS, analog telephony
e. MSS, digital data.