AMIETE – ET (OLD SCHEME)

Code: AE22 **Subject: SATELLITE & SPACE COMMUNICATION**
Time: 3 Hours **Max. Marks: 100**

JUNE 2009

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2 × 10)**

a. An era of expansion for telecommunication satellites was marked in

(A) the late 1930s. **(B)** the late 1970s.
(C) the late 1980s. **(D)** the late 1960s.

b. If an earth station is in the Northern Hemisphere with satellite to the SE of the earth station, then the azimuth look angle can be found from

(A) $A_Z = 90° - \alpha$. **(B)** $A_Z = 180° + \alpha$.
(C) $A_Z = 180° - \alpha$. **(D)** $A_Z = \alpha$; with usual notations.

c. For a nominal geostationary orbit, the requirement on the central angle for the satellite to be visible is that γ be

(A) $\leq 91.3°$. **(B)** $\leq 81.3°$.
(C) $\leq 61.3°$. **(D)** $\leq 71.3°$.

d. The width of the ionosphere above the troposphere is typically

(A) 200 Km. **(B)** 310 Km.
(C) 400 Km. **(D)** 500 Km.

e. If the EIRP for a satellite downlink at 12 GHz is 56 dBW and the antenna gain is 48.2 dB, then the operating transmit power of the link is

(A) 3.5 W. **(B)** 6 W.
(C) 8.23 W. **(D)** 2.192 W.

f. A system sends digital data with a baseband bandwidth of 4.8 KHz using analog FM and the resulting RF signal bandwidth is 16.8 KHz. If the CNR for the signal from the satellite is 10dB, then for a peak frequency deviation of 3.6KHz, the SNR of the baseband waveform for the FM receiver is

(A) 13.5 dB. **(B)** 15.5 dB.
(C) 10.5 dB. **(D)** 8.5 dB.

g. An earth station in a satellite network uses an antenna of 12m diameter with an efficiency of 65%. The gain of the earth station antenna is then equal to

(A) 52.16 dB. **(B)** 56.31 dB.
(C) 50.13 dB. **(D)** 62.2 dB.

h. A TDMA network of five earth stations shares a signal transponder equally. If the frame duration is 2 ms, the preamble time per station is 20 μs, and guard bands of 5 μs are used between bursts then the data burst duration for each earth station is

(A) 265 μs. **(B)** 375 μs.
(C) 175 μs. **(D)** 230.2 μs.

i. A (15, 11) BCH code can be correct upto

(A) Two errors. **(B)** Three errors.
(C) One error. **(D)** Four errors.

j. Most VSAT systems operate in

(A) X-band. **(B)** C-band.
(C) Ku-band. **(D)** L-band.

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Why geostationary orbit is preferred for all high capacity communication satellite systems? Briefly explain Kepler's second law of planetary motion, with necessary illustrations. **(9)**

b. An earth station is located at 30°W longitude and 50°N latitude. Determine the earth station azymnth and elevation angles with respect to geostationary satellite located at 50°W longitude. Assume the orbital radius and the earth's radius to be 42164 Km and 6378 Km respectively. **(7)**

Q.3 a. Distinguish between atmospheric attenuation and atmospheric absorption and write a brief note on atmospheric absorption loss. **(6)**

b. In the study of an earth station receiver, to determine its performance, which is the important quantity that the designer is required to evaluate? Briefly comment on the above quantity. Write the block diagram of an earth station receiver with single frequency conversion. **(7)**

c. An LNA is connected to a receiver which has a noise figure of 12 dB. The gain of the

LNA is 40 dB, and its noise temperature is 120K. What is the overall noise temperature referred to the LNA input? **(3)**

Q.4 a. What are the objectives in the design of any satellite communication? What do you mean by a link budget? How does it help the designer? **(7)**

b. A DBS-TV system has the following:
(i) Noise temperature of LNA=110 K;
(ii) Antenna noise temperature in clear sky condition = 12 K;
(iii) Clear sky system noise temperature = 145 K;
(iv) Down-link (C/N) ratio in clear sky conditions = 14.3;
(v) Sky noise temperature in rain = 147 K.

Calculate the increase in noise power, caused by the increase in the sky noise temperature due to rain and the resulting $\left(\frac{C}{N}\right)_{dn\,rain}$ value, when rain intersects the down link. Take the rain attenuation in the downlink as 3-dB. **(9)**

Q.5 a. Why PSK is preferred in satellite links that FSK? Write the general expression for the baseband S-N-R of a satellite system that uses FM. Define the term deviation ratio for FM. **(6)**

b. Distinguish between TDM and FDM. Write six important points that one should know of a TDM system in general. Illustrate the slot organisation of one T1 frame for the US.T1 TDM system **(10)**

Q.6 a. What is a transponder? What is the typical bandwidth of a transponder and how many transponders can be accommodated in the bandwidth allocated for C-band service? **(7)**

b. What is the function of antennas carried aboard a satellite? Write the equations for the gain and the –3 dB beamwidth for a paraboloidal reflector and comment on the key factor in the above equations. **(9)**

Q.7 a. Distinguish between multiple access and multiplexing. What do you mean by a TDM-TDMA signal? With necessary illustrations, briefly describe a typical fixed assignment FDMA plan for two C-band transponders. **(6)**

b. Three identical large earth stations with 500 W saturated output power transmitters access a 36 MHz bandwidth transponder using FDMA. The saturated output power of the transponder is 40 W and it is operated with 3-dB output backoff when FDMA is used. The bandwidths of the earth station signals are : *Station 1* = 15MHz, *Station 2* = 10MHz, *Station 3* = 5MHz. Find the transponder output power allocated to each earth station's signal. **(10)**

Q.8 a. What is the function of the CDMA chip sequence? CDMA is also known as spread spectrum, why is it so? What do you mean by low probability of intercept? Is CDMA widely adopted by satellite communication systems? Support your answer with relevant reasoning. **(7)**

b. What is the underlying concept behind most VSAT systems? What is spoofing? What are

the major elements that concern VSAT systems design? What are the factors that often determine the choice between FDMA, TDMA & CDMA for VSAT networks? Define outbound or outroute channel for an FDMA VSAT system. **(9)**

Q.9 a. Write the equation that describes the upper limit on the information capacity of the channel for any digital communication system that operates with a noisy channel. **(4)**

b. Write the general form of a linear block codeword. What does error control perform? Why are cyclic codes widely used in satellite transmission? Write a note on Golay codes. **(9)**

c. How are convolutional codes generated? Define the term 'state' of a convolution encoder. **(3)**