M. E. Electronics & Telecommunication Engineering Examination 2024
(1st Year, 2nd Semester)
Satellite Communication (COMM)

Time: Three hours | Full Marks: 100

Answer any seven questions from Part-I and any three questions from Part-II
Answer all the parts of a question in the same place

Part – I

1. a) Explain the relevance of Kepler's laws to artificial satellites orbiting the earth.
   b) Why higher frequencies are used for uplink compared to downlink in satellite communication?
   c) Write the difference between bent-pipe and on-board processing satellite transponder.

   (4+3+3)

2. a) Write important merits and demerits of GEO satellite.
   b) A LEO satellite orbits around the earth at an altitude of 250 km above the earth's surface. Assume mean earth's radius is approximately 6378.14 km and the value of Kepler's constant (μ) = 3.986×10^5 km^3/s^2. Calculate the period of the satellite and linear velocity along its orbit.

   (4+6)

3. a) What do you mean by system noise temperature?
   b) Derive a system noise temperature expression for a satellite receiver.
   c) A 4-GHz satellite receiver has following noise temperatures and gains.
   T_{in} = 25 K, T_{RF} = 50 K, T_{IF} = 1000 K, T_m = 500 K
   G_{RF} = 23 dB, G_{IF} = 30 dB, G_m = -10 dB
   Calculate the system noise temperature.

   (2+ 5+3)

4. a) Write the basic requirements for an earth station antenna. Briefly describe the operation of a cassegrain antenna with a neat sketch.
   b) Explain the operation of HPAs in a 1:2 redundancy configuration for dual polarization operation.

   (6+4)

5. a) Write the names of main sub-systems of a communication satellite. Explain the operation of TT&C subsystem with a block diagram.
   b) Briefly explain the effect of rain in the uplink and downlink satellite communication.

(6+4)

6. a) Write the different losses occurred during radio propagation in a satellite link.
   b) A Ku-band satellite transponder has a linear gain of 127 dB and a nominal output power at saturation of 5W. The satellite's 14-GHz receiving antenna has a gain of 26 dB on axis. Calculate the power output of an uplink Earth station transmitter that gives an output power of 1 W from the satellite transponder at a frequency of 14.45 GHz when the Earth station antenna has a gain of 50 dB and there is a 1.5 dB loss in the waveguide run between the transmitter and antenna. Assume that the atmosphere introduces a loss of 0.5 dB under clear sky conditions and antenna pointing loss of 2 dB. If rain in the path causes attenuation of 7 dB for 0.01% of the year, then calculate the output power required for the transmitter to guarantee that 1 W output can be obtained from the satellite transponder for 99.99% of the year.

(2+8)

7. a) What is VSAT network? Describe different VSAT network topologies.
   b) Consider a typical VSAT earth station which is a part of TDMA network using 54 MHz bandwidth transponder on a domestic Ku-band GEO satellite. The VSAT earth transmits a single 64 kbps signal at 14 GHz. Assume that the TDMA network uses QPSK modulation and that all transmitters have a symbol rate of 30 Mbaud. Calculate the required uplink transmit power to achieve $(C/N)_{up}$ = 20 dB. The system parameters: Earth station antenna gain = 41.5 dB, satellite antenna gain (on axis) = 32.0 dB, edge of beam loss = 3 dB, transponder noise temperature = 500 K, atmospheric and other losses = 1.0 dB; Boltzmann's constant = -228.6 dBW/K/Hz

(4+6)

8. a) What do you mean by MSAT? Describe different types of handover in MSAT.
   b) For a satellite communication link with equal uplink and downlink performance, show that the composite system carrier to noise ratio is 3 dB below the value of each of the individual links.

(7+3)

Part – II

9. Draw the block diagram of a satellite communication sub-system of 24 transponders for the 6/4 GHz band operated with orthogonal circularly polarized signals. Also show the corresponding frequency plan for this satellite.

(5+5)

10. Use a neat sketch to show the configuration of the Intermediate Frequency (IF) bandwidth (54MHz) of a FDMA receiver with 25 data channels, where the IF band is centered at 70 MHz. Also, draw the block diagram of this IF section and explain its operation by identifying each block.

(5+5)

11. Explain with detailed mathematical derivation, how, third order Inter Modulation (IM) products are generated in the transponder of the satellite communication system using FDMA.

(10)

12. Draw the block diagram of a Single Channel Correlator for C/A code acquisition used in GPS. Also, explain the correlation process considering two situations: a) when the locally generated C/A code exactly matches the received code; b) when the locally generated C/A code does not match the received code.

(2+8)