Registration No : | | | | | | | | | | |

Total Number of Pages : 03 **B.Tech**

PET7J002

7th Semester Regular Examination 2019-20

SATELLITE COMMUNICATION SYSTEMS

BRANCH : ECE, ETC

Max Marks : 100

Time : 3 Hours

Q.CODE : HR035

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.

The figures in the right hand margin indicate marks.

Part- I

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

a) Write the conditions required for an orbit to be geo-stationary.

b) Calculate the maximum possible line-of-sight distance between two GEO satellites.

c) Which batteries are preferred for space craft applications? Specify the reason behind it.

d) Why is Faraday rotation of no concern with circularly polarized waves?

e) Why is it desirable to down convert the satellite TV signal received at the antenna?

f) What is the effective aperture of an isotropic antenna operating at a wavelength of 5 cm?

g) Why does the period of a satellite in an equatorial synchronous orbit deviate a small amount from 24 hours? What technique is adopted to correct the period?

h) What is understood by look angle in satellite communication systems? What parameters must be known to calculate the look angle of a geosynchronous satellite?

i) Why is it preferable to operate with a satellite positioned west, rather than east, of earth station longitude?

j) What are the significances of energy dispersal waveform in television signal?

Part- II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) An earth station uses a 2.5-m diameter parabolic antenna to receive a 4-GHz signal from a geostationary satellite. If the satellite transmitter delivers 20 Watt power into a 3-m diameter transmitting antenna and the satellite is located 36000 km from the receiver, what is the power received?

b) With suitable block diagram discuss the simplified double conversion transponder for 14/11 GHz band.

c) Briefly describe the following tests performed during earth station installation and commissioning:

a. Receiver figure of merit
b. EIRP stability
c. Spectral shape
d. Transmit cross-polarization isolation

d) A 14/11 GHz satellite link has a transponder with an output power level of 20W. The satellite transmit antenna gain at 11 GHz is 35 dB. Path loss to this station is 22 dB, including clear air atmospheric loss. The earth stations used to receive the voice signals with a gain of 40 dB (1m diameter) and a receiver with Tsystem = 160K in clear air, and IF noise bandwidth 50 kHz. Calculate the C/N link margin over a threshold of 6 dB.

e) The typical minimum elevation angles used by earth stations operating in the commercial Fixed Services using Satellites (FSS) communications bands are as follows: C-Band 5°; Ku-Band 10°; and Ka-Band 20°.

a. Determine the maximum and minimum range in kilometers from an earth station to a geostationary satellite in the these bands.
b. To what round-trip signal propagation times do these ranges correspond?

f) How do you define TDMA frame efficiency? Why do we need to have a high TDMA frame efficiency? What are the various possible approaches to increase TDMA frame efficiency?

g) A geostationary satellite has a round trip delay variation of 40 ns per second due to station keeping errors. If the time synchronization of DS-CDMA signals from different earth stations is not exceed 10% of the chip duration, determine the maximum allowable chip rate so that a station can make a correction once per satellite round trip delay. Assume satellite round trip delay to be 300 ms.

h) Explain in detail the operation of Spade system of demand assignment. What is the function of the common signaling channel?

i) Explain what is meant by pre-emphasis and de-emphasis. Why these are effective in improving signal-to-noise ratio in FM transmission. State typical improvement levels expected for both telephony and TV transmissions

j) Explain how a QPSK signal can be represented by BPSK signal. Draw the constellation diagram for QPSK signal. Derive the relationship between the bandwidth of QPSK signal with that of BPSK signal.

k) Derive an expression for a digital satellite link and explain how it is dependent on system bandwidth?

l) An earth station is located at Delhi (28.7041° N, 77.1025° E). Determine the earth station's azimuth and elevation angles with respect to a satellite located over Sriharikota (13.73° N, 80.20° E) . The orbital radius is 42164 km. (Assume radius of earth is 6378 km)

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Describe the complete uplink and downlink system design for 14/11 GHz band satellite system in a clear air atmosphere. **(16)**

Q4 A satellite communication system uses a single 50 MHz bandwidth Ku-band transponder to carry 250 two way telephone conversations using analog modulation with SCPC-FM. The parameters of any one channel are, Voice channel bandwidth: 100 - 3400 Hz, RF channel bandwidth: 45 kHz, RF channel spacing: 65 kHz, downlink path loss (incl. atmos. loss):206.5 dB, satellite downlink antenna gain (on axis): 29 dB, demodulator FM threshold: 5 dB. The transponder has a saturated power output of 40 watts, but is run with 2 dB output back off to achieve near-linear operation. The uplink stations which transmit the SCPC-FM signals to the transponder achieve (C/N) up= 25 dB in the 45 kHz channel noise bandwidth of the earth station receiver. The system noise temperature of the receiving earth station is 120 K in clear air. **(16)**

a) Calculate the power per RF channel at the transponder output.
b) Calculate the diameter of the receiving antenna with a circular aperture having 55% aperture efficiency at a frequency of 12 GHz.
c) The receiver applies a de-emphasis weighting of 6 dB to recover the voice signal and a psophometric weighting of 2.5 dB. Calculate the weighted S/N at the base band output of the receiver.
d) Is the S/N adequate in clear air? If the downlink fades by 5 dB because of the rain, what is the S/N at the baseband? Is this acceptable for voice communication?

Q5 The eastern belt of Odisha can be represented approximately on a map as an area bounded by 19.31° N latitude, 21.34° N latitude, 84.79° E longitude, and 86.66° E longitude. A geostationary satellite located at 85.48° E longitude has an antenna with a spot beam that covers all of the area at a downlink center frequency of 12.54 GHz. So estimate the antenna dimensions subject to two different assumptions. In both cases use an aperture efficiency of 55 percent. **(16)**

a) The antenna is a circular parabolic reflector generating a circular beam with a 3 dB beam width equal to the diagonal of the area bounding the eastern belt of Odisha. Calculate the beam width of the antenna from simple geometry. Hence determine the diameter of the antenna on the satellite in meters and its approximate gain in decibels.

b) The antenna is an elliptical parabolic reflector with 3 dB beam widths in the N-S and E-W directions are equal to the height and the width of the area bounding eastern belt of Odisha. Calculate the required 3 dB beam widths of the satellite antenna. Calculate the approximate gain of the antenna.

Q6 Two earth station are located at Chandipur (21.43° N, 87.01° E) and Sunabeda (18.72° N, 82.83° E). They are communicating with each other via a satellite located over Sriharikota (13.73° N, 80.20° E) .Calculate the total delay in sending 1500 kbs of information if the transmission speed is 50 Mbps. Assume the orbital radius to be 42164 km and radius of earth is 6378 km. **(16)**