(b) A geostationary satellite carries a C-band transponder which transmits 20 watts into an antenna with an on-axis gain of 30 dB. An earth station is in the center of the antenna beam from the satellite, at 38,000 km. For a frequency of 4.0 GHz:

(i) Calculate the incident flux density at the earth station in watts per square meter and in dBW/m^2. (3)

(ii) The earth station has an antenna with a circular aperture 2 m in diameter and an aperture efficiency of 65%. Calculate the received power level in wafts and in dBW at the antenna output port. (3)

(iii) Calculate the on-axis gain of the antenna in dB. (3)

(iv) Calculate the free space path loss between the satellite and the earth station. (3)

(v) Calculate the power received, Pr, at the earth station. (3)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 90459

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Fifth/Seventh/Eighth Semester

Electronics and Communication Engineering

EC 8094 – SATELLITE COMMUNICATION

(Common to: Electronics and Telecommunication Engineering/ Geoinformatics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name the six orbital elements used to coordinate the satellite.

2. How can sun transit outage be prevented?

3. What is the use of attitude and orbit control system in a satellite?

4. Write short note on the two types of transponders used in satellites.

5. What is ionospheric scintillation?

6. State Effective Isotropic Radiated Power?

7. What is DAMA? Where it is useful?

8. Which are the preferred modulation schemes in DVB-S2 standard and why?

9. Mention the two types of codes used in GPS.

10. What is a VSAT? In which frequency band it is operated?

PART B — (5 × 13 = 65 marks)

11. (a) (i) How do you describe the orbit of a satellite? Explain with necessary equations and figure. (8)

(ii) Describe various types of orbital perturbations an Earth orbiting satellite may experience with illustration. (5)

Or

(b) (i) Describe the steps involved in locating the satellite in the orbit. (8)

(ii) Determine the geostationary Earth Orbit Radius using Kepler's third law. (5)

12. (a) Explain in detail about the communication subsystem in a satellite that uses orthogonal circularly polarized signals with block diagram and frequency plan. (13)

Or

(b) (i) Explain in detail about Station Keeping for a satellite. (6)

(ii) Explain the telemetry, tracking, command, and monitoring subsystem with block diagram. (7)

13. (a) (i) How do you find the noise temperature from the noise figure of a receiver? Also explain how GNR can be found from the G/T ratio of a receiver. (6)

(ii) An earth station antenna has a diameter of 30 m with an aperture efficiency of 68% and is used to receive a signal at 4150 MHz. At this frequency, the system noise temperature is 60 K when the antenna points at the satellite at an elevation angle of 28°. What is the earth station G/T ratio under these conditions? If heavy rain causes the sky temperature to increase so that the system noise temperature rises to 88 K, what is the new G/T value? (7)

Or

(b) (i) Write about output back-off used to reduce non-linearity at the satellite output. How is it related to input back-off? (6)

(ii) Derive a formula for the combined C/N ratio of bent-pipe transponder satellite link. (7)

14. (a) Explain in detail about the radio frequency transmission of digital data with transmitter and receiver block diagrams along with the details of time and frequency domain signals. (13)

Or

(b) Derive the processing gain and the system capacity of a DSSS CDMA system. (13)

15. (a) (i) Show with block diagram how L1 and L2 signals are generated on board a GPS satellite. (6)

(ii) Explain the C/A code generator in GPS. (7)

Or

(b) Draw and explain about:

(i) Single channel Ku-band satellite TV receiver. (6)

(ii) Four channel Ku-band LNC block to receive signal from two satellites. (7)

PART C — (1 × 15 = 15 marks)

16. (a) A digital communication system uses a satellite transponder with a bandwidth of 54 MHz. Several earth stations share the transponder using QPSK modulation using either FDMA or TDMA. Standard message data rates used in the system are 80 kbps and 2.0 Mbps. The transmitters and receivers in the system all use ideal RRC filters with $\alpha = 0.25$, and FDMA channels in the satellite are separated by 100 kHz guard bands. When TDMA is used, the TDMA frame is 125 μs in length, and a 2 μs guard time is required between each access. A preamble of 148 bits must be sent by each earth station at the start of each transmitted data burst.

(i) What are the symbol rates for the 80 kbps and 2.0 Mbps QPSK signals sent using FDMA? (3)

(ii) What is the symbol rate of each earth station's transmitted data burst when TDMA is used? (3)

(iii) Calculate the number of earth stations that can be served by the transponder when 80 kbps channels are sent using FDMA and TDMA. (4)

(iv) Calculate the number of earth stations that can be served by the transponder when 2.0 Mbps channels are sent using FDMA, and TDMA. (5)

Or