J/L/TX

Reg. No: 21BEC0328

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BECE310L - Satellite Communications

Class NBR(s): 3615 Slot: F2+TF2

Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instructions: Assume any missing data appropriately. Provide illustration, wherever necessary

Answer ALL Questions

(10 X 10 = 100 Marks)

1. a) A satellite orbit has an eccentricity of 0.2 and a semimajor axis of 10,000 km. Find the values of (i) the latus rectum; (ii) the minor axis; (iii) the distance between foci, (iv) find the length of the position vector when the true anomaly is 130°. **[7]**

   b) Determine the escape velocity for an object to be launched from surface of earth from a point where earth's radius is 6360 km. **[3]**

   (G= 6.67 ×10-11 Nm^2/kg^2 and M=5.98×10^{24}kg).

2.(a) Consider two earth stations A and B with longitudes at 60°W and 90°W respectively and latitudes at 30°N and 45°N respectively. They are communicating with each other via a geostationary satellite located at 105°W. Measure the total delay in sending 500 kbps of information from one station to the other, if the transmission speed is 10 Mbps. (Assume earth's radius=6378 km and satellite orbital radius of 42164 km.)

OR

2.(b) i) Determine the latitude and longitude of the farthest north earth station which can link with any given geostationary satellite. The longitude should be given relative to the satellite longitude and a minimum elevation angle of 5° should be assumed for the earth station antenna. A Spherical earth of mean radius 6378 km may be assumed. **[5]**

ii) A Geosynchronous satellite moving in an equatorial circular orbit at a height of 35800 km above the surface of earth gets inclined at an angle of 2° due to gravitational pull of sun. Calculate the maximum deviation in latitude and also the maximum deviation in longitude. Also determine maximum displacements in kms caused by latitude and longitude displacements. **[5]**

(Earth's radius = 6378 km).

3. A satellite launch into geostationary orbit from Sriharikota (latitude 13.73° N) is optimized if 1.5° of inclination is removed at perigee and the remainder at apogee. If the height of the parking orbit is 300 km, compute the total incremental velocity required to place the satellite in a geostationary orbit using a liquid bi-propellant engine based Hohmann transfer. Also compute the time

periods of the various orbits involved. Assume radius of Geo-stationary orbit as 42164 km.

4. a) A Three-axis stabilized satellite has to generate 4000 W of electrical power from the solar panels. Assuming that the solar flux falling normal to the solar cells in the worst case is 1270 W/m^2, area of each solar cell is 4 cm^2 and conversion efficiency of solar cells including the losses due to cabling is 20%, determine the number of solar cells needed to generate the desired power. [6]

b) Determine the power gain and 3 dB beam width of a reflector antenna having an aperture area of 20 m^2 at an operating frequency of 10 GHz. [4]

5. A TDMA network of 5 earth stations shares a single transponder equally .The frame duration is 2 ms, the preamble time per station is 20μs, and guard band of 5μs are used between bursts. Transmission burst are QPSK at 30 MBaud. Calculate the number 64 Kbps voice channels that each TDMA earth station can transmit. If the earth stations send data rather than digital speech, what is the transmission rate of each earth station in Mbps? What is the efficiency of the TDMA system and find the data burst duration for each earth station, T_d in micro seconds.

6.(a) In a TV receiver, the antenna is often mounted on a tall mast and a long lossy cable is used to connect the antenna and the TV set. To overcome the effect of the lossy cable, a pre-amplifier is mounted on the antenna. In the given below Figure.1, XY represents the lossy Cable.

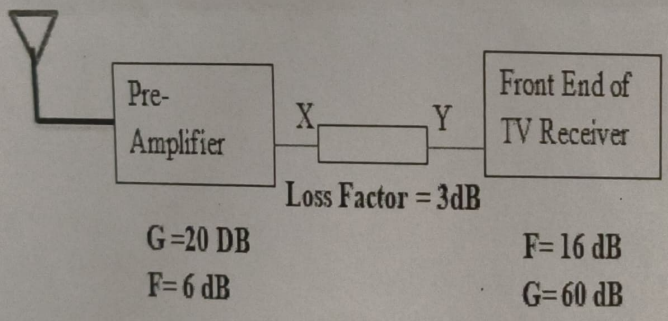

Figure.1

i) Find the overall noise figure of the system

ii) What will be the effect on the noise figure, if the pre-amplifier is removed, and instead the gain of the receiver front end is increased by 20 dB?

iii) Will the noise figure of the system change if the pre-amplifier is inserted after the cable, ie., between Y and the TV receiver?

OR

6.(b) Consider the earth station receive chain with Antenna, Waveguide; Low noise Amplifier and a Down converter respectively. Find the system noise temperature and (G/T) as referred to the input.

Antenna Gain = 55 dB, Waveguide Loss = 0.1 dB

Low noise amplifier gain = 55 dB,

Low noise amplifier equivalent noise temperature = 45 K,

Down converter equivalent noise temperature = 215000 K,

Ambient Temperature = 300 K,

Antenna noise temperature contributors: Main beam = 25 K,

Sub reflector spill over = 3.3 K, Main reflector spillover = 1 K,

Blockage = 10 K and Feed Loss = 15 K.

7. A C-band earth station has an antenna with a transmit gain of 54 dB. The transmitter output power is set to 100 W at a frequency of 6.100 GHz. The signal is received by a satellite at a distance of 37,500 km by an antenna with a gain of 26 dB. The signal is then routed to a transponder with a noise temperature of 500 K, a bandwidth of 36 MHz, and a gain of 110 dB.

i) Calculate the path loss

ii) Calculate the power at the output port of the satellite antenna, in dBW.

iii) Calculate the noise power at the transponder input, in dBW

iv) Calculate the C/N ratio, of the transponder in dB

v) Calculate the carrier power, at the transponder output in dBW and Watts.

8. Compare the STAR and MESH VSAT Network on their architecture implementation and specify their advantages and disadvantages.

9. Draw the block diagram of a DBS-TV receiver and explain in detail.

10. a) Explain with suitable diagram of Position Location in Global Positioning System (GPS). [7]

b) Compare the GPS and GLONASS satellite systems. [3]

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