

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2017

Level : B.E.
Year : IV

Course : ETEG 427
Semester : II

Exam Roll No. :

Time : 30 mins.

F. M. : 10

Registration No. :

Date AUG 25 2017

SECTION "A"

[20 Q. \times 0.5 = 10 marks]

Choose the most appropriate answer:

1. What is the approximate beamwidth of a global beam of a satellite?
a) 10° b) 12° c) 18° d) 20°
2. A satellite with a circular orbit of radius r takes 12 hours to complete one revolution of earth. If the same satellite had been at orbit with radius $2r$, how long will it take to complete one revolution?
a) 5 hours b) 24 hours c) 49 hours d) 68 hours
3. Satellite has maximum gain of 60 dB and power output of 10 kW. What is its EIRP?
a) 600 dB W b) 600000 dBW c) 100 dBW d) 60 dBW
4. A satellite is moving in an elliptical orbit. It is desired that it should be shifted to a circular orbit. The required maneuver is executed by activating kick motors when at.....
a) apogee b) perigee
c) either apogee or perigee d) neither apogee nor perigee
5. The duration of satellite eclipses peak during.....
a) equinoxes b) solstices
c) both during equinoxes and solstices d) summer solstices
6. The owner of a communication satellite operating in Ku band is usually required to keep the spacecraft on station at its assigned place in the geosynchronous orbit with an accuracy of _____ degree.
a) 0.01° b) 0.05° c) 0.1° d) 1°
7. Various bands of frequencies including L, C, Ku and Ka are used in satellite communication. They all are however designatedin ITU specification:
a) HF b) VHF c) SHF d) EHF
8. The fixed satellite services (FSS) are usually operated on C band. The common C band frequency range is:
a) 3.5-6.5 GHz b) 11-15 GHz c) 26-40 GHz d) 1-2 GHz
9. Which of the following is NOT the factor contributing to orbital perturbation?
a) Solar radiation b) Weight of the satellite
c) Gravitational pull of sun and moon d) Oblateness of the earth
10. What does INTELSAT stands for?
a) International Telephone Satellites b) International Telecommunication Satellites
c) Intel Satellites d) Intercontinental Telephone Satellites
11. The typical bandwidth of a communication satellite is.....
a) 500 MHz b) 36 MHz c) 24 MHz d) 1 GHz

12. The angle measuring satellite position clockwise from the direction of true north in local horizontal plane is called _____
a) look angle b) inclination angle c) elevation angle d) azimuth angle
13. What is the minimum acceptable value of elevation angle?
a) 10° b) 20° c) 2° d) 5°
14. The smallest beam of satellites that concentrate power in very small areas are called....
a) hemispherical beam b) global beam
c) spot beam d) regional beam
15. The angle of inclination in polar orbits is _____
a) 90° b) 180° c) 0° d) 270°
16. Movement of satellite about yaw axis _____
a) moves footprint north south on earth b) moves footprint east west
c) rotates the footprint d) does not have any effect on the footprint
17. Why are internal walls of a horn antenna corrugated?
a) To increase gain
b) To reduce cross polarization
c) To increase the operational bandwidth
d) To increase the mechanical strength of the antenna
18. The sub reflector used in Cassegrain feed mechanism is a _____
a) Concave mirror b) convex mirror c) Paraboloid d) hyperboloid
19. What does link budget include?
a) Cost of establishing a single satellite link
b) Cost of leasing a single transponder bandwidth for a communication link
c) Signal and noise power calculation in a link
d) Delay calculation of a link
20. What is the most used modulation techniques in digital satellites?
a) FM b) PAM c) BPSK d) QPSK

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Time : 2 hrs. 30 mins.

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F. M. : 40

SECTION "B"

[5Q × 8 = 40 marks]

Attempt *ANY FIVE* questions. Use values and relations provided wherever necessary. Assume suitable values for missing data.

1. a. 'A satellite is a microwave repeater placed high above in the sky'. Explain the above statement highlighting the principles and components of satellite based communication and broadcasting systems. [2]
b. The apogee and perigee distance of a satellite orbiting in an elliptical orbit are respectively 45000 km and 7000 km. Determine the semi major axis, orbit eccentricity and period of the orbit. What is the velocity of the satellite when at its perigee? [3]
c. Satellite orbits can be classified into different types based on their orientation, eccentricity, and distance from earth. Define and explain various types of satellite orbits. How are highly elliptical Molniya orbits very useful for countries at high latitude like Russia? [3]
2. a. A DTH user subscribing TATA Sky, is located at Delhi (77.1° E longitude and 28.7° N latitude). The satellite broadcasting TATA Sky signals is a geostationary satellite named INSAT 4A at 83.0° E. Determine the azimuth and elevation angles at which the subscriber's home receiver antenna must be installed for proper viewing? [3]
b. What are various components of a satellite transponder? Explain them with example of a typical satellite transponder. [3]
c. Discuss about different methods of launching a satellite. [2]
3. a. For a satellite transmission path, the angle of elevation of the earth station antenna is 35° and the earth station is situated at mean sea level. The signal is vertically polarized at a frequency of 18 GHz. The rain height is 1 km, and a rain rate of 10 mm/h is exceeded for 0.001 percent of the year. Calculate the rain attenuation under these conditions. [3]
b. A satellite in orbit tends to deviate from its desired path and orientation. Explain various factors that cause orbital perturbation and also what effect they have on satellite orbits. [3]
c. Define the concept of equivalent noise temperature referring to the input. 'A receiver has equivalent noise temperature of 200 K'. What do you understand by this? [2]
4. a. A satellite communication system has following parameters related to the satellite, link and the earth station. Find the uplink transmitted power to achieve the required C/N at the satellite transponder in clear air conditions. Also find the link margin if the heavy rain causes the attenuation of 2 dB. [4]

SATELLITE:

Geostationary at 73°W longitude

24 C-Band and 28 Ku-band transponders

3.2 kW RF power output

Antenna gain (receiving): 31 dB

Receiver equivalent noise temperature: 500 K

Transponder saturated output power: 40 W

Transponder bandwidth: 36 MHz

LINK:

FM-TV analog signals of bandwidth 27 MHz

Clear air atmospheric and other losses: 0.5 dB

EARTH STATION:

Transmitting in C-band at a frequency of 6.285 GHz

C/N ratio of 26 dB required at C-band transponder

Uplink antenna: 9 m diameter, aperture efficiency of 68%.

Station located at 2 dB contour of the satellite footprint

Consider: path length for satellite=38500 km & Boltzmann's constant $k = -228.6$ dB/K/Hz

- b. What do you understand by attitude of a satellite? Explain attitude and orbit control subsystem (AOCS) of a satellite. [2]
 - c. How is power supply managed in a space station? [2]
- 5.
- a. A satellite data transmission system transmits data from two T1 carriers as a single 3.088 Mbps bit stream using QPSK. The symbol rate on the link is 1.544 Msps. The satellite link uses ideal RRC filters with $\alpha=0.25$. At the receiving terminal, the clear air value of overall $\left(\frac{C}{N}\right)_0$ is 16 dB and the implementation margin of the QPSK demodulator is 1 dB. What is the bandwidth occupied by this signal, noise bandwidth of the receiver of this system and BER at the receiver? [3]
 - b. Multiple access techniques are used to share a satellite resource with multiple earth stations. Describe TDMA and FDMA techniques as used in satellite communication. [3]
 - c. What is GPS? Describe the constellation used by GPS. [2]
- 6.
- a. A 4 GHz receiver consists of a RF amplifier (LNA) followed by a mixer and a IF amplifier. The RF amplifier is fed from an antenna through a lossy waveguide. The noise temperatures and gains of LNA, mixer and IF amplifier are $T_{RF} = 50$ K, $G_{RF} = 23$ dB, $T_m = 500$ K, $G_m = 0$ dB, $T_{IF} = 1000$ K, $G_{IF} = 30$ dB. If the input noise temperature from antenna is $T_{ant} = 25$ K and the loss of the waveguide is 2 dB (gain of 0.631), find the equivalent system noise temperature referred to the input of LNA. Consider that the waveguide is operating at the physical temperature of 300°K. [3]
 - b. How does satellite based Direct To Home (DTH) television systems work? What are the major operations and hence components of a DTH head end station? [3]
 - c. Different types of antennas are used in satellite communication systems. Where and for what purpose horn and parabolic reflector antennas are used in satellite communication systems? [2]

Note: Some useful constants and relationships:

For a geostationary satellite to be visible from an earth station, $b \leq 81.3^\circ$

$$b = \cos^{-1}(\cos B \cos \lambda_f)$$

$$\text{and, } A = \sin^{-1}\left(\frac{\sin|B|}{\sin b}\right)$$

$$d = \sqrt{R^2 + a_{GSO}^2 - 2Ra_{GSO} \cos b}$$

$$E_l = \cos^{-1}\left(\frac{a_{GSO}}{d} \sin b\right)$$

$$\text{Boltzmann's constant: } k = 1.38 \times 10^{-23} \text{ J/K}$$

$$\text{Earth's radius: } r = 6370 \text{ km}$$

$$\text{Orbital radius of GEO orbit: } R = 42000 \text{ km}$$

$$\mu = 39.8 \times 10^{13} \text{ Nm}^2 \text{ Kg}^{-1}$$

For length in km and rain rate in mm/h, slant length for large elevation angle is: L_s

$$= \frac{h_R - h_0}{\sin El}$$

reduction factor for $p = 0.001\%$: $r_{0.01} = \frac{10}{10 + L_G}$

Effective path length: $L = L_s r_p$

Rain attenuation: $A_p = a R_p^b L_s r_p \text{ dB}$

Occupied bandwidth of RF signal in PSK modulation: $B_{occ} = R_s(1 + \alpha)$

BER in BPSK: $Q \left[\sqrt{2 \frac{C}{N}} \right]$

Frequency, GHz	a_h	a_v	b_h	b_v
1	0.0000387	0.0000352	0.912	0.88
2	0.000154	0.000138	0.963	0.923
4	0.00065	0.000591	1.121	1.075
6	0.00175	0.00155	1.308	1.265
7	0.00301	0.00265	1.332	1.312
8	0.00454	0.00395	1.327	1.31
10	0.0101	0.00887	1.276	1.264
12	0.0188	0.0168	1.217	1.2
15	0.0367	0.0335	1.154	1.128
20	0.0751	0.0691	1.099	1.065
25	0.124	0.113	1.061	1.03
30	0.187	0.167	1.021	1

