

**SATELLITE COMMUNICATION AND APPLICATIONS
(ECE5141)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Difference between apogee and perigee distances in case of an elliptical orbit is 34000 km. If the major axis of the elliptical orbit is 50000 km, determine apogee and perigee distances.
(a) 42000 km, 8000 km (b) 50000 km, 42000 km
(c) 42500 km, 8500 km (d) None of these
- (ii) The point of intersection of satellite's orbital plane and equatorial plane where the satellite enters from northern hemisphere into southern hemisphere is called as.
(a) Ascending node (b) Perigee
(c) Apogee (d) Descending node
- (iii) The orbital period in case of Monliya satellites is as.
(a) 12 hr (b) 24 hr
(c) 8 hr (d) 16 hr.
- (iv) In case of Geostationary satellites, the inclination of the orbit increases at an average rate of about.
(a) 0.85° per year (b) 1° per year
(c) 0.65° per year (d) 1.85° per year.
- (v) A table or data file giving the calculated position of a celestial object at regular intervals throughout a period is called
(a) Almanac data (b) Ephemeris data
(c) AKM data (d) None of these
- (vi) Specific impulse of a propulsion system is defined as
(a) Product of thrust force produced and mass expelled.
(b) Ratio of thrust force produced to the rate at which weight is expelled.
(c) Ratio of mass expelled to the thrust force produced.
(d) None of these.

- (vii) The chip rate and bit rate in a certain DS-CDMA transmission are 3 Mbps and 30 kbps respectively. Processing gain in decibel is:
 (a) 20 Db (b) 30 dB
 (c) 40 dB (d) 90 dB
- (viii) A satellite Earth station has transmitter output power of 10 kW. This is radiated through an antenna having a gain of 40 dB. The earth station EIRP is
 (a) 50 dB (b) 80 dB
 (c) 400 kW (d) 40 kW
- (ix) The part of the GPS signal structure used for computing the range between the GPS receiver and the satellite is
 (a) Pseudorandom code (b) Almanac data
 (c) Ephemeris data (d) All of the above
- (x) A satellite transponder receives an up-linked signal, alters its amplitude and frequency and then Performs some on-board processing. It can be classified as
 (a) Transparent transponder (b) C band transponder
 (c) Regenerative transponder (d) Bent pipe transponder

Fill in the blanks with the correct word

- (xi) _____ is the angle that the orbital plane of the satellite makes with the Earth's equatorial plane.
- (xii) Satellites in _____ orbit appear stationary relative to a fixed position on Earth.
- (xiii) The _____ band is one of the frequency bands most commonly used for satellite communication, especially for broadcasting and telecommunications.
- (xiv) _____ satellites are positioned at an altitude that allows them to orbit the Earth approximately every 90–120 minutes, commonly used for Earth observation.
- (xv) The processing gain is a key parameter in _____ systems that helps improve noise and interference performance.

Group - B

2. (a) Explain, with a diagram, the concept of Look Angle and its significance in Satellite tracking. [[CO2](Understand/LOCQ)]
- (b) The apogee and perigee distances of a satellite orbiting in an elliptical orbit are, respectively, 45000 km and 7000 km. Determine the following:
 (i) Semi- major axis of the elliptical orbit.
 (ii) Orbit eccentricity.
 (iii) Distance between the centre of Earth and the centre of elliptical orbit. [[CO2](Analyze/IOCQ)]
- 6 + (2 + 2 + 2) = 12**
3. (a) Briefly describe that why should a geostationary satellite be at an altitude of 35786 km above the surface of Earth. [[CO3](Understand/LOCQ)]

- (b) A typical Molniya orbit has perigee and apogee heights above the surface of the Earth as 400 km and 40000 km respectively. Show that the orbit has a 12-h time period assuming radius of Earth to be 6380 km and $\mu = 39.8 \times 10^{13} \text{ Nm}^2/\text{kg}$.
[[CO4](Apply/IOCQ)]
- (c) Differentiate between geosynchronous and geostationary orbit. *[[CO1](Analyze/IOCQ)]*
3 + 6 + 3 = 12

Group - C

4. (a) A geostationary satellite at a distance of 36000 km from the surface of the Earth radiates a power of 10 W in the desired direction through an antenna having a gain of 20 dB. Calculate the power density at a receiving site on the surface of Earth and also the power received by an antenna having an effective aperture of 10 m².
[[CO2](Analyze/IOCQ)]
- (b) Define antenna noise temperature. *[[CO2](Remember/LOCQ)]*
- (c) Discuss the major factors that help in deciding the antenna noise temperature.
[[CO2](Apply/IOCQ)]
4 + 3 + 5 = 12
5. (a) A 10 GHz receiver consists of an RF stage with gain $G_1 = 25 \text{ dB}$ and noise temperature $T_1 = 30 \text{ K}$, a down-converter with gain $G_2 = 12 \text{ dB}$ and noise temperature $T_2 = 400 \text{ K}$, and an IF amplifier stage with gain $G_3 = 20 \text{ dB}$ and noise temperature $T_3 = 800 \text{ K}$.
 Calculate the effective noise temperature and noise figure of the system. Assume a reference temperature of 290 K.
[[CO2](Analyze/IOCQ)]
- (b) For the receiver of the above problem, compute the noise figure specifications of the three stages and then compute the overall noise figure from the individual noise figure specifications.
[[CO2](Analyze/IOCQ)]
- (c) Define adjacent channel interference. *[[CO2](Remember/LOCQ)]*
4 + 5 + 3 = 12

Group - D

6. (a) Define TDMA frame. *[[CO3](Remember/LOCQ)]*
- (b) Explain and draw the different constituents of a TDMA frame structure
[[CO3](Understand/LOCQ)]
- (c) Explain the concept of multiple access in the context of satellite communication.
[[CO3](Understand/IOCQ)]
2 + 6 + 4 = 12
7. (a) Explain in details about the processing gain with reference to CDMA.
[[CO3](Understand/LOCQ)]
- (b) Explain the various payloads in a satellite. *[[CO3](Understand/LOCQ)]*
- (c) Compare satellite packet communication with terrestrial packet-switched networks in terms of latency and reliability.
[[CO3](Analyze/IOCQ)]
4 + 4 + 4 = 12

Group - E

8. (a) Briefly explain how call connections are set up in MSAT. *[(C04)(Understand/LOCQ)]*
(b) Define outbound and inbound link. *[(C05)(Remember/LOCQ)]*
(c) Discuss in details about how GPS is used to fix co-ordinates. *[(C06)(Evaluate/HOCQ)]*
4 + 4 + 4 = 12
9. (a) Explain how worldwide timing is maintained by a satellite relay link. *[(C06)(Understand/LOCQ)]*
(b) With a suitable diagram, explain the principle of operation of direct broadcast satellite system. *[(C06)(Understand/LOCQ)]*
6 + 6 = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	51	44.8	4.2