TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communication *(Elective I) (EX 72502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Write brief history on satellite communications system. What are the advantages and disadvantages of satellites working in geostationary orbit? Which factors that determine the life of satellite? [3 + 3 +3]
2. List the major applications of satellite communications. Explain the laws that govern the satellite orbital dynamics and stabilizations. Write short notes on orbital perturbations. [2+ 5+ 3]
3. A LEO satellite of 385 Kg weight in the orbit is revolving at 680 Km on the circular orbit above the Earth surface. What are it's the weight while on the Earth surface and the orbital period in hour, minutes and seconds? Find out the change in velocity if the altitude of the satellite increases to 860 Km. While the mass of the Earth (M_E) = 5.975×10^{24} Kg and the gravity constant (G) = 6.67×10^{-11} Nm^2/Kg^2. [3+3+2]
4. What is the multiple access? Write advantages of TDMA system over the FDMA system. What are the propagation effects during radio waves travel on satellite-Earth links? Explain your views on radio window consideration in satellite communications. [2+4+ 4]
5. Describe the basic VSAT Earth station with necessary block diagrams. How does direct broadcast satellite (DBS) work? Explain with required diagrams. [5 + 5]
6. Assume that one of the geostationary satellites is located at 36^0 E longitude which has given -5dB/K G/T and the value of C/N_O of the satellite is 76.4 dBHz; if the Earth station (ES) is situated within the given satellite footprint at 27.64^0 N latitude and 4.8^0 W longitude. The ES uses a dish antenna diameter of 9.2 m with antenna efficiency 78%; and it is considered that various atmospheric losses equal to 24 dB as well as a waveguide loss is 2.3 dB. What is the transmit power of the Earth station that can establish uplink communication for 6036 MHz to 5964 MHz C-band frequencies? [11]
7. What are the non-geostationary satellites' coverage and delay considerations? Explain with suitable example and necessary diagrams. [6]
8. Find out the following equation of elevation angle (El): [7]

$$El = \tan^{-1} [(\cos \varphi - 0.1513) / \sin \varphi]$$

Where,

$$\varphi = \cos^{-1} [\cos (L_{SAT} - L_{ES}) \cos(l_{ES})]$$

L_{SAT} = longitude of satellite
L_{ES} = longitude of Earth station
l_{ES} = latitude of Earth station

9. Write short notes(Any three): [3 x 3]
   a) Meteorological satellite system
   b) Glonass
   c) Van-Allen belt
   d) Onboard processing
   e) TT&C

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271 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communication *(Elective I) (EX72502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain what the terms centrifugal and centripetal forces mean with regard to a satellite orbit around the earth. What is the orbital period of the geostationary satellite? Give your answer in hours, minutes and seconds. Note: assume the average radius of the earth is 6,378.137 Km and Kepler's constant (μ) is 3.986004418×10^5 Km^3/s^2. [3 + 5]
2. Explain about ionospheric effects in the path of the radio wave propagation. Define Faraday rotation and ionospheric scintillation with mathematical derivations if necessary. [4 + 6]
3. What is a transponder? Explain the simplified double conversion transponder for 14/12 GHz band and explain its operation with necessary diagrams. [2 + 5]
4. How do you determine the four conditions of azimuth angles when the satellite sub-point (SS) is considered in the center of all four earth stations within the given footprint? Determine the look angles for the Earth station (ES) having coordinates as 12.6^0 E and 26.4^0 N. The geostationary satellite that is to be accessed by the given ES located at 10.4^0 W longitude. [4 + 6]
5. How does satellite GPS system work? Describe the working principles of GPS position location system with necessary diagrams. [4 + 5]
6. Describe a typical VSAT earth station with necessary diagrams. Explain the working principle of DBS-TV system. [5 + 4]
7. Assume that a geostationary satellite is located at 65^0 E longitude having -5.5 dB/K, figure of merit (G/T) and the value of required C/N_O of the satellite is 67.6 dBHz; if the Earth station is situated at 28.84^0 N latitude and 114.8^0 E longitude; the Earth station uses a dish antenna with diameter 6.4 m as well as antenna efficiency 65%; and considered that various atmospheric losses is 24.5 dB as well as a waveguide loss is 1.5 dB. The saturated PFD for given satellite is -80.6 dBw/m^2. Calculate the transmit power (in watt) of the Earth station that can establish uplink communication for Ku-band and find out output backoff (BO_O). Assume 3 dB backoff margin is taken. [11 + 3]
8. Find out the following equation of elevation angle (El): [7]

   $$El = Tan^{-1} [(Cos \varphi - 0.1513)/ Sin \varphi]$$

   Where,

   $$\varphi = Cos^{-1} [Cos (L_{SAT} - L_{ES}) Cos(l_{ES})],$$ L = longitude and l = latitude.
9. Write short notes(Any three): [3 × 2]
   a) Power sub-system
   b) INTELSAT
   c) Life of satellite
   d) PDMA
   e) Retrograde orbit

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241 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communication *(Elective I) (EX72502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Write a brief note how satellite communication are utilized in your country and also mention the advantages and disadvantage of satellite communications. [4+3]
2. Define the Apogee and Perigee. Assume that the INSAT satellite is in geostationary orbit with following orbital parameters: Semi major axis = 42165 km, Orbit location = 74.0°E, Mean earth radius = 6378.14 km. For an earth stations at 21.0°N and 80.0°E, what will be the look angles (i.e. elevation angle, azimuth angle) and the range to the satellite? [2+6]
3. Describe different types of antennas used in SATCOM. Mention different types of antenna tracking techniques. [4+2]
4. Show that the elevation angle for GEO stationary satellite is calculated as $E_l = \tan^{-1}\left(\frac{\cos\phi - 0.1513}{\sqrt{1-\cos^2\phi}}\right)$, where symbols have usual meaning. [6]
5. Which type of Multiple access techniques mostly used in satellite Communications? Describe On Board Processing in detail. [2+5]
6. Describe each element of Earth Station System with a neat block diagram. [7]
7. A GEO stationary satellite located at 3°E longitude with C/N equals 34 dB communicate with earth station located at 17.5°W longitude and 36.6°S latitude having ES facilities as receiving antenna diameter 7 m, antenna efficiency 86%, as well as it is assumed various atmospheric loss is 21dB. Satellite antenna gain is 32 dB with channel bandwidth of 45 MHz and system noise temperature 520°k. Calculate the ES transmitter power required to make up-link communication operated at 12 GHz with 1.2 dB feeder or waveguide loss to antenna. [12]
8. How does DTH work? Explain with block diagram. [5]
9. What do you mean by orbit perturbation? What are the general methods currently in practice to stabilize the satellite in its orbit? [2+4]
10. How GPS system provides timing accuracy? Show with a suitable diagram. [7]
11. Write short notes on: (any three) [3×3]
    i) Frequency band in SATCOM
    ii) Satellite Mobile Network
    iii) DAMA
    iv) Life of satellite
    v) Albedo

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27F TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communications *(EX72503) (Elective I)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain Kepler's laws which govern the orbital mechanics for the satellite's motion in the space. List the merits of non-GEO satellites and their applications. [6 + 4 + 2]
2. A satellite weighted 550 Kg on the surface of Earth is revolving on the circular orbit of 8050 Km above the Earth surface. What would be the orbital period and the weight of the satellite on the orbit? And find out its change in velocity if the altitude of the satellite decreases to 7500 Km circular orbit? Considering the mass of the Earth (M_E) = 5.975 x 10^{24} Kg and the gravity constant (G) = 6.67 x 10^{-11} Nm^2/Kg^2. [5 + 4 + 4]
3. What is a TT & C? How does the VSAT system work? Describe the main features with VSAT network architecture. [4 + 8]
4. Why the satellite transponder is also called bent pipe? Sketch the simplified double conversion transponder for 14/12 GHz band and explain its operation. [4 + 8]
5. One of the INTELSAT satellites located at 64^0 E longitudes with the saturated EIRP equals 44 dBW as per given footprint. The Earth station (ES) is to be accessed by the given satellite is located at 82.6^0 E longitude and 26.8^0 N latitude having ES facilities as diameter of receiving antenna is 6.4 m; antenna efficiency, 75%; system noise temperature is considered 320^0 K as well as if it is assumed various atmospheric losses is 24 dB. What would be the value of required power flux density ($PFD_{Reqd.}$) for the satellite input? If input backoff (BO_i) is generally 3 dB greater than output backoff (BO_o). Whereas the saturated power flux density (PFD) of satellite is – 84.32 dBw/m^2 given and the carrier power-to-noise density power ratio of the ES is 76.4 dBHz for 36 MHz frequency band downlink data communication of 6.245 GHz central frequency. (Boltmann's Constant, k = 1.381 X 10^{-23} $J/^0K$) [14]

6. Prove the following elevation angle (El) equation: [8]

$$\text{Tan}(El + \varphi) = [(6.611 - \text{Cos}\,\varphi)/\sqrt{1 - \text{Cos}^2\,\varphi}]$$

Where,

$\Phi = \text{Cos}^{-1}[\text{Cos}(L_{SAT} - L_{ES})\,\text{Cos}(l_{ES})]$
L_{SAT} = longitude of satellite
L_{ES} = longitude of Earth station
l_{ES} = latitude of Earth station

7. Write shorts notes (Any THREE): [3 x 3]
   i) Up converter
   ii) Global navigation satellite system
   iii) Ionospheric scintillation
   iv) Random access
   v) Friis transmission equation
   vi) Sun synchronous orbit

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24F TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communications *(Elective I) (EX72502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. State Kepler's laws. Explain the orbital dynamics that governs the satellite revolving on the orbit. Write down the merits and demerits of GEO satellite communications. [3 + 2 + 2]
2. Define an azimuth and elevation angles. Find out the azimuth angles for the Earth stations, X and Y, if they are situated at North-East and South-East from the same sub-satellite point (SS) inside the given footprint. [3 + 6]
3. Explain different atmospheric losses during the radio wave propagation. Explain the considerations of radio window and radio duct in satellite communication systems? [4 + 5]
4. Explain about the VSAT system with its star and mesh network architecture. What will be the elevation angle for the VSAT Earth station if its geographic coordinates are of 12.6^0E longitude and 28.6^0N latitude? The INTELSAT satellite which is to be accessed by the given VSAT located at 6.6^0W longitude. [4 + 5]
5. A GEO satellite is located at 48^0 W longitude having G/T of -6dB/K and the value of carrier to noise density (C/N_O) of the satellite is assumed 80.2 dBHz; saturated power flux density ($PFD_{Saturated}$) of the given satellite is -82.36 dBW/m^2. If the distance between Earth station and the satellite is 39,645 Km and the Earth station uses 6.25 m diameter of the dish antenna with antenna efficiency 65%; waveguide loss is 1.4 dB; as well as, considering various atmospheric losses including rain attenuation is 18 dB. Determine the transmit power of the Earth station that can establish uplink communication for 5.975 GHz - 6.055 GHz frequency band and find out input back-off (BOi) of the satellite. [8 + 4]
6. Describe the basic working principle of satellite Earth station with necessary diagram. What is a multiple access? What is a polarization division multiple access (PDMA)? [6 + 4]
7. Find out the following equation of elevation angle (El): [8]

$$El = Tan^{-1}[\ (Cos\varphi - 0.1513)/\ \sqrt{(1 - Cos^2\varphi)}\ ]$$

8. What is a global positioning system (GPS)? Explain major features of NAVSTAR-GPS system. [2 + 5]
9. Write short notes(Any three): [3 × 3]
   a) Satellite direct broadcasting system (DBS)
   b) Antenna sub-system
   c) On-board processing
   d) Van-Allen belts
   e) Meteorological satellite system

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27F TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communication *(Elective I) (EX725)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Describethe principle of orbital dynamics which is applied for revolving the satellite on the orbit. Write down the merits and demerits of geostationary satellite communications. [6 + 4]
2. What is the meaning of look angles? How do you obtain azimuth angles for the Earth stations, A and B, if they are located at North-West and South-East from the same sub-satellite point (SS) ? Explain how you prove that the velocity of the GEO satellite is equal to about 3.074 Km/s. [2+4+ 4]
3. Explain aboutatmospheric effects in the path of the radio wave propagation. Why it is necessary to consider different ionospheric losses while designing satellite link? [5 + 5]
4. Describe the VSAT system with access control protocol. Compare between VSAT Earth station and Hub Earth station. Determine the elevation angle for the VSAT Earth station having geographic coordinates as 2.6^0 W and 26.4^0 S. The geostationary satellite that is to be accessed by the given VSAT located at 25.6^0 E longitudes. [4 + 3+ 4]
5. Assume that a GEO satellite is located at 56^0 E longitude having -5dB/K G/T and the value of C/N_O of the satellite is 78.5dBHz; if the Earth station is situated at 26.84^0 N latitude and 124.8^0 E longitude; the Earth station uses a dish antenna with diameter 6.5 m as well as antenna efficiency 68%; and considered that various tropospheric losses is 26 dB as well as a waveguide loss is 2.5dB. What should be the transmit power of the Earth station that can establish uplink communication for 5.925 GHz - 6.005 GHz frequency band? [12]
6. Describe on the basic working principle of satellite Earth station with necessary diagram. What is a multiple access? Compare between the FDMA and TDMA systems in different aspects. [6+4]
7. Find out the following equation of elevation angle (El): [8]

$$El = Tan^{-1}[(Cos\varphi - 0.1513)/ Sin\varphi]$$

Where,

$$\Phi = Cos^{-1}[Cos(a_{SAT} - a_{ES}) Cos(\beta_{ES})]$$

a = longitude

ß = latitude

8. Write short notes(Any three): [3 ×3]
   a) DBS-TV system
   b) Power sub-system
   c) INTELSAT
   d) Van Allen radiation belts
   e) Molniya Orbit

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05C TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Satellite Communication *(Elective) (EX72502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. State Kepler's laws of Orbital motion. List also the six Keplerian parameters that define the position of satellite and its orbital plane. [4+4]
2. What are the different subsystems of a Satellite Platform? Explain briefly the TT&C subsystem. [2+6]
3. Describe different types of antenna used in SATCOM. Explain briefly the different reflectors (parabolic antennas) with neat diagram. [4+4]
4. Briefly explain the different Multiple Access Techniques used in Satellite Links. An Earth Station is located at 30°S an 130°E. Calculate the antenna look angles for a satellite at 156°E. [4+4]
5. What do you understand by a VSAT Network? Explain the typical configuration of TDM/PSK/FDMA scheme used in VSAT networks. [2+6]
6. Discuss different applications of Non-GSO Satellite System. Draw a block diagram of a Digital DBS-TV link labelling each component in the link. [4+4]
7. The atmosphere and ionosphere influences the wave propagation in SATCOM. Briefly explain the types of propagation effects and the countermeasures for such impairments. [4+4]
8. An Earth Station antenna with 4m diameter is fed with power of 100 Watts and operates at uplink frequency of 14 GHz. It radiates power toward a GEO satellite at 40000 km with 3-dB antenna beamwidth of 2 degrees. If the efficiency of satellite antenna and Earth Station antenna are 0.55 and 0.6 respectively. Find :
   a) Power Flux Density at the satellite and b) Power received at the satellite receiver. [4+4]
9. A GEO stationary satellite located at 5°W longitude with C/N equals 29 dB communicate with earth station located at 17.5°E longitude and 36.6°S latitude having ES facilities as receiving antenna diameter 16m, antenna efficiency 60%, system noise temperature 520°k as well as it is assumed various atmospheric loss is 10dB. Satellite antenna gain is 33 dB with channel bandwidth of 36 MHz. Calculate the ES transmitter power required to make up-link communication operated at 12 GHz. [12]
10. Write short notes on(**any two**) [2*2]
    a. Different Satellite Navigational Systems
    b. Frequency Bands for MSS
    c. Life of a satellite

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