Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem 2019-20 | **Date**: 12.10.2019

Course Code: ECE 305 | **Time**: 9.30AM to 10.30AM

Course Name: SATELLITE COMMUNICATION | **Max Marks**: 40

Program & Sem: B.Tech (ECE) & VII DE | **Weightage**: 20%

Instructions:

(i) *Read the question properly and answer accordingly.*

(ii) *Question paper consists of 3 parts.*

(iii) Scientific and Non-programmable calculators are permitted.

Part A (Memory Recall Questions)

Answer all the Questions. Each Question carries four marks. **(4Qx4M=16M)**

1. Compare LEO, GEO, MEO & HEO with different particulars.

(C.O.NO.1) [Comprehension]

2. Define the terms: a) Argument of Perigee b) Sub satellite Point with proper diagram.

(C.O.NO.1) [Knowledge]

3. Calculate the Orbital Time Period of an elliptical orbit for which the major axis is given 10000 Km. (C.O.NO.1) [Comprehension]

4. List the advantages of Satellite Communication. (C.O.NO.1) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries eight marks. **(2Qx8M=16M)**

5. Refer the diagram Fig.1 & Answer the following questions: [2+4+2M]

(C.O.NO. 1) [Comprehension]

a) What is f1 and f2 in the figure, If ES1 (Earth Station 1) wants to communicate with ES2 (Earth Station 2).

b) What is the condition that need to be followed for choosing the values for f1 and f2 and why?

c) If f1= 12 GHz and f2 =18 GHz, can ES1 send signal to ES2 properly? Justify. Name the Band in which the system is operating?

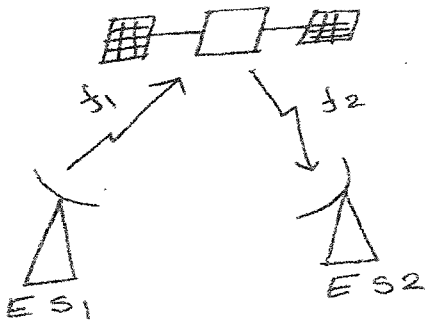

Fig.1

6: Answer the following: (C.O.NO.1) [Comprehension] [6+2M]

a) Discuss the significance of the mentioned dates: a) March 21 & December 21 with proper notation & diagram.

b) Why the satellite in an elliptical orbit can't have a uniform velocity as it orbits around earth?

Part C [Problem Solving Questions]

Answer the Question. The Question carries eight marks. (1Qx8M=8M)

7. Answer the following questions: (C.O.NO.1) [Comprehension] [5+3M]

i) Refer the Figure 2 below. Satellite A is orbiting Earth in a circular orbit of radius 25000 Km. Satellite B is orbiting Earth in an elliptical Orbit with its apogee & perigee distances of 43000 Km & 7000 Km, respectively. Determine the velocities of the two satellites at the indicated points X & Y. For satellite B, find a) Orbit eccentricity, b) Orbital Period in hr.

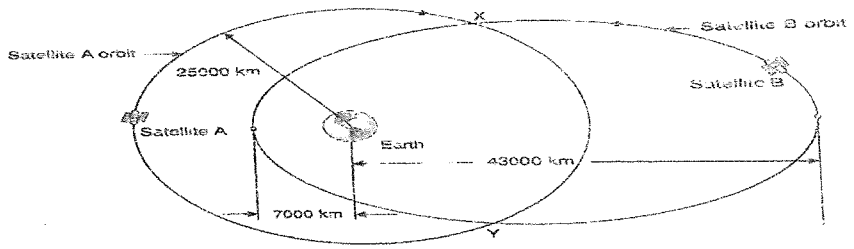

Fig.2

ii) State & Explain Keplar's three laws of planetary motion.

SCHOOL OF ENGINEERING

Semester: 7th

Course Code: ECE 305

Course Name: Satellite Communication

Date: 27/9/19

Time: 9.30 am to 10.20 am

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	CO 1	**Introduction to Communication System and modulation**	4M	L1		-	-	-	-	-	-	4M
2	CO1	**Introduction to Communication System and modulation**	4M	L2		-	-	-	-	-	-	4M
3	CO1	**Orbits & Link Budget Calculation**	-	-		4M	L2	-	-	-	-	4M
4	CO1	**Introduction to Communication System and modulation**	4M	L2		-	-	-	-	-	-	4M
5	CO1	**Introduction to Communication**	-	-	-	8M	L2		-	-	-	8M

		System and modulation										
6	CO 2	**Orbits & Link Budget Calculation**	-	-	-	8M	L2	-		--	-	8M
7	CO2	**Orbits & Link Budget Calculation**	-	-	-	8M	L2	--		-	-	8M
	Total Marks				16M			16M			8M	40M

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Mr. Swastik Sahoo]

Reviewers' Comments

1. Question 5, Refer the diagram, the diagram has no number
2. Question 7, Diagram not visible
3. Little bit lengthy
4. Marks should be evenly distributed

Dr. M. Lenka
Professor

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: 7th

Course Code: ECE 305

Course Name: Satellite Communication

Date: 27/9/19

Time: 9.30 am to 10.30 am

Max Marks: 40

Weightage: 20%

Part A (4Q x 4M = 16 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**LEO:** 160-2000 Km from the earth surface. 40-80 no. of satellites are required to cover the whole earth. 10-40 Min is required for Time of Revolution. Propagation delay is 1-10 ms.. Operating Frequency is 1- 2.5 GHz. **MEO:** 2000-35780 Km from the earth surface. 8-20 no. of satellites are required to cover the whole earth. 2-8 hr. is required for Time of Revolution. Propagation delay is 70-80ms. Operating Frequency is 1.2 GHz to 1.66 GHz. **GEO:** 35786 km from the earth surface. 3 satellites are required to cover the whole earth. 24 hours is the Time of Revolution. 270ms is the propagation delay. Operating frequency: C-Band. Ku Band. Ka Band. **HEO:** Distance is greater than 35786 Km. 3 satellites are required to cover whole earth. time required is >24 hours. propagation delay is >270 ms. Operating frequency is around Ka Band.	1+1+1+1	7 Min

2	a) **Argument of Perigee:** It the angle formed by the line joining perigee & the satellite in orbit with respect to center of Earth. b) **Sub satellite Point:** It is the point on the earth surface that is located in a straight line between center of Earth & Satellite. Seen from Earth, called Zenith & seen from satellite called Nadir.	2+2	**6 Min**
3	$T = \frac{2\pi}{\sqrt{\mu}} a^{1.5}$=50 sec, where a= 10000/2= 5000 Km.	4	**6 Min**
4	**Advantages of Satellite Communication:** • Large Coverage area for GEO Satellites. • Mobile communication can be easily established through satellite communication. • Offers service to all users over the entire coverage area • Cost of service does not increase with no. of users. • Provides unmatched speed, uniformity & end-to-end control useful for two way IP Networks. • Very efficient & convenient for search, rescue & navigation. • Offers service to remote or underdeveloped areas.	4	**6 Min**

Part B 2Q x8M =16Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
5	a) f1 is uplink frequency & f2 is downlink frequency. b) f1 should be greater than f2 because of following reason: - Narrow beam width: $\theta_{3-dB} = \frac{70\lambda}{d}$. - Limited power and bandwidth availability on transponder c) If f1=12 GHz & f2= 18 GHz, only one way communication can be done. In Transponder, frequency down conversion is done & not the Up-Conversion. This is in the range of Ku Band.	2+4+2	7 Min
6	a) March 21: This is called Spring Equinox where the length of day & night are exactly equal. Equatorial plane of the Earth will be aligned with the direction of Sun. December 21: This is called Winter Solstice. Here the inclination angle is at its maximum. b) According Keplar's 2nd Law, satellite sweeps out equal areas in equal interval of time. As perigee is the nearest point, the velocity is less & as apogee is the farthest point, the velocity is more in order to cover the same distance in same time. So, depending on the distance of the satellite from Earth, the velocity will also change accordingly & it will have non-uniform Velocity.	3+3 2	8 Min

Part C (Q NO 7 - 6 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	a) For Satellite A, in circular orbit: $v = \frac{\mu}{r} = 3.98\ Km/s.$ For Satellite B, in elliptical Orbit, $v = \sqrt{\mu(\frac{2}{r} - \frac{1}{a})} = 3.98\ Km/s.$ For Satellite B, eccentricity: $e = \frac{A-P}{A+P} = 0.72.$ Time Period of the elliptical Orbit (in hr.)= $T = \frac{2\pi}{\sqrt{\mu}} a^{1.5} \cong 11\ hr.$ b) Keplar's Laws of Planetary Motion: 1. The orbit of a planet is an ellipse with the Sun at one of the two foci. 2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. 3. The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit.	1+2+1+1 3	15 Min

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20 **Date**: 12.10.2019

Course Code: ECE 314 **Time**: 9.30AM to 10.30AM

Course Name: LINEAR ALGEBRA FOR COMMUNICATION ENGINEERING **Max Marks**: 40

Program & Sem: B.Tech. (ECE) & VII DE **Weightage**: 20%

Instructions:

(i) Read the questions carefully and answer them all

(ii) Use only pen to answer

(iii) Programmable calculators are not allowed

Part A (Memory Recall Questions)

Answer all the Questions. Each Question carries one mark. (10Qx1M=10M)

1. Choose the correct option: $(AB)^{-1}$ = _____ (C.O.NO.1)[Knowledge]

a) AB^{-1} b) $A^{-1}B$ c) $A^{-1}B^{-1}$ d) $B^{-1}A^{-1}$

2. A matrix times a vector ($A\boldsymbol{x}$) is a combination of (C.O.NO.1)[Knowledge]

a) Columns of A b) Rows of A c) both a & b d) neither a nor b

3. In Gauss-Jordan method, the augmented matrix [A I] is row reduced to

a) [U I] b) [I A^{-1}] c) [L A^{-1}] d) [A^{-1} I] (C.O.NO.1)[Knowledge]

4. Gaussian elimination factors A into (C.O.NO.1)[Knowledge]

a) L times U b) U times L c) A^{-1} times L d) L times A^{-1}

5. The upper triangular system is solved by back substitution starting at the

a) bottom row b) top row c) middle row d) none of these (C.O.NO.1)[Knowledge]

State if TRUE/FALSE

6. If A is non-invertible then $\boldsymbol{x}=A^{-1}\boldsymbol{b}$ is a solution to $A\boldsymbol{x}=\boldsymbol{b}$ (C.O.NO.1)[Knowledge]

7. A zero in the pivot position can be repaired if there is a non-zero below it. (C.O.NO.1)[Knowledge]

8. A linear system $Ax=b$ becomes lower triangular matrix system ($Ux=c$) after elimination. (C.O.NO.1)[Knowledge]

9. A times BC equals AB times C (C.O.NO.1)[Knowledge]

10. Column space is spanned by the rows. (C.O.NO.1)[Knowledge]

Part B (Thought Provoking Questions)

Answer both the Questions. Each Question carries five marks. (2Qx5M=10M)

11. Suppose E subtracts 7 times row 1 from row 3. Then what should you do to invert that step? Also what inverse matrix takes that reverse step? If the reverse step is applied first (and then E) show that $EE^{-1} = I$ (C.O.NO.1)[Comprehension]

12. Write down the 3x3 matrices that produce these elimination steps:

    a) E_{21} subtracts 5 times row 1 from row 2

    b) E_{32} subtracts -7 times row 2 from row 3

    c) P exchanges rows 1 and 2, then rows 2 and 3.

    Applying E_{21} and then E_{32} to $b = (1,0,0)$ gives a matrix M. Applying E_{32} and then E_{21} to b gives N. Write down M and N. (C.O.NO.1)[Comprehension]

Part C (Problem Solving Questions)

Answer both the Questions. Each Question carries ten marks. (2Qx10M=20M)

13. Reduce this system to upper triangular form by two row operations:

$$\begin{aligned} 2x + 3y + z &= 8 \\ 4x + 7y + 5z &= 20 \\ -2y + 2z &= 0 \end{aligned}$$

    Circle the pivots. Solve by back substitution for z, y, x. (C.O.NO.1)[Application]

14. Apply elimination (circle the pivots) and back substitution to solve

$$\begin{aligned} 2x - 3y &= 3 \\ 4x - 5y + z &= 7 \\ 2x - y - 3z &= 5 \end{aligned}$$

    List the three row operations in the following format: Subtract _____ times row _____ from row _____. (C.O.NO.1)[Application]

SCHOOL OF ENGINEERING

Semester: 7

Course Code: ECE 314

Course Name: LACE

Date: 27/9/2019

Time: 9.30 am to 10.30 am

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	1	1	1			
2	1	1	1			
3	1	1	1			
4	1	1	1			
5	1	1	1			
6	1	1	1			
7	1	1	1			
8	1	1	1			
9	1	1	1			
10	1	1	1			
11	1	1		5		

12	1	1				5						
13	1	1							10			
14	1	1							10			
	Total Marks		10			10			20			40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Mr. Ramzan Basheer]

Reviewers' Comments

1. Marks should be evenly distributed
2. Here K = 10, C = 10, A = 20
3. Answer scheme steps to be given (11, 13)
4. Question paper to set for 42.5 mins.

Dr. M. Lang

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester: 7

Course Code: ECE 314

Course Name: LACE

Date: 27/9/2019

Time: 9.30 am to 10.30 am

Max Marks: 40

Weightage: 20%

Part A

(10Q x 1M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	d	1	0.5min
2	a	1	0.5min
3	b	1	0.5min
4	a	1	0.5min
5	a	1	0.5min
6	TRUE	1	0.5min
7	TRUE	1	0.5min
8	FALSE	1	0.5min
9	TRUE	1	0.5min
10	FALSE	1	0.5min

Part B

(2Q x 5M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
11	To reverse E_{31}, add 7 times row 1 to row 3. The inverse of the elimination matrix $E = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -7 & 0 & 1 \end{bmatrix}$ is $E^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 7 & 0 & 1 \end{bmatrix}$ Multiplication confirms $E^{-1}E = I$	1+3+1	10mins

12	$E_{32}E_{21}b = (1, -5, -35)$ but $E_{21}E_{32}b = (1, -5, 0)$. Where P_{23} comes first, row 3 feels no effect from row 1. $E_{21} = \begin{bmatrix} 1 & 0 & 0 \\ -5 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, $E_{32} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 7 & 1 \end{bmatrix}$, $P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$.	1+1+2+1	8mins

Part C (1Q x 10M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
13	Elimination leads to this upper triangular system, then comes back substitution $2x - 3y - z = 8 \qquad x = 2$ $y - 3z = 1$ gives $y = 4$ Row zeroes at the start of row 2 or row 3 $8z = 8 \qquad z = 1$ that avoids a row operation	2+2+3+3	10 min
14	$2x - 3y \quad = 3 \qquad 2x - 3y = 3 \qquad 2x - 3y = 3 \qquad x = 3$ $4x - 5y - z = 7$ gives $y - z = 1$ and $y - z = 1$ and $y = 1$ $2x - y - 3z = 5 \qquad 2y - 3z = 2 \qquad -5z = 0 \qquad z = 0$ Here are steps 1, 2, 3. Subtract 2 × row 1 from row 2, subtract 1 × row 1 from row 3, subtract 2 × row 2 from row 3.	3+3+2+2	10min

Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST- 2

Sem & AY: Odd Sem 2019-20
Course Code: ECE 305
Course Name: SATELLITE COMMUNICATION
Program & Sem: B. Tech & VII (DE)

Date: 16.11.2019
Time: 9.30 AM to 10.30 AM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Read the question properly and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries four marks. (4Qx4M=16M)

1. Define with proper diagram the terms: Roll, Pitch & Yaw. (C.O.NO.3) [Knowledge]
2. Explain what is meant by Thermal Control & why this is necessary in a satellite? (C.O.NO.3) [Knowledge]
3. Describe how power supply is being done in a Satellite? (C.O.NO.3) [Knowledge]
4. Calculate the uplink CNR if Downlink CNR is given as 28 dB & Overall CNR is 9.5 dB. (C.O.NO.2) [Comprehension]

Part B [Thought Provoking Questions]

Answer both the Questions. Each Question carries eight marks. (2Qx8M=16M)

5. A Ku-Band earth station has an antenna with a transmitter gain of 54 dB.The Transmitter output power is set to 100 W at a frequency of 30 GHz. The signal is received by satellite at a distance of 37500 Km by an antenna with a gain of 26 dB.The signal is then routed to a transponder with a noise temperature of 500K, a Bandwidth of 36 MHz & a gain of 110 dB. Calculate: [2+2+2+2M] (C.O.NO.2) [Comprehension]

i) Path Loss at 30 GHz.

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 with a BW of 36 MHz.

iv) Calculate CNR of transponder in dB.

6. Calculate antenna look angles (Elevation Angle & Azimuth Angle) for the following cases. Consider the satellite to be in GEO.

[2+2+2+2] (C.O.NO.2) [Comprehension]

i) ES at 35°N & longitude of 100°W and SSP is at 67°W.

ii) ES at 12°S & longitude of 52°W and SSP is at 70°W.

iii) ES at 35°N & longitude of 65°E and SSP is at 19°E.

iv) ES at 30°S & longitude of 130°E and SSP is at 156°E.

Part C [Problem Solving Questions]

Answer the Question. The Question carry eight marks. (1Qx8M=8M)

7. Calculate the attenuation due to rain, taking PRESIDENCY UNIVERSITY (13.17N & 77.53E) as an earth station in the state Karnataka & the satellite is located at 83E in GEO. The Rain Rate from IMD is given as 73.1mm/hr which is calculated for 0.01% of an average year. For Vertical Polarization & a downlink frequency of 12 GHz, K= 0.0168, α=1.2, Height above Mean Sea Level is 920m.

(C.O.NO.2) [Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: Odd Sem 2019-20
Course Code: ECE 305
Course Name: **Satellite Communication**

Date: 16/11/19
Time: 9.30- 10.30 AM
Max Marks: 40
Weightage: 20

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO (%age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	3	Space Segment	4M	-	-	4M
2	3	Space Segment:	4M	-	-	4M
3	3	Space Segment:	4M	-	-	4M
4	2	Orbits & Link Budget Calculation	-	4M	-	4M
5	2	Orbits & Link Budget Calculation	-	8M	-	8M
6	2	Orbits & Link Budget Calculation	-	8M	-	8M
7	2	Orbits & Link Budget Calculation	-	-	8M	8M
	Total Marks		12M	20M	8M	40M

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines. [Mr. Swastik Sahoo]

Reviewer's Comments: QP appears little lengthy - Please check.

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: 7th

Course Code: ECE 305

Course Name: **Satellite Communication**

Branch & Sem: ECE & 7th

Date: 16/11/19

Time: 9.30- 10.30 AM

Max Marks: 40

Weightage: 20

Part A (Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Roll: For an equatorial orbit, movement of satellite about roll axis moves the antenna footprint north & south. Pitch: Movement of satellite about pitch axis moves the antenna footprint east & West. Yaw: Movement of satellite about yaw axis rotates the antenna footprint.	**1 M for each description+ 1M for diagram**	**3**
2	Thermal Control is necessary in order to avoid large thermal gradients, receiving sun's radiation on one side while the other side faces into space. Also, thermal radiation from Earth & Earth's albedo, which is the fraction of the radiation falling on earth which is reflected, can be significant for LEO satellites. Equipment in the satellites also generates heat which is to be removed. Thermal Control is done by providing Thermal Blankets & Shields. Radiation Mirrors are often used to remove heat from the communication Payloads.	**4M for description**	**4**

3	The primary electrical power is solar cells. Arrays of cells in series-parallel connections are done to achieve high power. At the beginning this panels will produce 940 W of DC power & reduced to 760 W after 10 years .Higher power can be achieved with the solar panels arranged in the form of rectangular solar sails. This must be folded during launching & expanded when in GEO. The secondary source is batteries made up of Ni-Cd & Ni-H_2. This is used during eclipse that will occur during Spring & Autumnal Equinoxes. Eclipse will start before 23 days & end after 23 days of eclipse & on the day of eclipse it will continue for 72 min.	**4M for description**	**5**
4	$(CNR)_{Overall}$= 9.5 dB= 8.91 $(CNR)_{Downlink}$= 28 dB= 630.95 $\frac{C}{N} = \left[(\frac{C}{N})_U^{-1} + (\frac{C}{N})_d^{-1}\right]^{-1}$. Using this formula. $(CNR)_{Uplink}$=9.03= 9.55 dB	**2M Formula+ 2M Calculation**	**6**

Part B (Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
5	i) Path Loss= $(\frac{4\pi R}{\lambda})^2$= 2.21×10^{21}=213.46 dB ii) Received Power= $P_r = \frac{P_t G_t G_r}{L_P}$=-113.46 dB iii) Noise Power= KTB= 2.48×10^{-10}=-96.04 dB iv) C/N= $(\frac{EIRP}{L_p}) \times \frac{G}{T} \times \frac{1}{KB}$= 18.21= 12.60 dB	2+2+2+2	12
6	i) Elevation Angle= 45.84 Elevation Angle= 232.78 ii) Elevation Angle= 74.73 Elevation Angle= 296.46 iii) Elevation Angle= 36.02 Elevation Angle= 114.05 iv) Elevation Angle= 54.65 Elevation Angle= 48.47 Central Angle is calculated by: Cos (γ) = cos (L_E) cos ($l_S - l_E$). Elevation angle is calculated by: $\theta = tan^{-1}\left[\frac{(6.6107345 - cos(\gamma))}{sin(\gamma)}\right] - \gamma$. For Calculating Azimuth angle, intermediate angle will be calculated: $\alpha = tan^{-1}(\frac{\tan(l_S - l_E)}{Sin\ L_E})$. For Northern Hemisphere:	2+2+2+2	15

	- If Satellite to the East of ES: 180 –α - If Satellite to the West of ES: 180+α For Southern Hemisphere: - If Satellite to the East of ES: α - If Satellite to the West of ES: 360-α		

Part C (Q x M = Marks)

Q No	**Solution**	**Scheme of Marking**	**Max. Time required for each Question**
7	The Procedure is as follows: • The central angle will be calculated as: Cos (γ) = cos (L_E) cos ($l_S - l_E$). • Elevation angle will be determined from: $\theta = tan^{-1}\left[\frac{(6.6107345 - cos(\gamma))}{sin(\gamma)}\right] - \gamma.$ • Slant path length will be as: $L_S = \frac{(h_r - h_s)}{sin(\theta)}$ Km. • Horizontal projection is $L_G = L_S cos(\theta)$. • Specific attenuation will be calculated as: $\gamma_r = k(R_{0.01})^{\alpha}$ dB/Km • Horizontal reduction factor will be calculated as: $r_{0.01} = \frac{1}{1 + 0.78\sqrt{\frac{L_G \gamma_R}{f}} - 0.38(1 - e^{-2L_G})}$. • Vertical adjustment factor will be calculated as:- $v_{0.01} = \frac{1}{1 + \sqrt{\sin(\theta)}\left(31\left(1 - e^{-\left(\frac{\theta}{1+\chi}\right)}\right)\frac{\sqrt{L_R \gamma_r}}{f^2} - 0.45\right)}$ • The intermediate parameters are given as $\vartheta = tan^{-1}\left(\frac{h_r - h_s}{L_G r_{0.01}}\right)$ deg. ($h_R = h_O + 0.36$) Km. For $\vartheta > \theta$, $L_R = \frac{L_G r_{0.01}}{COS(\theta)}$ Km Or Else, $L_R = \frac{(h_r - h_s)}{\sin(\theta)}$ Km. If, $\lvert L_E \rvert < 36$, $\chi = 36 - \lvert L_E \rvert$ Km Else $\chi = 0$ deg. • The effective path length and the rain attenuation will be calculated as:- $L_{eff.} = L_R v_{0.01}$ Km. $A_{0.01} = \gamma_r L_{eff.}$ dB So, from above procedure rain attenuation is given by: 23.74 dB.	8M	15

Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20
Course Code: ECE 305
Course Name: SATELLITE COMMUNICATION
Program & Sem: B.Tech (ECE) & VII (DE-III)

Date: 20 December 2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Instructions:

(i) *Read the question properly and answer accordingly.*
(ii) *Question paper consists of 3 parts.*
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 2 marks. **(10Qx2M=20M)**

1.

a. The point where the orbit crosses the equatorial plane going from north to south is called _____ and the angle between the orbital plane and the earth's equatorial plan is called _____ . (C.O.No.1) [Knowledge]

b. _____ and _____ are the two basic segments of satellite communication system. (C.O.No.3) [Knowledge]

c. Name the device which is responsible for separating the transmit and receive signal. (C.O.No.3) [Knowledge]

d. Mention the type of controlling torques applied to stabilize the satellite in space. (C.O.No.3) [Knowledge]

e. Calculate the gain in decibels of a 3-m paraboloidal antenna operating at a frequency of 12 GHz. Assume an aperture efficiency of 0.55. (C.O.No.2) [Knowledge]

f. Orthocoupler differentiates the signal on the basis of_____, With increase in frequency, the gain of the antenna_____ (C.O.No.2) [Knowledge]

g The total bandwidth available in a Transponder is _____ & how many channels can be accommodated within that frequency. (C.O.No.3) [Knowledge]

h. Differentiate between prograde and retrograde orbit. (C.O.No.1) [Knowledge]

i. Define the term SDMA (Space Division Multiple Access) as_____ (C.O.No.4) [Knowledge]

j. Name the GPS satellite and also mention the segments of GPS. (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 6 marks. **(5Qx6M=30M)**

2. While designing an antenna the two main important parameters that we have to keep in mind is Gain and Beam width. Explain with proper mathematical formula how these factors play a major role in antenna designing. Also explain the role of OMT in antenna subsystem. (C.O.No.3) [Comprehension]

3. Refer Figure 1 and answer the following questions:

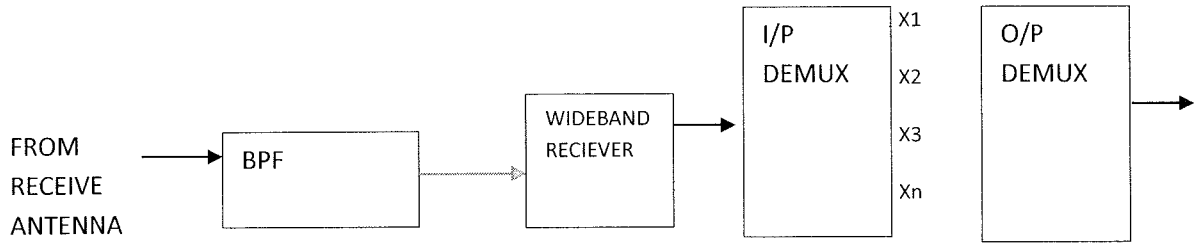


Fig:1

Centre frequency

(C.O.No.3) [Comprehension]

(a) The above block diagram represents the very important part of satellite communication. Identify that. [1M]

(b) For a typical C-band communication mention the uplink and downlink frequency range. [2M]

(c) Mention the role of BPF and also explain where the frequency conversion from uplink to downlink takes place. [3M]

4. Answer the following questions: (C.O.No.3) [Comprehension]

(a) Write the name of the device which is widely used in transponders to provide the final output power required to the transmit antenna. [1M]

(b) Draw the diagram of the device. [2M]

(c) Explain the significance of 1-dB compression point and power back off w.r.t to the above identified device. [3M]

5. Answer the following questions: (C.O.No.4) [Knowledge]

(a) Differentiate between demand assigned and pre assigned FDMA. (Minimum 3 points)

(b) Name the methods used in Demand assigned FDMA. Explain any one of the method.

6. (a) Identify the Fig:2 shown below. [1M] (C.O.No.4) [Comprehension]

(b) What is SCPC? [2M]

(c) Explain how the communication takes place between any of the earth station in the above diagram. [3M]

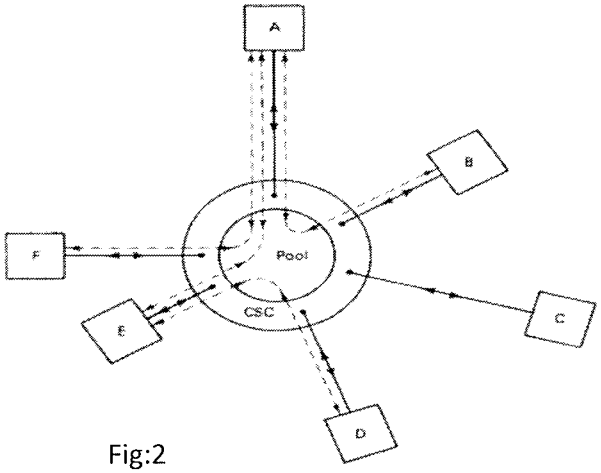


Fig:2

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

7. 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 antenna beam from the satellite, at a distance of 38000 Km/. For a frequency of 4.0 GHz, Calculate: The Earth station has an antenna with a diameter of 2m & an aperture efficiency of 65%..

(C.O.No.2) [Comprehension]

- Incident Flux Density in W/m^2 &dBW/m^2.
- Received power level in W & dBW at the antenna output port.
- On-axis gain of antenna in dB.
- Calculate free space path loss between satellite & Earth Station.

8. (a) For receiving proper service from the satellite launched ,it has to be in its proper orbit and its orientation should also be proper. Explain how to maintain proper orientation of the satellite in space and also name the methods used for the latter case.

(C.O.No.4) [Knowledge]

(b) Explain the concept of polarization isolation and also mention the reason of providing receiver in wideband receiver. (C.O.No.3) [Comprehension]

9. (a) Write a short note on the satellite service which helps us to navigate from one place to other place with necessary diagrams. (C.O.No.4) [Knowledge]

(b) In a satellite earth station, the higher power TWA delivers an output signal of 600W at 12 GHz. The feeder line is connected to the parabolic dish antenna consumes a power of 2.0 dB. The gain of the dish antenna with respect to an isotropic antenna is 55 dB. Compute EIRP with reference to 1KW. (C.O.No.2) [Comprehension]

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1. a	CO.1	**Introduction to Communication System**	2M			
b	CO.3	**Space Segment**	2M			
c	CO.3	**Space Segment**	2M			
d	CO.3	**Space Segment**	2M			
e	CO.2	**Orbits & Link Budget Calculation**	2M			
f	CO.2	**Orbits & Link Budget Calculation**	2M			
g	CO.3	**Space Segment**	2M			
h	CO.1	**Introduction to Communication System**	2M			
i	CO.4	**Satellite Communication Services**	2M			
j	CO.4	**Satellite Communication Services**	2M			
2	CO.3	**Space Segment**		6M		

3	CO.3	**Space Segment**		6M		
4	CO.3	**Space Segment**		6M		
5	CO.4	**Satellite Communication Services:**		6M		
6	CO.4	**Satellite Communication Services**		6M		
7	CO.2	**Orbits & Link Budget Calculation**			10M	
8	CO.4	**Satellite Communication Services**	5M			
	CO.3	**Space Segment**		5M		
9	CO.4	**Satellite Communication Services**	5M			
	CO.2	**Orbits & Link Budget Calculation**			5M	
	Total Marks		30	35	15	

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I Ms. ISHITA DEB hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

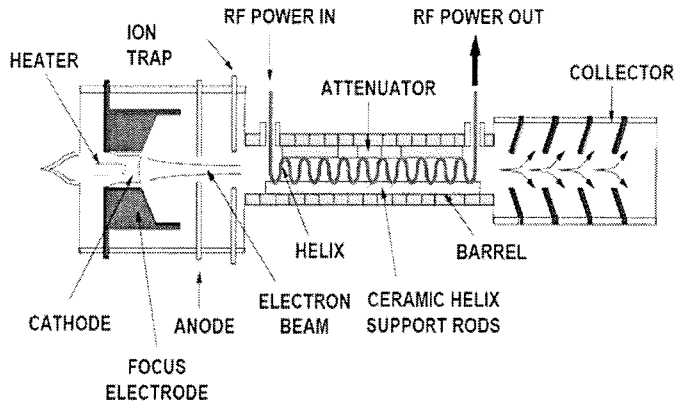
Semester: Odd Sem. 2019-20
Course Code: ECE 305
Course Name: Satellite Communication
Program & Sem: B.tech & 7th

Date: 20 December 2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

Part A (10Q x 2M = 20Marks)

Q No. 1	Solution	Scheme of Marking	Max. Time required for each Question
a	Descending node , angle of inclination	2	1 min
b	Earth segment , space segment	2	1 min
c.	Diplexer	2	1 min
d.	Active & Passive Attitude Control.	2	1 min
e.	$G = 0.55 \times (10.472 \times 12 \times 3)^2 = 78168$ $[G] = 10 \log 78168 = 48.9$ dB	2	1 min
f.	Polarization, increases	2	1 min
g.	500 MHz & 12 channels can be accommodated, having bandwidth of each channel is 36 MHz, with 4 MHz guard band.	2	1 min
h.	Prograde rotation means the direction of rotation is same as that of the sun(the central hub of our system) which is in the counter-clockwise direction when viewed from the north pole. Retrograde rotation means the direction of rotation is opposite to that of the sun.So clockwise rotation.	2	1 min
i.	SDMA: The process where, satellite as a whole to be accessed by earth station widely separated geographically but transmitting on the same frequency	2	1 min
j	NAVSTAR Space Segment. Control Segment. User Segment	2	1 min

Part B (5Q x 6M = 30 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
2	Gain= $\eta(\frac{\Pi D}{\lambda})^2$ & Beam width= 70λ/D. The ratio (D/λ) is the key factor. Gain proportional to the square of the ratio & beam width inversely proportional to the ratio. Hence the gain can be increased and the beam width made narrower by increasing the reflector size or decreasing the eave length. OMT (Orthogonal Mode Transducer) is use to receive two frequency with different polarization.	2+2+2	15min
3	(a) Satellite transponder (b) uplink- 5.925 to 6.425 GHz , downlink- 3.7 to 4.2 GHz (c) The input filter passes the full 500-MHz band to the common receiver while rejecting out-of-band noise and interference such as might be caused by image signals. There will be many modulated carriers within this 500-MHz passband, and all of these are amplified and frequency converted in the common receiver. The frequency conversion shifts the carriers to the downlink frequency band, which is also 500 MHz wide, extending from 3.7 to 4.2 GHz. At this point the signals are channelized into frequency bands which represent the individual transponder bandwidths.	1+2+3	15min
4.	(a) TWT (b) PRINCIPAL COMPONENTS OF A HELIX TWT  (c) **1-dB Compression Point:** The point where the actual transfer characteristics of output power drops below 1 dB. **Power Back-off:** In order to reduce the intermodulation distortion, the operating point of the TWT must be shifted closer to the linear portion of the curve, the reduction in input power being referred to as input back-off. The corresponding drop in output power is called Output	1+ 2+ 3	20min

	Back-off. Thumb rule says, input back-off is less than output back-off by 5 dB.		
5	(a) Pre assigned FDMA — Demand assigned FDMA A station has periodic access to the channel independent of its actual need — It gives the station access to the channel only when it requests access Best applied to high capacity commercial system — For intermittent traffic the demand assignment is more efficient. Less efficient — More efficient than the preassigned ones No control mechanism required — Increases the cost of the system because it requires control mechanism (b) Polling Method. Centrally controlled random access. Distributed control random access	3+1+2	15min
6.	(a) Spade communication system (b)SCPC stands for Single Carrier Per Channel. This refers to a single voice or data channel per carrier not a transponder channel, which may in fact carry some hundreds of voice channels by this method. (c) Station C will first select a frequency pair at random from those currently available on the list and signal this information to station F through the CSC. Station F must acknowledge, through the CSC, that it can complete the circuit. Once the circuit is established, the other earth stations are instructed, through the CSC, to remove this frequency pair from the list	1+2+3	20min

Part C (3Q x 10M = 30Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	) Flux density is given by F = 20 log [EIRP / ($4\Pi R^2$)] dBW/m^2 Hence for R = 38,000 km, f = 4.0 GHz, λ = 0.0750 m, EIRP = 13.0 + 30.0 = 43.0 dBW F = 43.0 - 10 log (4 π) - 20 log (38,000 × 10^3) dBW / m2 = 43.0 - 11.0 - 151.6 = -119.6 dBW /m^2. **ii)** The effective area of the antenna is $A_{eff} = \eta_A \pi r^2 = 0.65 \times \pi \times 1 = 2.042$ m or 3.1 dBm^2 For an incident flux density of -119.6 dBW / m^2 or 1.10 × 10^{-12} W/m^2 $P_r = 2.042 \times 1.10 \times 10^{-12} = 2.24 \times 10^{-12}$W or –116.5 dBW or P_r = -119.6 + 3.1 = -116.5 dBW.	3+3+2+2	20 min

	iii) $G = \eta_A (\pi D / \lambda)^2$ $G = 10 \log (0.65 \times (\pi \times 2 / 0.0750)^2) = 36.6$ dB. **iv)** At a frequency of 4.0 GHz, $\lambda = 0.075$ m. Path loss = $20 \log (4 \pi R / \lambda) = 20 \log (4 \pi \times 38{,}000 \times 10_3 / 0.075)$ dB $L_p = 196.1$ dB		
8.	(a) **Station Keeping:** It is the process of keeping the satellite in its correct orbital position. It is of two types: East- West station keeping is to prevent the satellite from drifting to the stable points. North South station keeping will prevent the satellite to change its inclination from its drift. The satellites in C-band must be kept within ±0.1 of designated longitude & ±0.0.5 for Ku-Band. **Attitude Control:** The attitude of a satellite refers to its orientation in space. Much of the equipment carried aboard a satellite is there for the purpose of controlling its attitude. In the case of earth environmental satellites, the earth-sensing instruments must cover the required regions of the earth, which also requires attitude control. A number of forces, referred to as disturbance torques, can alter the attitude, some examples being the gravitational fields of the earth and the moon, solar radiation, and meteorite impacts. To exercise attitude control, there must be available some measure of a satellite's orientation in space and of any tendency for this to shift. In one method, infrared sensors, referred to as horizon detectors, are used to detect the rim of the earth against the background of space. With the use of four such sensors, one for each quadrant, the center of the earth can be readily established as a reference point. Any shift in orientation is detected by one or other of the sensors, and a corresponding control signal is generated which activates a restoring torque. (b) Atypical transponder bandwidth is 36 MHz, and allowing for a 4-MHz guardband between transponders, 12 such transponders can be accommodated in the 500-MHz bandwidth. By making use of polarization isolation, this number can be doubled. Polarization isolation refers to the fact that carriers, which may be on the same frequency but with opposite senses of polarization, can be isolated from one another by receiving antennas matched to the incoming polarization. With linear polarization, vertically and horizontally polarized carriers can be separated in this way, and with circular polarization, left-hand circular and right-hand circular polarizations can be separated. Because the carriers with opposite senses of polarization may overlap in frequency, this technique is referred to as frequency reuse Aduplicate receiver is provided so that if one fails, the	(a) 2.5+2.5 (b) 2.5+2.5	20 min

	other is automatically switched in. The combination is referred to as a redundant receiver, meaning that although two are provided, only one is in use at a given time		
9	(a) **GPS**: Consists of a constellation of 24 Satellites divided in 6 Regions. Each satellite transmits low powered radio signals. GPS Satellite name is NAVSTAR, located at 11000 miles, inclination 55°. Orbital period around 11 hours 58 min. (b) Given. $P = 600\ W$ Feeder line loss $(\alpha) = 2\ dB = 10^{0.2} = 1.58$ So, transmitted Power, $P_t = \frac{P}{\alpha} = \frac{600}{1.58}$ $= 378.57\ W.$ $G_t = 55\ dB = 10^{5.5} = 316.22 \times 10^3.$ So, EIRP $= P_t G_t$ $= 378.57 \times 316.22 \times 10^3$ $= 119.71 \times 10^6$ EIRP with reference to 1KW is, $EIRP = \frac{119.71 \times 10^6}{1000} = 119.71 \times 10^3.$ In dB, $(EIRP)_{dB} = 10 \log (119.71 \times 10^3)$ $= 50.78\ dB.$ (Ans).	5+5	20 min