MGM’S
Jawaharlal Nehru Engineering College
N-6, CIDCO, Aurangabad
Department of Electronics & Telecommunication

Vision of the Department:

To develop GREAT technocrats and to establish centre of excellence in the field of Electronics and Telecommunications.

- Global technocrats with human values
- Research and lifelong learning attitude,
- Excellent ability to tackle challenges
- Awareness of the needs of society
- Technical expertise

Mission of the Department:

1. To provide good technical education and enhance technical competency by providing good infrastructure, resources, effective teaching learning process and competent, caring and committed faculty.
2. To provide various platforms to students for cultivating professional attitude and ethical values.
3. Creating a strong foundation among students which will enable them to pursue their career choice.
Jawaharlal Nehru Engineering College

Technical Document

This technical document is a series of Laboratory manuals of Electronics and Telecommunication Department and is a certified document of Jawaharlal Nehru Engineering College. The care has been taken to make the document error-free. But still if any error is found, Kindly bring it to the notice of subject teacher and HOD.

Recommended by,

HOD

Approved by,

Principal

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1. Departmental Library
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FOREWORD

It is my great pleasure to present this laboratory manual for Final year engineering students for the subject of Satellite Communication keeping in view the vast coverage required for visualization of concepts of Satellite Communication.

As a student, many of you may be wondering with some of the questions in your mind regarding the subject and exactly what has been tried is to answer through this manual.

Faculty members are also advised that covering these aspects in initial stage itself, will greatly relived them in future as much of the load will be taken care by the enthusiasm energies of the students once they are conceptually clear.

H.O.D.
LABORATORY MANUAL CONTENTS

This manual is intended for the Final year students of engineering branches in the subject of Satellite Communication. This manual typically contains practical/Lab Sessions related Satellite Communication covering various aspects related to the subject to enhance understanding.

Students are advised to thoroughly go through this manual rather than only topics mentioned in the syllabus as practical aspects are the key to understanding and conceptual visualization of theoretical aspects covered in the books.

Good Luck for your Enjoyable Laboratory Sessions

Prof. S.J. Tupe
SUBJECT INDEX

1. Do's and Don'ts in the laboratory

2. Lab Experiments:
   1. To Study Satellite Trainer kit.
   2. To set up an active satellite link and demonstrate link fail operation.
   3. To communicate voice signal through satellite link.
   4. To establish analog / digital Communication link and transmit and receive three Signals (audio, video, tone) simultaneously using satellite communication trainer.
   5. To transmit and receive PC data through satellite link.
   6. To find the link C/N Ratio
   7. Evaluation of SNR in Satellite Links
   8. To observe effect of Fading margin of received signal in satellite link

3. Quiz on the subject

4. Conduction of Viva-Voce Examinations

5. Evaluation and Marking System
**DOs and DON’TS in Laboratory:**

1. Do not handle any equipment before reading the instructions/Instruction manuals.

2. Read carefully the power ratings of the equipment before it is switched on whether ratings 230 V/50Hz or 115V/60 Hz. For Indian equipments, the power ratings are normally 230V/50Hz. If you have equipment with 115/60 Hz ratings, do not insert power plug, as our normal supply is 230V/50 Hz, which will damage the equipment.

3. Observe type of sockets of equipment power to avoid mechanical damage.

4. Do not forcefully place connectors to avoid the damage.

5. Strictly observe the instructions given by the teacher/Lab Instructor.

**Instruction for Laboratory Teachers:**

1. Submission related to whatever lab work has been completed should be done during the next lab session.

2. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.
Experiment No. 1
Aim: - To study Introduction of Satellite Trainer Kit ST2272

Detailed Product Description
Satellite Communication Trainer ST2272 provides an in-depth study of basic Satellite Communication system. It consists of Uplink Transmitter, Satellite Link and Downlink Receiver, which can be conveniently placed in the laboratory. The Satellite can be placed at an elevated position if needed. The Satellite Transponder receives signal from Uplink Transmitter and retransmits at different frequencies to a Downlink Receiver. The Uplink and Downlink frequencies are selectable and carry three signals - Video, Audio/Voice/Tone and Data simultaneously. The Operating manual illustrates basic theory and glossary of Satellite Communication terms along with Experiments. Experiments that can be performed Understanding Basic concepts of Satellite Communication. To establish a direct communication link between Uplink Transmitter and Downlink receiver using tone signal. To setup an Active satellite link and demonstrate Link Fail operations.

To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver.

And Many More Technical Specification
Uplink Transmitter. Transmit 3 signals simultaneously at each up linking frequency 2414 /2432/2450/2468 MHz up linking frequencies selectable by up-down 2 Switch and LED indication. 4 MHz clock frequency. Wide band RF amplifier. No manual matching required. PIC16F84 - 8 Bit RISC processor based PLL. 16 MHz Bandwidth. FM Modulation of Audio and Video. 5/5.5/8 MHz Audio and Video Modulation Detachable Dish Antenna. Radiated Power output 25 mW (approx.) . Transmit Audio, Video, Digital/Analog data, Tone, Voice Function Generator waveforms etc. Separate terminals provided for Different inputs Power Supply: 230 Volts 10% ,50 Hz. Satellite Link. Transponder with selectable frequency conversion. Choice of 4 downlink frequencies 2414 /2432/2450/2468 MHz Rotary Switch for selecting uplink frequency. Link Fail Operation. Detachable Dish Antennas. Radiated power 25 mW Approx. with gain

Scientech 2272A Satellite Communication platform provides an in-depth study of basic Satellite Communication system. It consists of Uplink Transmitter, Satellite Link and Downlink Receiver, which can be conveniently placed in the laboratory. The Satellite can be placed at an elevated, position if needed. The Satellite Transponder receives signal from Uplink Transmitter and retransmits at different frequencies to a Downlink Receiver. The Uplink and Downlink frequencies are selectable and can have variety of signals such as Video, Audio, Voice, Tone, Data and Telemetry (Temperature and Light intensity). The Operating manual illustrates basic theory and glossary of Satellite Communication terms along with Experiments

FEATURES
- Simultaneous communication of three different signals
- Communicate Audio, Video, Digital data, PC data, Tone, Voice, function generator waveforms etc
- 2414 - 2468MHz PLL microwave operation
- Communication of external broad band digital signal
- Choice of different transmitting and receiving frequencies
- Built-in Speaker and Microphone for Voice and Audio link
- Remote detection of Light intensity and environment temperature
- Detachable Dish Antenna at each station
- USB port for PC communication
- 2 Year Warranty

Result: Thus we have studied Introduction of Satellite Trainer Kit ST2272
Experiment No.2

Aim: To setup an active satellite link and demonstrate link fail operations

Apparatus: Satellite Trainer kit, connecting cords.

Procedure:
1. Place uplink transmitter, transponder and downlink receiver at a convenient distance of 3 meters, in a triangular manner.
2. Set first dish antenna of uplink Transmitter and R1 receiving dish antenna of satellite transponder position in sight.
3. Set X2 transmitting antenna of satellite transponder and R2 dish antenna of downlink receiver position in sight.
4. Set downlink frequency to 2414 MHz by frequency selection switch on board.
5. Now connect tone output signal to tone input socket onboard uplink Transmitter by patch cord.
6. Keep downlink receiver speaker switch in ON position and you will be to hear tone in speaker of receiver.
7. When the frequency combinations of transmitter and receiver are mismatched no signal is received and no tone can be heard on the downlink receiver. This demonstrates satellite link operations.

Result: Hence active satellite link and its failure operation is demonstrated.
Experiment No.3

Aim: To setup an active satellite link and demonstrate link fail operations.
Apparatus: Satellite Trainer kit, connecting cords.
Procedure:-
1. Place Satellite Transmitter, downlink receiver and transponder, preferably all three in equilateral triangle of distance 3 meters.
2. Set X1 dish antenna of uplink transmitter of satellite transponder and R2 dish antenna of downlink receiver position insight.
3. Set downlink receiver frequency to 2414 MHz by adjusting knob provided onboard.
4. Connect microphone to the socket onboard uplink transmitter.
5. Now switch on the speaker onboard downlink receiver.
6. Speak though the microphone and you will hear the same sound in speaker of downlink receiver.

Result: Voice signal can be transmitted through satellite link.

Fig 1. Block Diagram of Satellite Communication System
Experiment No.4

Aim:— To transmit and receive three separate signals (Audio, video, tone) simultaneously through satellite link

Apparatus :— Satellite Trainer kit, connecting cords.

Procedure:—
1. Place Satellite Transmitter, downlink receiver and transponder, preferably all three in equidistant triangle of distance 3 meters.
2. Set X1 dish antenna of uplink transmitter of satellite transponder and R2 dish antenna of downlink receiver position insight.
3. Set downlink receiver frequency to 2414 MHz by adjusting knob provided onboard.
4. Connect separate audio, video and tone signal to the socket onboard uplink transmitter.
5. Now switch on the speaker onboard downlink receiver and also TV receiver to the downlink receiver.
6. Check for different combination of frequencies on transmitter and receiver.

Result:—
With proper frequency matching, simultaneous transmission of all three signals can be demonstrated.

Fig 1. Block Diagram of Satellite Communication System
Experiment No.5

**Aim:** To transmit and receive PC data through satellite link.

**Apparatus:** Uplink Transmitter, Downlink Receiver, dish antennas, Transponder, 2 No. of RS-232 9-pin cables, 2 Male to -1 Female RS-232 cable, 2 sets of PC, Satellite software and connecting cables.

**Theory:** The Uplink transmitter sends signals at an uplink frequency, which is higher than downlink frequency to avoid the interference. The quality of signal is much improved with active satellite specially when distances between transmitter and receiver are considerable.

**Block diagram:**

![Block Diagram of transmit and receive PC data through satellite link.](image)

**Procedure:**

1. Connect the satellite uplink transmitter to AC mains.
2. Switch on the transmitter by mains switch and frequency display will come on.
3. The transmitting frequency can be selected by up–down switch. The frequency can be changed from 1200 -1250-1300 MHz.
4. The transmitter on -off switch will switch on -off the transmission.
5. Connect X1 antenna to uplink transmitter with BNC-BNC cable.
6. Set the o/p gain of uplink transmitter to maximum.
7. Place downlink receiver at a distance of 5-7 m.
8. Connect the downlink receiver to the AC mains and switch it on by mains switch.
9. The downlink receiver frequency can be changed from 1100 -1150-1200 MHz.
10. The downlink receiver also has tuning potentiometer, which can be used to tune any frequency from 950-1500 MHz.
11. Keep the tuning POT fully anticlockwise.
12. The downlink receiver on -off switch will switch on -off the receiver.
13. Attach R2 antenna to the downlink receiver with BNC-BNC cables.
14. Align both the transmitter and receiver antenna in line.
15. Place a satellite transponder between transmitter and receiver at a distance of 5-7 m.
16. Connect the satellite transponder to the AC mains and switch it on by mains switch.

17. The receiver side of satellite Transponder has an on-off switch, which will switch off the receiver of the satellite. Similarly on-off switch on transmitter side will switch off transmitter of satellite.

18. Adjust transmitter uplink frequency to 1300 MHz and transponder receiver frequency also to 1300MHz.

19. Keep downlink frequency of Transponder to 1100MHz.

20. Keep the downlink receiver to 1100MHz.

21. Connect RS-232 cable from uplink transmitter to one set of PC.

22. Connect RS-232 cable from downlink receiver to one set of PC.

23. Switch on the PC and install sat. Software on both PC and select communication port COM 1 on both PC.

24. When the link is established, the typed matter on first set up PC will be transmitted to second set up PC via Satellite link. (If transmitted data is not received correctly then adjust gain POT of satellite Transponder.)

**Result**: PC data transmitted from first setup PC is received in the second setup PC via. Satellite link.
Experiment No.6

Aim: - To find the link C/N Ratio

Theory :-

The Uplink

The uplink earth station is transmitting the signal and the satellite is receiving it. Equation (1) can be applied to the uplink, but with subscript U denotes that the uplink is being considered.

\[
\left[ \frac{C}{N_0} \right]_U = [EIRP]_U + [\frac{G}{T}]_U - [LOSSES]_U - k
\] --(2)

Eq (2) contains: the earth station EIRP, the satellite receiver feeder losses, and satellite receiver G/T. The freespace loss and other losses which are frequency-dependent are calculated for the uplink frequency. The resulting carrier-to-noise density ratio given by Eq. (2) is that which appears at the satellite receiver.

Downlink

The downlink the satellite is transmitting the signal and the earth station is receiving it. Equation (1) can be applied to the downlink, but with subscript D to denote that the downlink is being considered.

\[
\left[ \frac{C}{N_0} \right]_D = [EIRP]_D + [\frac{G}{T}]_D - [LOSSES]_D - k
\] --(3)

Eq. (3) contains: the satellite EIRP, the earth station receiver feeder losses, and the earth station receiver G/T. The free-space and other losses are calculated for the downlink frequency.

The resulting carrier-to-noise density ratio given by Eq. (3) is that which appears at the detector of the earth station receiver.

Where the carrier-to-noise ratio is the specified quantity rather than carrier-to-noise density ratio, Eq. (1) is used. On assuming that the signal bandwidth B is equal to the noise bandwidth BN, we obtain:
Combined Uplink and Downlink C/N Ratio

The complete satellite circuit consists of an uplink and a downlink, as sketched in Fig. 3.1.

Noise will be introduced on the uplink at the satellite receiver input.

\[ \frac{C}{N} = \left[ \frac{EIRP}{N} \right]_U + \left[ \frac{G}{T} \right]_D - [LOSSES]_U - [k][B] \] --(4)

---

**Fig 3.1** (a) combined uplink and downlink (b) power flow diagram

Noise will be introduced on the uplink at the satellite receiver input.

- **PNU** = noise power per unit bandwidth
- **PRU** = average carrier at the same point

The carrier-to-noise ratio on the uplink is

\[ \frac{C}{N_U} = \frac{PR_U}{P_{NU}} \]

Note that power levels, and not decibels, are being used.

- **PR** = carrier power at the end of the space link
- **PRU** = the received carrier power for the downlink
- **P_{RU}** = K x the carrier power input at the satellite
Where

\[ K = \text{the system power gain from satellite input to earth station input. This includes the satellite transponder and transmit antenna gains, the downlink losses, and the earth station receive antenna gain and feeder losses.} \]

The noise at the satellite input also appears at the earth station input multiplied by \( K \), and

in addition, the earth station introduces its own noise, denoted by PND. Thus the end-of-link noise is KPNU + PND.

The \( C/No \) ratio for the downlink alone, not counting the KPNU contribution, is \( PR/PND \), and the combined \( C/No \) ratio at the ground receiver is \( PR/(KPNU + PND) \).

The power flow diagram is shown in Fig. b.

The combined carrier-to-noise ratio can be determined in terms of the individual link values. To show this, it is more convenient to work with the noise-to-carrier ratios rather than the carrier-to-noise ratios, and these must be expressed as power ratios, not decibels.

Denoting the combined noise-to-carrier ratio value by \( No/C \), the uplink value by \( (No/C)_U \), and the downlink value by \( (No/C)_D \) then,

\[
\frac{N_o}{C} = \frac{P_N}{P_R} \]
\[
= \frac{\gamma P_{NU} + P_{ND}}{P_R} \]
\[
= \frac{\gamma P_{NU}}{P_R} + \frac{P_{ND}}{P_R} \]
\[
= \frac{\gamma P_{NU}}{P_R} + \frac{P_{ND}}{P_R} \]
\[
= \left( \frac{N_o}{C} \right)_U + \left( \frac{N_o}{C} \right)_D \]

Equation (4) shows that to obtain the combined value of \( C/NO \), the reciprocals of the individual values must be added to obtain the \( NO/C \) ratio and then the reciprocal of this taken to get \( C/NO \). The reason for this reciprocal of the sum of the reciprocals method is that a single signal power is being transferred through the system, while the various noise powers which are present are additive.

**Result**: Thus we have studied uplink and downlink C/N ratio.
Experiment No. 7

Aim: - Evaluation of SNR in Satellite Links

Theory: -

Concept of signal to noise ratio SNR

Although there are many ways of measuring the sensitivity performance of a radio receiver, the S/N ratio or SNR is one of the most straightforward and it is used in a variety of applications. However it has a number of limitations, and although it is widely used, other methods including noise figure are often used as well. Nevertheless the S/N ratio or SNR is an important specification, and is widely used as a measure of receiver sensitivity.

Signal to noise ratio for a radio receiver

The difference is normally shown as a ratio between the signal and the noise (S/N) and it is normally expressed in decibels. As the signal input level obviously has an effect on this ratio, the input signal level must be given. This is usually expressed in microvolts. Typically a certain input level required to give a 10 dB signal to noise ratio is specified.

Signal to noise ratio formula

The signal to noise ratio is the ratio between the wanted signal and the unwanted background noise.

$$SNR = \frac{P_{signal}}{P_{noise}}$$

It is more usual to see a signal to noise ratio expressed in a logarithmic basis using decibels:

$$SNR_{dB} = 10 \log_{10}\left(\frac{P_{signal}}{P_{noise}}\right)$$
If all levels are expressed in decibels, then the formula can be simplified to:

\[ \text{SNR}_{eb} = P_{\text{signal}_{eb}} - P_{\text{noise}_{eb}} \]

The power levels may be expressed in levels such as dBm (decibels relative to a mill watt, or to some other standard by which the levels can be compared.

**Effect of bandwidth on SNR**

A number of other factors apart from the basic performance of the set can affect the signal to noise ratio, SNR specification. The first is the actual bandwidth of the receiver. As the noise spreads out over all frequencies it is found that the wider the bandwidth of the receiver, the greater the level of the noise. Accordingly the receiver bandwidth needs to be stated.

Additionally it is found that when using AM the level of modulation has an effect. The greater the level of modulation, the higher the audio output from the receiver. When measuring the noise performance the audio output from the receiver is measured and accordingly the modulation level of the AM has an effect. Usually a modulation level of 30% is chosen for this measurement.

**Signal to noise ratio specifications**

This method of measuring the performance is most commonly used for HF communications receivers. Typically one might expect to see a figure in the region of 0.5 microvolt’s for a 10 dB S/N in a 3 kHz bandwidth for SSB or Morse. For AM a figure of 1.5 microvolt’s for a 10 dB S/N in a 6 kHz bandwidth at 30% modulation for AM might be seen.

**Points to note when measuring signal to noise ratio**

SNR is a very convenient method of quantifying the sensitivity of a receiver, but there are some points to note when interpreting and measuring signal to noise ratio. To investigate these it is necessary to look at the way the measurements of signal to noise ratio, SNR are made. A calibrated RF signal generator is used as a signal source for the receiver. It must have an accurate method of setting the output level down to very low signal levels. Then at the output of the receiver a true RMS AC voltmeter is used to measure the output level.

**Result:** Thus we have studied S/N ratio for satellite link.
Experiment No. 8

Aim: - To observe effect of Fading margin of received signal in satellite link

Theory: -

The [EIRP] is the power input to one end of the transmission link, and the problem is to find the power received at the other end. Losses will occur along the way, some of which are constant. Other losses can only be estimated from statistical data, and some of these are dependent on weather conditions, especially on rainfall. The first step in the calculations is to determine the losses for clear weather, or clear-sky, conditions. These calculations take into account the losses, including those calculated on a statistical basis, which do not vary significantly with time. Losses which are weather-related, and other losses which fluctuate with time, are then allowed for by introducing appropriate fade margins into the transmission equation.

How do we predict the effects of fading?
It's impractical to calculate strength of all the reflections of a radio wave in a real-world setting with many objects. (In an empty field you can calculate it because the only thing to consider is reflections off the ground.) In anything more populated than an empty field, we turn to statistical models to work out the probability of the signal strength at any one point. A mobile phone company, for example, doing this calculation will know at a given distance from the tower, what percentage of the time the signal will be above a certain threshold.

Many processes in nature can be modeled well by the Gaussian distribution, also called "the bell curve". Fading is best modeled by a Rician distribution. The sigma and nu parameters of the distribution depend on the environment. There will be much more fading, and much more broadly spread probability distribution function, in dense urban environments and indoors. In a dense environment, it is common to see fades that are 30dB deep or deeper in 1% of locations.

How does this affect the real-world wireless system we talked about above?
Earlier we talked about a system proven to provide -57dBm of signal strength in an outdoor environment. The receiver's packet error rate is low (i.e. it works reliably) until the signal falls below -85dBm.

In an rich-fading indoor environment, however, the signal fades by 30dB 1% of the time. During these occasions, the signal strength drops below -87dBm. In rare
unlucky stops it may fall as long as -97dBm. In extremely rare “lottery-jackpot
winning” locations (i.e. much rarer than 1 in 100), the signal made fade to zero. What we
care about is that packet error rate becomes high enough to make the system
noticeably unreliably at -85dBm. In this environment, 1% of the locations will
experience packet loss.

What can we do about these deep fades?
• Increase fading margin: The easiest thing to do, if it’s an option, is to crank up the
power. If you have 40dB more power than you need (i.e. 40dB of fade margin), it
will cover all but the most lottery-winning fades.
• Antenna diversity: In the scenario above we said 1% of locations experience 30dB fades. But it’s much less likely (ideally 0.01^2 = 0.01%) that two locations will
experience deep fades at the same time. This is why you see wireless equipment
with more than one antenna.
• Frequency diversity: Fading environments are “frequency selective”, meaning the
locations of “dead spots” due to fading change with frequency. If the system can
change frequency when a fade occurs, it may not experience fading at the new
frequency.
• Higher-Level Protocols: The higher level protocols must be able to tolerate some
loss of information at the physical layer. Layer 2 should acknowledge messages and
retry messages that are not acknowledged. Maybe the user will have moved out of
a “dead spot” by the time the retry occurs. Even if retries fail, the layers above
should handle the loss gracefully. If the system is a voice phone call, maybe it
would choose to maintain the connection for a second or two even though there is
no signal in case the connection improves. This way the user will experience the
audio breaking up but not lose the call altogether.

Fade Duration Distributions at Higher Elevation Angles

Sforza and Buonomo [1993] derived fade duration distributions at 1.3 GHz from
aircraft measurements executed in North Yorkshire, UK at elevation angles of 40°,
60° and 80° for a “wooded” environment with percentage of optical shadowing
(POS) varying between 35% and 85%. In Figure 5-5 are shown fade duration
distributions for these

elevation angles and a fade threshold of 6 dB. These distributions were converted
from a time duration abscissa to the shown distance duration distribution
employing their stated average vehicle speed of 8.6 m/s. As in Figure 5-4, an
elevation angle dependence is exhibited for each of the distributions.
Figure 5-5: Fade duration distributions at 1.3 GHz derived from measurements of Sforza and Buonomo [1993] in North Yorkshire, U.K. for a "wooded" environment.

Result: Thus we have studied fade margin.
Experiment No.9

Aim:- Analysis The Link-Power Budget Equation

Theory :-

The [EIRP] can be considered as the input power to a transmission link. Now that the losses for the link have been identified, the power at the receiver, which is the power output of the link, may be calculated simply as [EIRP] - [LOSSES] - [GR], where the last quantity is the receiver antenna gain.

Note carefully that decibel addition must be used.

The major source of loss in any ground-satellite link is the free-space spreading loss. [FSL] is the basic link-power budget equation taking into account this loss only. However, the other losses also must be taken into account, and these are simply added to [FSL]. The losses for clear-sky conditions are

[LOSSES] = [FSL] + [RFL] + [AML] + [AA] + [PL]

The decibel equation for the received power is then

[PR] = [EIRP] + [GR] - [LOSSES]

Where, [PR] _ received power, dBW

[EIRP] _ Equivalent isotropic radiated power, dBW

[FSL] _ Free-space spreading loss, dB

[RFL] _ Receiver feeder loss, dB

[AML] _ Antenna misalignment loss, dB

[AA] _ Atmospheric absorption loss, dB

[PL] _ Polarization mismatch loss, dB

Example:

- A satellite downlink at 12 GHz operates with a transmit power of 6W and an antenna gain of 48.2 dB. Calculate the EIRP in dBW.

Solution:

[EIRP] = 10log(6W/1W) + 48.2

= 56dBW

- Calculate the gain in decibels of a 3-m paraboloidal antenna operating at a frequency of 12GHz. Assume an aperture efficiency of 0.55.

\[ G = \eta (3.192fD)^2 \]

\[ G = 0.55 \times (10.472 \times 12 \times 3)^2 = 78168 \]

\[ [G] = 10 \log 78168 = 49.9dB \]

- A satellite link operating at 14 GHz has receiver feeder losses of 1.5 dB and a free space loss of 100 dB. The atmospheric absorption loss is 0.5 dB, and
the antenna pointing loss is 0.5dB. Depolarization losses may be neglected.

Calculate the total link loss for clear-sky condition.

Solution: the total link loss is the sum of all the losses:

\[ [\text{LOSSES}] = [\text{FSL}] + [\text{RFL}] + [\text{AA}] + [\text{AML}] \]
\[ = 100 + 1.5 + 0.5 + 0.5 \]
\[ = 102.5 \text{dB} \]

\[ [P_r] = [\text{EIRP}] + [G_r] - [\text{LOSSES}] \]
\[ = 56 + 49.9 - 102.5 \]
\[ = 3.4 \text{dB} \]

**Result:** Hence Link power budget equation is studied.
3. Quiz on the Subject

Quiz should be conducted on tips in the laboratory, recent trends and subject knowledge of the subject. The quiz questions should be formulated such that questions are normally are from the scope outside of the books. However twisted questions and self formulated questions by the faculty can be asked but correctness of it is necessarily to be thoroughly checked before the conduction of the quiz.

1. The first geostationary satellite launched in 1965 was called
   A. ANIK
   B. EARLY BIRD (Intelsat-I)
   C. WESTAR
   D. MOLNIYA

2. Rotation of a geosynchronous satellite means its
   A. drift from stationary position
   B. wobbling
   C. three-axis stabilization
   D. three-dimensional stabilization

3. The present total cost per watt of power generation in geosynchronous orbit is nearly Rs.
   A. 20
   B. 50
   C. 100
   D. 5

4. Noise temperature of Sun is more than __________ °K.
5. A 20 m antenna gives a certain uplink gain at frequencies of 4/6 GHz. For getting same gain in the 20/30 GHz band, antenna size required is metre.

   A. 100  B. 4  
   C. 1  D. 10

6. The discussing sharing of a communication satellite by many geographically dispersed Earth station, DAMA means

   A. Demand-Assigned Multiple Access  
   B. Decibel Attenuated Microwave Access  
   C. Digital Analog Master Antenna  
   D. Dynamically-Assigned Multiple Access

7. The angle subtended by earth at geostationary communication satellite is

   A. 17.34°  B. 51.4°  
   C. 120°  D. 60°

8. The INTELSAT-IV satellite launched in 1974 had two earth coverage antenna and two narrower-angle antennas subtending 4.5°. The signal from narrow-angle antenna was stronger than that from earth-coverage antenna by a factor of

   A. 17.34/4.5  
   B. 17.34 x 4.5  
   C. (17.34/4.5)^2
9. A transponder is a satellite equipment which
   A. receives a signal from Earth station and amplifies
   B. changes the frequency of the received signal
   C. retransmits the received signal
   D. does all of the above-mentioned functions

10. A geosynchronous satellite
    A. has the same period as that of the Earth
    B. has a circular orbit
    C. rotates in the equatorial plane
    D. has all of the above

11. To make antenna more directional, either its size must be increased or
    A. the number of its feed horns must be increased
    B. the frequency of its transmission must be increased
    C. its effective isotropic radiated power (EIRP) must be increased
    D. its footprint must be increased

12. India’s first domestic geostationary satellite INSAT-IA was launched on 10th April 1982 from
    A. USSR
    B. USA
    C. UK
    D. UP
13. Satellite launch sites are invariably located on Eastern seabords to ensure that
   A. launch takes place eastward
   B. expenditure of propulsion fuel is reduced during plane changing
   C. the satellite achieves circular orbit quickly
   D. spent rocket motor and other launcher debris falls into the sea

14. The owner of a communication satellite is usually required to keep the spacecraft on station at its assigned place in the geosynchronous orbit with an accuracy of __________ degree.
   A. 0.1 
   B. 1.0 
   C. 2.0 
   D. 0.5 

15. The number of days when Earth’s shadow falls on a geosynchronous satellite is
   A. 88 
   B. 277 
   C. 5 
   D. 10
4. Conduction of VIVA-VOCE Examinations :

Teacher should conduct oral exams of the students with full preparation. Normally the objective questions with guess are to be avoided. To make it meaningful, the questions should be such that depth of the student in the subject is tested. Oral Exams are to be conducted in co-cordial situation. Teachers taking oral exams should not have ill thoughts about each other & courtesies should be offered to each other in case of opinion, which should be critically suppressed in front of the students.

5. Evaluation and marking system:

Basic honesty in the evaluation and marking system is essential and in the process impartial nature of the evaluator is required in the exam system. It is a primary responsibility of the teacher to see that right students who really put their effort & intelligence are correctly awarded.

The marking pattern should be justifiable to the students without any ambiguity and teacher should see that students are faced with just circumstance.