American International University- Bangladesh (AIUB)
Faculty of Engineering (EEE)

Course Name :	**Telecommunication Engineering [FE]**		
Semester :	**Summer 2020-2021**	**Sec :**	B
Lab Instructor :	Mr. Shuvra Saha	**Group No:**	01

Final Term Lab Project

Group Members		**ID**	**Name**	**Contribution**
	1.	18-37913-2	SAHA, ANKUR	Project Implementation
	2.	18-38291-2	URME, TAHMINA AKTHER	Report Making
	3.	18-37566-1	RONY, MD	
	4.			
	5.			
	6.			

Submission Date :	**14.08.2021**

Marking Rubrics (to be filled by Lab Instructor)

Category	Proficient [5]	Good [4]	Acceptable [3]	Unacceptable [1]	Secured Marks
Theoretical Background, Methods & procedures sections	All information, measures and variables are provided and explained.	All Information provided that is sufficient, but more explanation is needed.	Most information correct, but some information may be missing or inaccurate.	Much information missing and/or inaccurate.	
Data Acquisition and Results	All of the criteria are met. results are described clearly and accurately.	Most criteria are met, but there may be some lack of clarity and/or incorrect information.	Experimental Data and results do not match exactly with the theoretical values and/or analysis is unclear.	Experimental results are missing or incorrect.	
Discussion	Demonstrates thorough and sophisticated understanding. Conclusions drawn are appropriate for analyses.	Hypotheses are clearly stated, but some concluding statements not supported by data or data not well integrated.	Some hypotheses missing or misstated. conclusions not supported by data.	Conclusions do not match hypotheses, not supported by data. no integration of data from different sources.	
Writing & organization	Writing is strong and easy to understand. ideas are fully elaborated and connected. effective transitions between sentences. no typographic, spelling, or grammatical errors.	Writing is clear and easy to understand. ideas are connected. effective transitions between sentences. minor typographic, spelling, or grammatical errors.	Most of the required criteria are met, but some lack of clarity, typographic, spelling, or grammatical errors are present.	Very unclear, many errors.	
				Total Marks (Out of 20):	
Comments:				Total Marks (Out of 10):	

Design a new communication system to communicate position information between planes close enough to each other to be potentially dangerous. Each plane periodically broadcasts its position, heading, speed, and other relevant information about its trajectory using an air traffic frequency, so that another plane in range knows of its presence and can react if it will pass to close to the first plane.

Design Criteria:

- To avoid collision, assume any two planes within 50 km of each other should be able to communicate, and the communication system is noise limited.
- Consider short cables with 0.5~1 dB cable loss for each antenna.
- Use an appropriate center frequency from a VHF/UHF band under the "Aeronautical Radionavigation" category of radio frequency spectrum as specified by Bangladesh Telecommunication Regulatory Commission (BTRC).
- Transmitter and receiver antennas must be close to isotropic to be able to communicate with planes and thus have a low gain in the range of 1.10-1.25 dBi.
- Assume a receiver noise figure of 6 dB with bandwidth of 50 kHz, but due to the lower temperatures at high elevation, you may assume an ambient temperature of 243 K.
- In addition to the free space loss, you must leave high fading margin (>10 dB minimum) in case of loss due to rain or other precipitation.
- The receiver must have adequate SNR (15~20 dB) for reliable demodulation.

Based upon the above criteria, **write a report** answer the following questions:

a) Design the complete system and justify the parameter choices (e.g., EIRP, Antenna gain, Fading margin, Receiver Sensitivity, Noise figure etc.) during each step of the design.
b) Calculate the necessary transmit power (in watts) in your design to satisfy the above criteria.
c) Plot the link budget using MATLAB, showing all gains and losses in different parts of the system.
d) Include your code in the report **with proper comments.**
e) If the two planes are double the distance apart compared to the previous case (leading to higher free space loss) and we are using the same transmitter, what is the maximum fade margin possible now? What is the significance of the change in fading margin? Is this better or worse?

Additionally, **create a presentation** where you explain the work process of the code step by step.

Answer to the question no. (a)

After designing the complete system, we got these values –

EIRP = -0.5000 dB

Free Space Path Loss = 116.2806 dB

Antenna Gain for both Tx and Rx = 1.12 dBi

Fading Margin = 21 dB

Receiver Sensitivity = -137.2806 dB

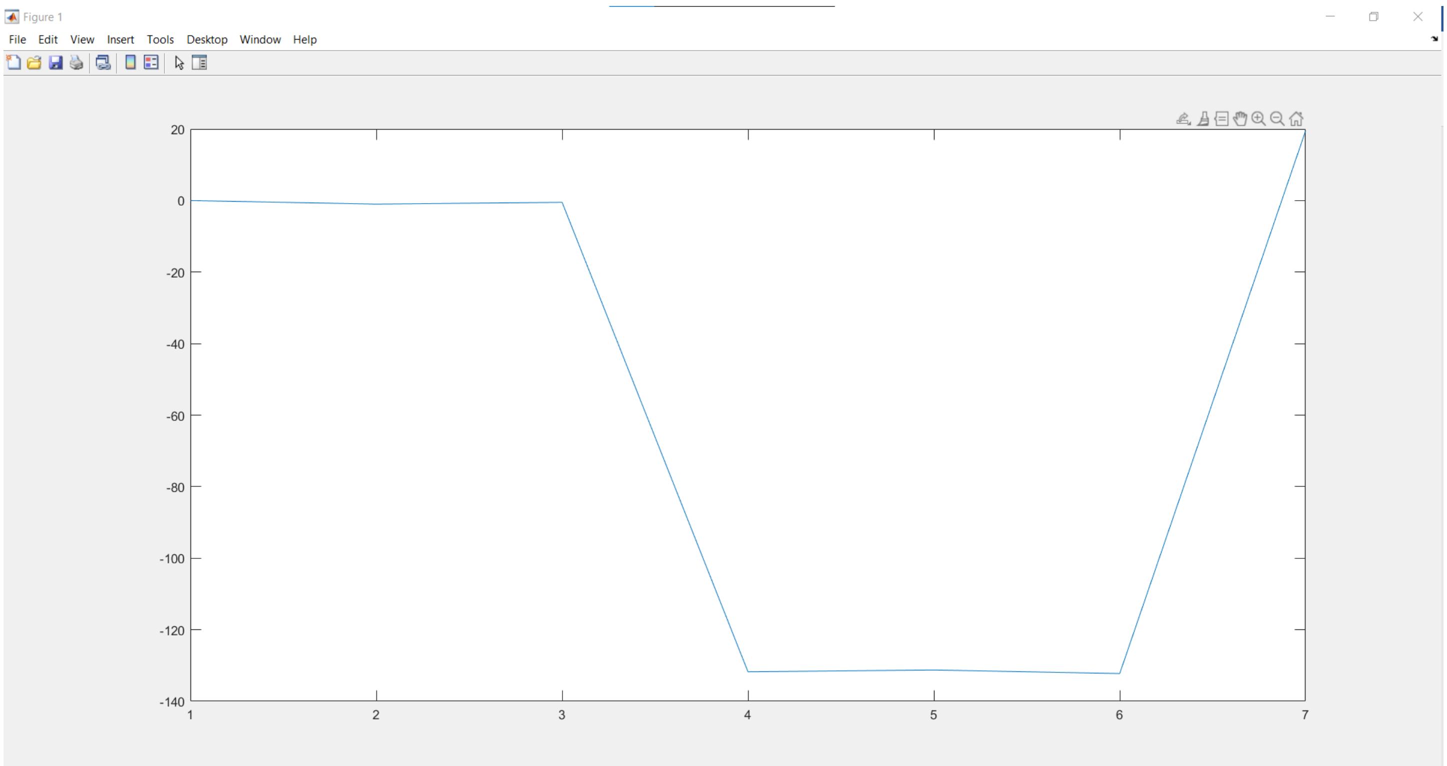
Noise Figure = 6 dB

Signal-to-Noise Ratio = 19.4945 dB

Answer to the question no. (b)

Necessary transmit power = 0 db or 1 watt.

Answer to the question no. (c)



Answer to the question no. (d)

```
Pt=0; % transmit power is dBW
Pt_abs=1; % 1 watt
cable_loss_tx=1; % total cable loss is 2 dB
cable_loss_rx=1;
fc=0.156325; % carrier frequency is 156.325 MHz
d=50000; % distance between Tx and Rx is 50 km
d_km=50;
Gt=0.5; % transmit antenna gain 0.5 dB
Gt_abs=10^(Gt/10); % absolute value 1.12 dBi
Gr=0.5; % transmit antenna gain 0.5 dB
Gr_abs=10^(Gr/10); % absolute value 1.12 dBi
k_bol_cons=1.3803*10^-23; % Boltzman constant J/K
Tempr=243; % receiver temperatur 243 K
rec_BW=50*10^3; % receiver IF BW is 50 KHz
N_fig=6; % noise figure is 6 dB
```

```
% receiver thermal noise
%
% Effective isotropic radiated power (EIRP)
EIRP=Pt_abs*Gt_abs;
EIRP_dBW=Pt-cable_loss_tx+Gt; % in dBW
% power flux density at the receiver, i.e. at distance d
W=EIRP/(4*pi*d^2); % in watt/m2
% free space path loss
L_dB_km=92.4+20*log10(fc)+20*log10(d_km);
% or
%L_dB_mile=96.6+20*log10(fc)+20*log10(d_mile);
% fade margin is 21 dB
fade_mar=21;
% received power sensitivity (at the receiver input)
Pr_sen_dB=EIRP_dBW-(L_dB_km+fade_mar)+Gr-cable_loss_rx;
% noise threshold at the output end of the receiver
N_thres_dBW=10*log10(k_bol_cons*Tempr*rec_BW)+N_fig;
% carrier-to-noise ratio at the receiver front end
C_N_ratio=Pr_sen_dB-N_thres_dBW;
% antenna diameter
ante_dia=10^((Gt-(20*log10(6)+17.8))/20); % in meter
LB1=Pt;
LB2=LB1-cable_loss_tx;
LB3=EIRP_dBW;
LB4=LB3-L_dB_km-fade_mar;
LB5=LB4+Gr;
LB6=LB5-cable_loss_rx;
LB7=C_N_ratio;
link_budg=[LB1 LB2 LB3 LB4 LB5 LB6 LB7];
disp ('EIRP in dBW')
disp (EIRP_dBW)
disp ('Free Space Path Loss')
disp (L_dB_km)
disp ('Received Power Sensitivity')
disp (Pr_sen_dB)
disp ('Noise Threshold at Receiver')
disp (N_thres_dBW)
plot(link_budg)
disp('Signal-to-Noise ratio at the Receiver End')
disp(C_N_ratio)
```

Answer to the question no. (e)

If two planes are double the distance apart compared to the previous case (leading to higher free space loss) and we are using the same transmitter, the fade margin that we've to consider is between 15~19 dB. Because if we take the fade margin value < 15 dB, we get the SNR value as 20.4739 dB (for 14 dB fade margin) and if we take the fade margin value > 19 dB, we get the SNR value as 14.4739 dB (for 20 dB fade margin). We can see that, both the SNR values does not fall into the given range of 15~20 dB. That is why, for link distance of 100 km, the fade margin value must be between 15~19 dB with same transmitter.

Presentation Link:

https://drive.google.com/file/d/1X_oGGVsmlidSR_tjavVOh98x9QtqrfSN/view?usp=sharing