Task 1

LAB 1: FRIIS FREE SPACE PROPAGATION MODEL

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SECTION : 5

Objectives:

- Understanding the Friis free space Model
- To determine the free space loss and the power received in different environments using MATLAB
- Observing the effect of shadowing on the received signal

Summary:

- Friis free space propagation model is used to model the LOS path loss incurred in a free space environment, devoid of any objects that create absorption, diffraction, reflections, or any other characteristic-altering phenomenon to a radiated wave. It is based on the inverse square law of distance which states that the received power at a particular distance from the transmitter decays by a factor of square of the distance.

The Friis equation for received power is given by:

$$P_r(d) = P_t \frac{G_t G_r \lambda^2}{(4\pi)^2 d^n L}$$

"The parameter n is the path-loss exponent that takes constant values depending on the environment that is modeled."

Task (1):

- consider a Zigbee (IEEE 802.15.4 standard) transmission-reception system operating at f = 2.4 GHz or f = 915 MHz bands with 5 mW output power from the transmitter. The transmitter and the receiver are using an isotropic antenna. The system losses (transmission lines and antennas) are modelled by considering L = 1.4.

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a) Implement the Friis propagation model using a MATLAB function.

```matlab
% ===================Abdelrahman Matarawy====================%
% ========================Section 5==========================%
function [Pr_dBm, PL_dB] = FriisModel(Pt_dBm, Gt_dBi, Gr_dBi, f, d, L, n)

%Pt_dBm ->is Transmitted power
%Pr_dBm ->is Recieved power
%PL_dBm ->is Free space Path Loss power
%Gt_dBi ->Gain of Transmitted antenna
%Gr_dBi ->Gain of Recieved antenna
%L ->The system losses (transmission lines and antennas)

% to calc Lamda (speed of light in air / Frequency)
Lamda = (3*10^8) / f;
%to calc Free space Path Loss
PL_dB = 20*log10(4*pi) - 20*log10(Lamda) + 10*n*log10(d) + 10*log10(L);
%to Calc Recieved Power
Pr_dBm = Pt_dBm + Gt_dBi + Gr_dBi - PL_dB;

end
```

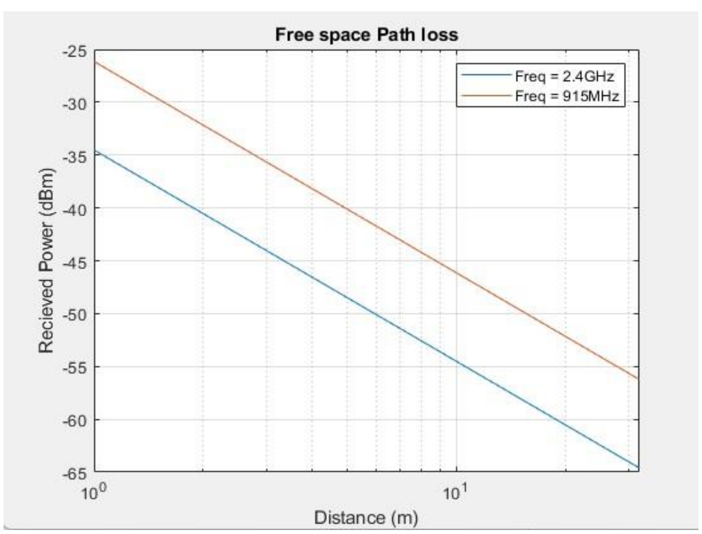
b) Plot the received power and the path loss versus distance if the channel environment is:

1) Free space:

- Code:

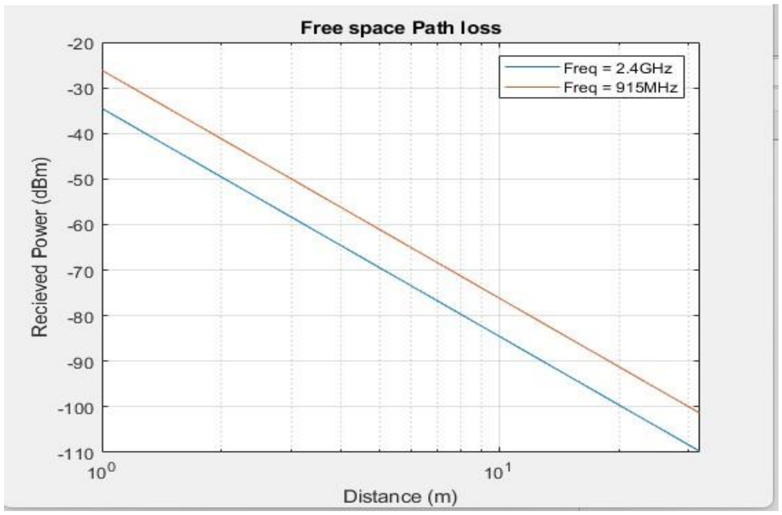
```
% ===================Abdelrahman Matarawy===================%
% ========================Section 5========================%
clc
clear
%output power from the transmitter
Pt_dBm = 10*log10(5);
%The transmitter and the receiver Gain are using an isotropic antenna
Gt_dBi = 0;
Gr_dBi = 0;

d = 2.^[0,1,2,3,4,5];
%The system losses (transmission lines and antennas)
L = 1.4;
%As we work on Free space so Path loss exp = 2
n = 5;
f = 2.4e9;
[Pr1_dBm, PL1_dB] = FriisModel(Pt_dBm, Gt_dBi, Gr_dBi, f, d, L, n);
semilogx(d, Pr1_dBm);
hold on;
f = 915e6;
[Pr1_dBm, PL1_dB] = FriisModel(Pt_dBm, Gt_dBi, Gr_dBi, f, d, L, n);
semilogx(d, Pr1_dBm);
grid on;
legend('Freq = 2.4GHz','Freq = 915MHz');
title ('Free space Path loss');
xlabel('Distance (m)');
ylabel('Recieved Power (dBm)');
```

- OutPut:



2) Obstructed by a building.

- By change n to be between 4 and 6



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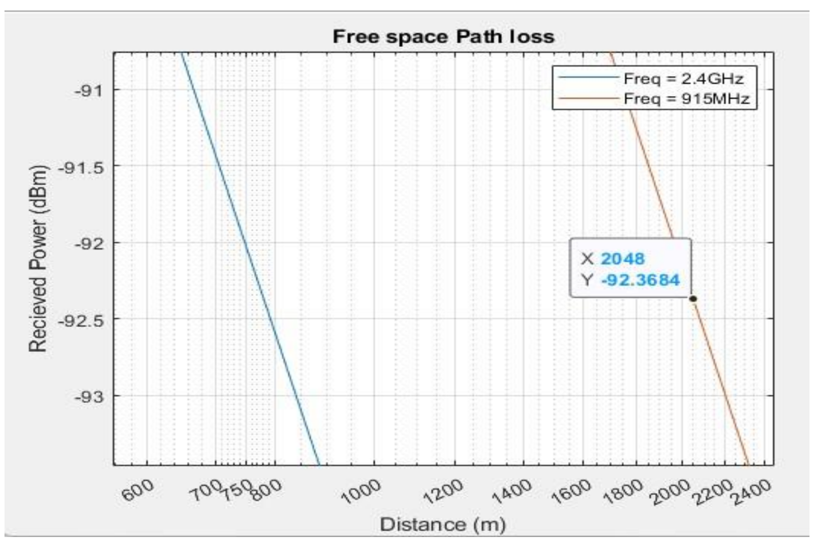
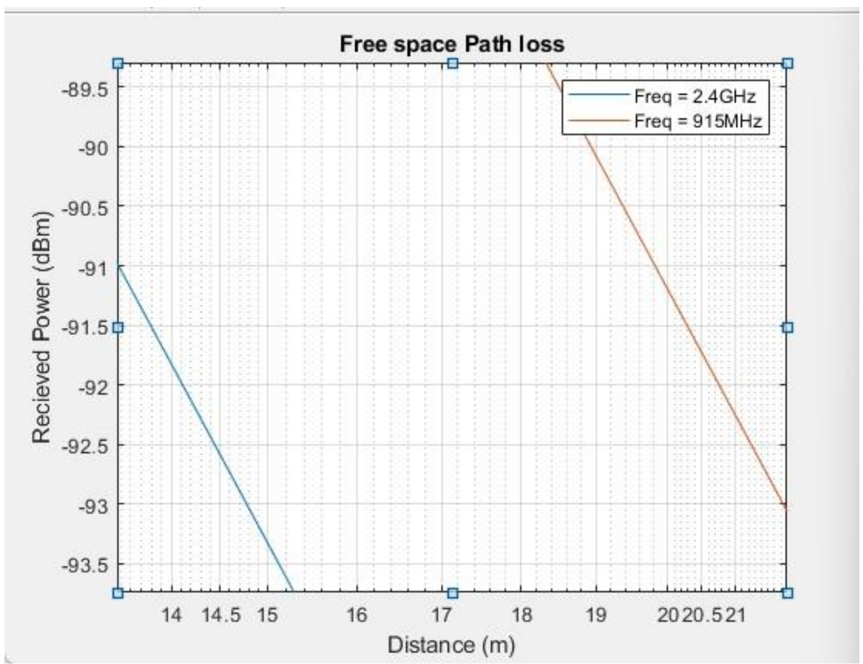
c) If the receiver sensitivity is -92dBm, the maximum range for this system at free space n = 2:



- We Found that approximately at frequency = 2.4GHz and receiver sensitivity is -92dBm, The Max distance equal 750m

- We Found that approximately at frequency = 915MHz and receiver sensitivity is -92dBm, The Max distance equal 2000m

d) If the receiver sensitivity is -92dBm, the maximum range for this system Obstructed by a building n = 5:



- We Found that approximately at frequency = 2.4GHz and receiver sensitivity is -92dBm, The Max distance equal 14.2m .
- We Found that approximately at frequency = 915MHz and receiver sensitivity is -92dBm, The Max distance equal 20.7m .