National University of Sciences & Technology (NUST)
School of Electrical Engineering and Computer Science (SEECS)
Department of Software Engineering

HW.2
(CLO-4: P4)
Marks 10

EE-357:Computer and Communication Networks BEE-12

HW2: Multiple Questions covering CLO-4

Question 1: mmWave communication is one of the emerging technologies for the future network like 5G. It uses frequency range from 30 GHz to 300 GHz. You are required to investigate the affects of frequency and distance both on the path loss. Write a matlab code considering the following conditions.

1. Use free space path loss model to calculate pathloss in dB using frequency range 30 Ghz to 150 Ghz at distance of 60m and plot a graph to display the variation in pathloss.
2. Use free space path loss model to calculate pathloss in dB using distance range 60m to 150m using frequency 40 Ghz plot a graph to display the variation in pathloss.
3. Use the following equation to calculate pathloss. Consider a non-line of sight (NLOS) communication with transmitter height 33m, receiver height 2.5m, fc=82Ghz

$$\overline{PL(d,f)}(dB) = \alpha + \overline{\beta} \cdot 10\log_{10}(d) + \gamma \cdot 20\log_{10}\left(\frac{f}{f_c}\right)$$

where α is the floating intercept, β is the average pathloss exponent, d is the distance from transmitter, f is the frequency used, fc is the carrier frequency, and γ is shadowing effect. Using the appropriate values of variables from the table given below to calculate path loss for frequency range f=30Gz to 120Ghz at d=30m and plot the comparison with part 1. Similarly, calculate pathloss for distance=50m to 100m and plot the comparison with part 2.

Frequency (GHz)	TX Height (meters)	Rx Height (meters)	TX,RX Antenna Gains (dBi)	Path Loss Scenarios	TX-RX Separation Range (meters)	Key Parameters for Equation (1)		
						$\overline{\beta}$ (Slope)	α (Floating Intercept, dB)	Shadow Factor σ_{SF} (dB)
28 GHz New York City	7	1.5	+24.5, +24.5	Non-line-of-sight (NLOS)	30 < d <200	3.73	75.85	8.36
	17					4.51	59.89	8.52
38 GHz Austin, Texas	8	1.5	+25, +25	Non-line-of-sight (NLOS)		1.28	115.17	7.59
	8		+25, +13.3			0.40	117.85	8.23
	23		+25, +13.3			0.12	118.77	5.78
	36		+25, +25			0.45	127.79	6.77
	36		+25, +13.3			0.41	116.77	5.96

For further understanding read the article [Path loss models for 5G millimeter wave propagation channels in urban microcells | IEEE Conference Publication | IEEE Xplore]

Question 2:

Consider the conditions mentioned in Question 1 calculate Received Power (Pr) in dB for part 1,2,3 using Pt=40dBm. Plot the graph in matlab and comment the variation in received power.

Question 3:

The doppler shift is defined by the following equation where fm = v/λ and λ is the wavelength of arriving plane wave, θn is the angle of incidence of the plane wave arriving at the mobile station. Consider a transmitter is moving towards the

receiver with v=60kmph, f=800 MHz, and θn=55. Implement the doppler shift effect in matlab to evaluate effects of θn, f, and v on doppler effects.

$$f_{D,n} = f_m \cos\theta_n \ \text{Hz}$$

1. Keeping all variable constant and vary θn from 0 to 90 degrees to calculate doppler shift and plot the graph for θn vs Doppler shift.
2. Keeping all variable constant and vary f from 600Mhz to 900 Mhz to calculate doppler shift and plot the graph for frequency vs Doppler shift.
3. Keeping all variable constant and vary v from 10kmph to 60kmph to calculate doppler shift and plot the graph for Velocity vs Doppler shift.
4. Repeat the part 1,2 and 3 and consider the transmitter is moving away from the receiver.
5. Comment on the variation in doppler shift on part 1,2 and 3.

Question 4:

Consider the 2-ray model with transmitter height 35m, receiver height 10m, distance 60m, Gt=4, Gr=2, Pt=33dBm. Write a matlab code to calculate received power and pathloss using 2-ray model in dB.

Question 5:

Diffraction gain due to presence of knife edge is given by the equation mentioned below where parameter v is the Fresnel-kirchoff diffraction parameter. Write a matlab code to calculate Diffraction gain for -3.5<=v<=3.5 and display the values of gain.

$$G_d\,(\text{dB}) = 20\log|F(v)|$$

Useful links:

- Matrices and Arrays - MATLAB & Simulink (mathworks.com)
- Execute statements if condition is true - MATLAB if elseif else (mathworks.com)
- for loop to repeat specified number of times - MATLAB for (mathworks.com)
- 2-D line plot - MATLAB plot (mathworks.com)