

**Department of Electrical Engineering**

**Faculty Member: Dr. Syed Ali Hassan**

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**Course/Section: BEE-11**

**Semester: 7<sup>th</sup>**

**EE355 Digital Communication Systems**

**Lab-08: Level Crossing Rate and Average Fade Durations**

			PLO4-CLO3		PLO5-CLO4
Name		Reg. No	Viva / Quiz / Lab Performan ce	Analysis of data in Lab Report	Modern Tool Usage
			5 Marks	5 Marks	5 Marks
Muhammad Abdullah Khan	284286				
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## Lab-08: Level Crossing Rate and Average Fade Durations

### **Objectives:**

The objective of this lab is to understand the level crossing rate and average fade durations through MATLAB simulations.

1. Analyzing the relation between the average fade duration and threshold level
2. Determining the bit error rate using the level crossing rate
3. Designing a Rayleigh fading simulator via the frequency domain method to confirm the analytical and simulation results of level crossing rates and average fade durations

### **Lab Instructions**

- ✓ The lab report shall be uploaded on LMS.
- ✓ Only those tasks that are completed during the allocated lab time will be credited to the students. Students are however encouraged to practice on their own in their spare time for enhancing their skills.

### **Lab Report Instructions**

All questions should be answered precisely to get maximum credit. A lab report must ensure the following items:

- ✓ Lab objectives
- ✓ MATLAB codes
- ✓ Results (graphs/tables) duly commented and discussed
- ✓ Conclusion

## Lab-08: Level Crossing Rate and Average Fade Durations

### Objectives:

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### Reading Task

Lecture slides by Dr. Syed Ali Hassan on **Level Crossing Rate and Average Fade Durations (Lecture-09)**.

### Task-1

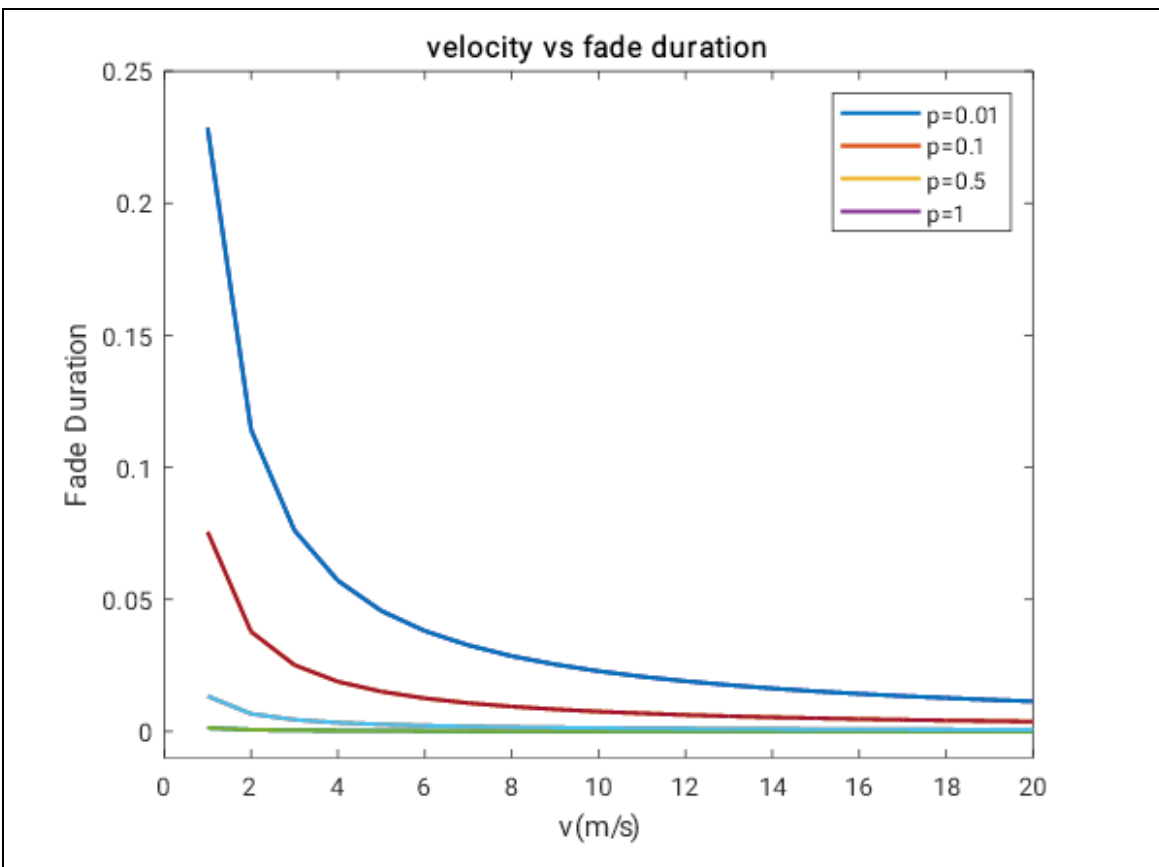
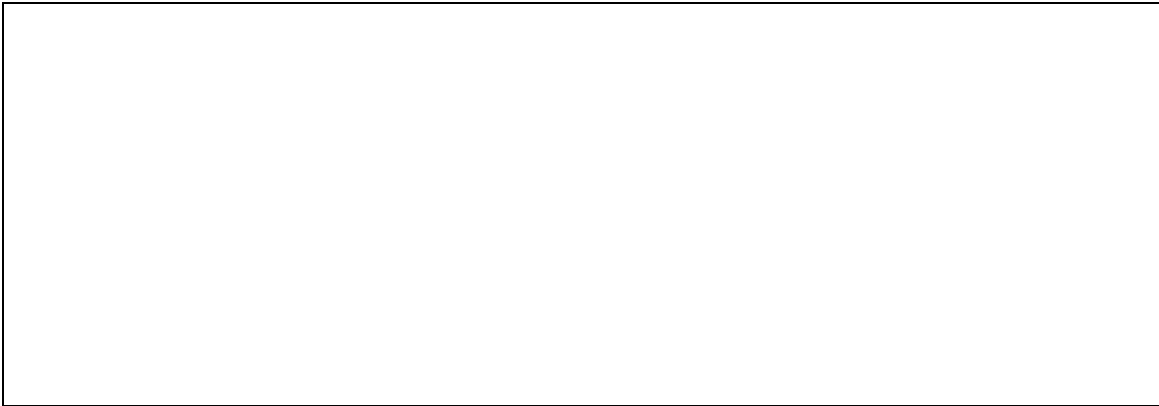
- Create a function that finds the average fade duration for a given threshold level to rms ratio and max doppler frequency.
- Create a function that finds the level crossing rate for a given threshold level to rms ratio and max doppler frequency.
- Using the function created in part (a), plot the average fade duration for threshold levels of  $\rho = 0.01, 0.1, 0.5, \text{ and } 1$  versus velocity. Consider carrier frequency is 900 MHz.

```
Fc= 900e6;
v=1:20;
p=[0.01 0.1 0.5 1];
c=3e8;
fd= Fc*v/c;

for i=1:length(p)
dur= avg_fade_dur(p(i),fd);
plot(v,dur, 'Linewidth',1.5);
hold on;
end
title('velocity vs fade duration');
xlabel('Velocity (m/s)');
ylabel('Fade Duration');
ylim([-0.01 0.25]);
legend('p=0.01','p=0.1','p=0.5','p=1');
function duration = avg_fade_dur (threshold,Fd)

duration= (exp(threshold^2)-1)./(sqrt(2*pi)*Fd*threshold);

end
```



- Using the functions created in part (a) and (b), plot bit error rate (BER) versus the velocity for a binary digital modulation with a bit duration of 50 bps and carrier frequency of 900 MHz.

```
Fc= 900e6;  
v=1:20;  
p=[0.01 0.1 0.5 1];  
c=3e8;  
fd= Fc*v/c;
```

```

bitrate = 50;
ber= 50*duration;

for i=1:length(p)
duration= afd(p(i),fd);

ber= 50*duration;
figure(1)
plot(v,duration,'Linewidth',1.5);
figure(2)
plot(v,ber,'Linewidth',1.5);
hold on;
end

figure(1)
title('velocity vs fade duration');
xlabel('v(m/s)');
ylabel('Fade Duration');
ylim([-0.01 0.25]);
legend('p=0.01','p=0.1','p=0.5','p=1');

figure(2)
title('BER vs Velocity');
xlabel('v(m/s)');
ylabel('Bit Error rate');
ylim([-0.01 0.25]);
legend('p=0.01','p=0.1','p=0.5','p=1');

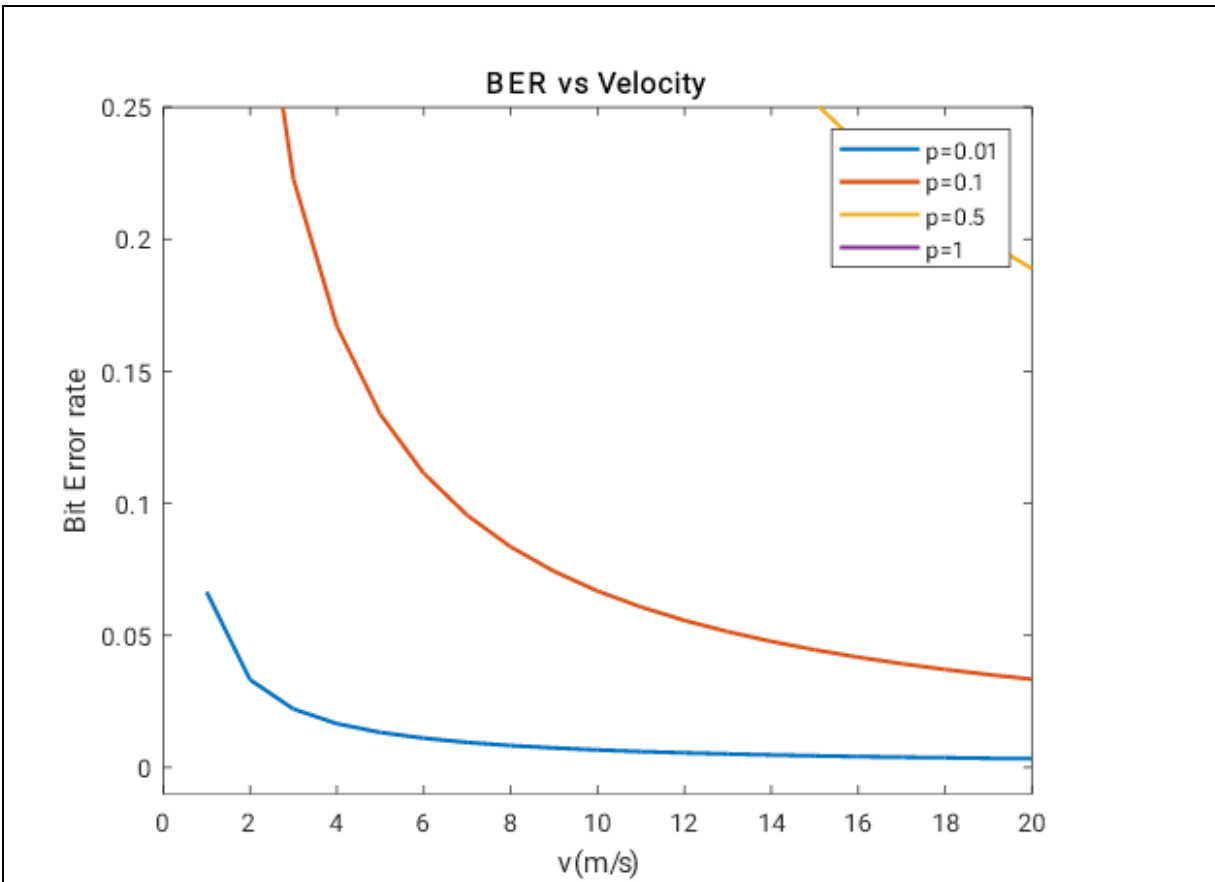
bitrate = 50;
ber= 50*duration;

function duration = afd (threshold,Fd)

duration= (exp(threshold^2)-1)./(sqrt(2*pi)*Fd*threshold);

end

```



## CONCLUSION:

In this lab, we analyzed the relation between the average fade duration and threshold level on MATLAB. Furthermore, we determined the bit error rate using the level crossing rate.

## Task-2

Design a Rayleigh fading simulator. Write a MATLAB program that simulates Rayleigh fading, using the frequency domain method, as described in Fig. 1. Assume the maximum Doppler frequency is 200 Hz. Confirm that level crossing rates and average fade durations of your simulated waveforms agree with the analytical results obtained via the mathematical formulas. Explain any discrepancies you observed in your simulated outputs. Attach the source code, waveform samples, and other pertinent results.

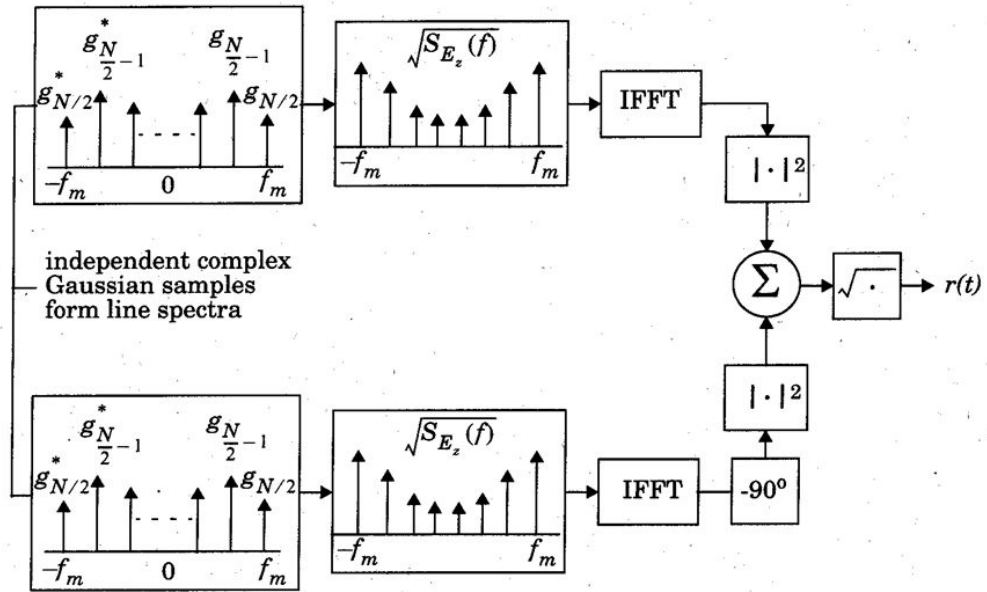


Fig.1: Frequency domain implementation of Rayleigh fading simulator at baseband.