Table of Contents

..... 1
Question 2 1
Question 3 1
Question 4 4

```
clc;
clear;
close all;

format long;
```

Question 2

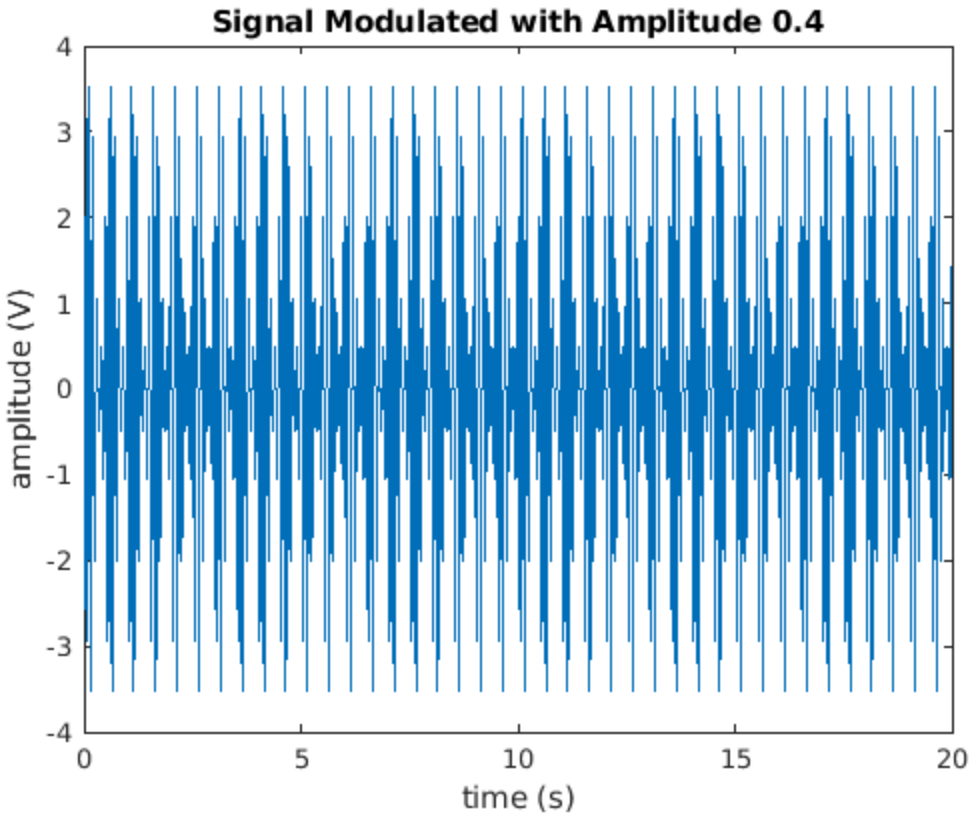
```
fc = 10;
kf = 3;

freqs = [ 15 10 20 ];
amps  = [ 2 10 2 ];

freq_dev = kf * amps;
bandwidth = 2 * freq_dev + 2*freqs;
beta = freq_dev ./ freqs;
universal = [9 4 12] .* freq_dev;

narrowband = beta < 1;
```

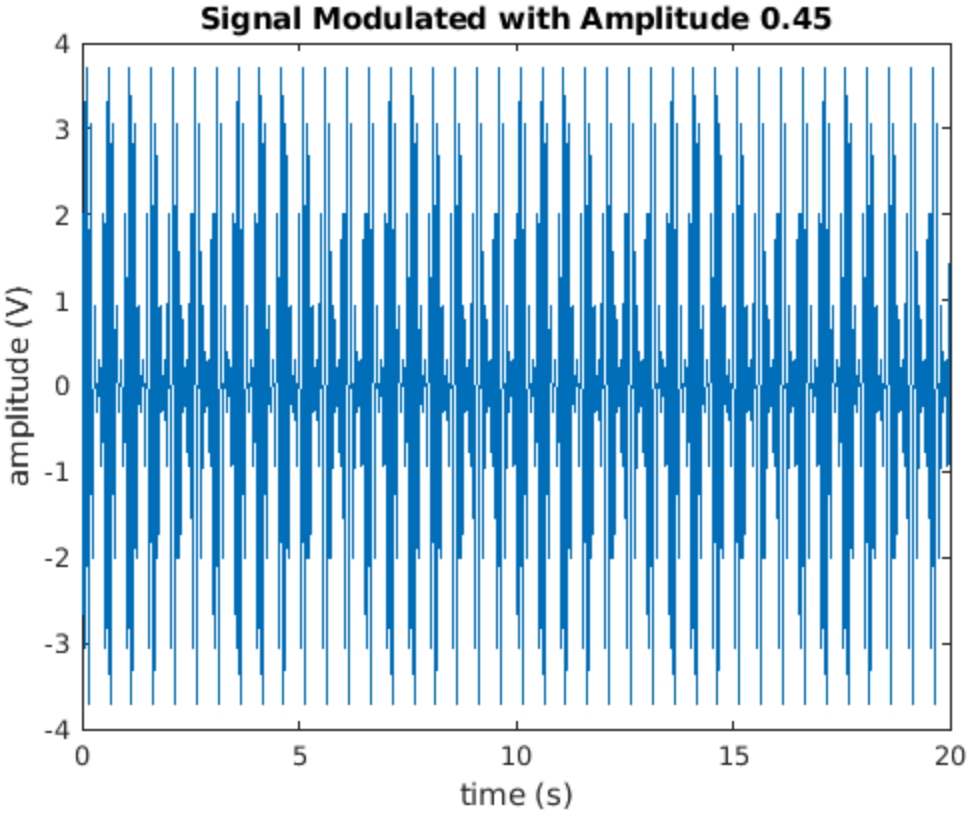
Question 3

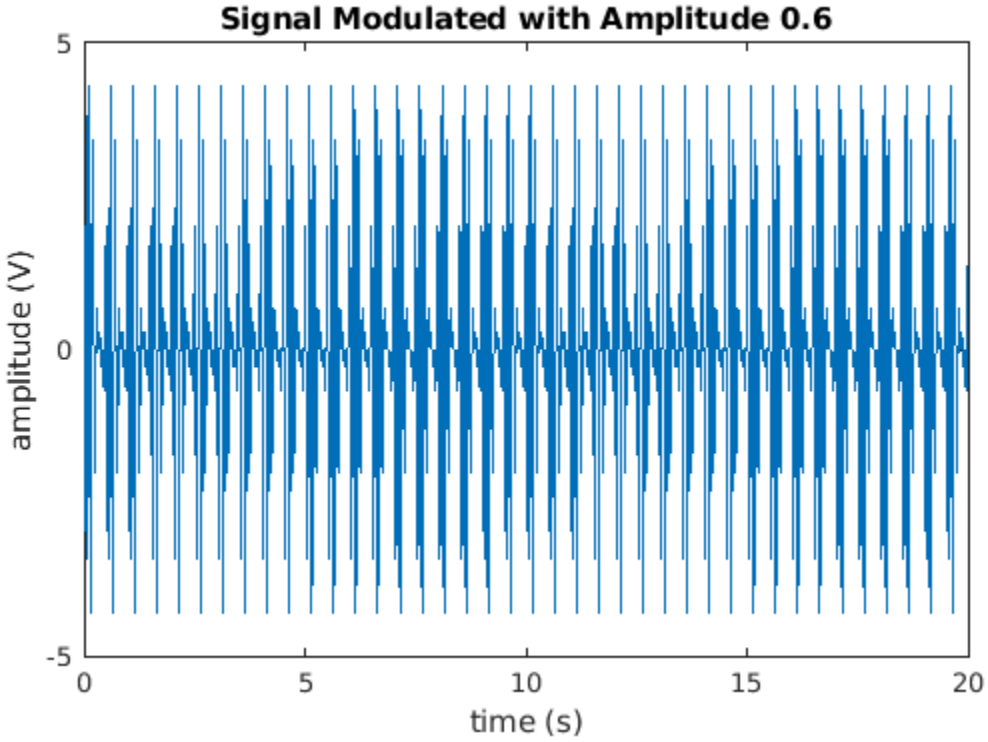
```
ka = 2;
fc = 10;
ac = 2;

amps = [ .4; .45; .6 ];

fs = 100;
t = 0:1/fs:2000/fs-1/fs;

m = amps .* sin(2*pi*2*t);
x = ac * (ones(size(m)) + ka*m) .* cos(2*pi*fc*t);

mod_index = ka*amps'*100;
over_mod = mod_index > 100;


for i = 1:3
    fprintf("Amp = %f V\n", amps(i));
```

```
    fprintf("  Modulation Index: %d\n", mod_index(i));
    fprintf("  Overmodulated? :  %d\n\n", over_mod(i));

    figure;
    plot(t, x(i, :));
    title("Signal Modulated with Amplitude " + amps(i));
    xlabel("time (s)");
    ylabel("amplitude (V)");
end
```

```
Amp = 0.400000 V
  Modulation Index: 80
  Overmodulated? :  0

Amp = 0.450000 V
  Modulation Index: 90
  Overmodulated? :  0

Amp = 0.600000 V
  Modulation Index: 120
  Overmodulated? :  1
```



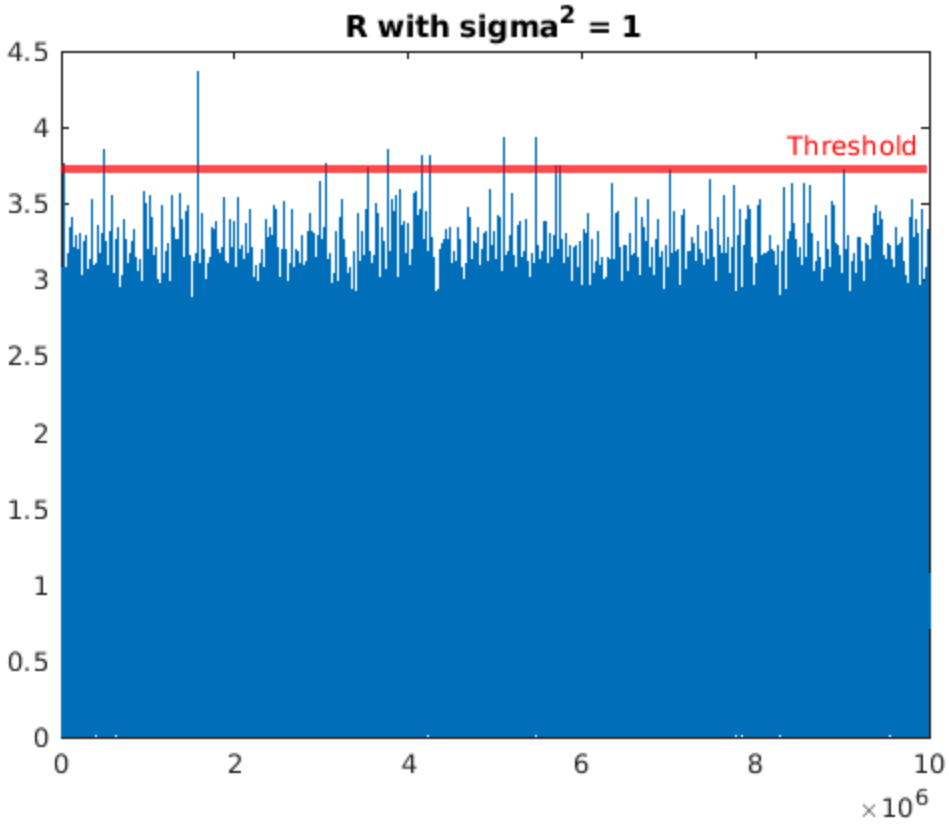

Signal Modulated with Amplitude 0.45
amplitude (V)
time (s)
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20

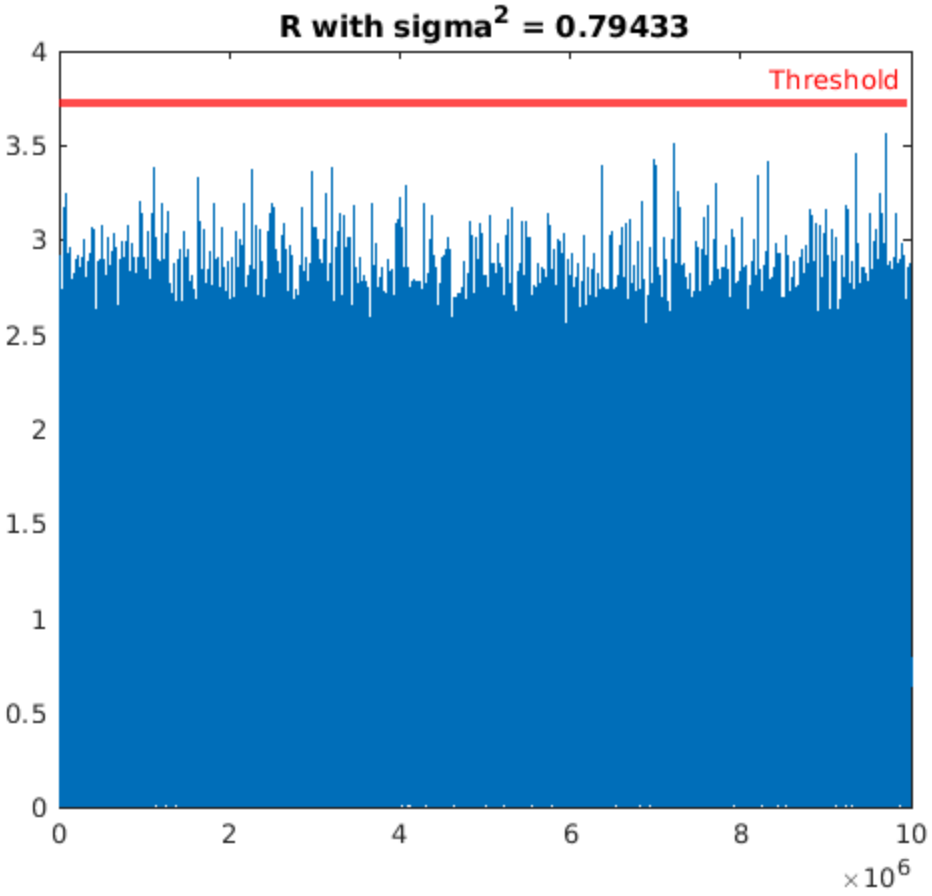

Signal Modulated with Amplitude 0.6
amplitude (V)
time (s)
5
0
-5
0
5
10
15
20

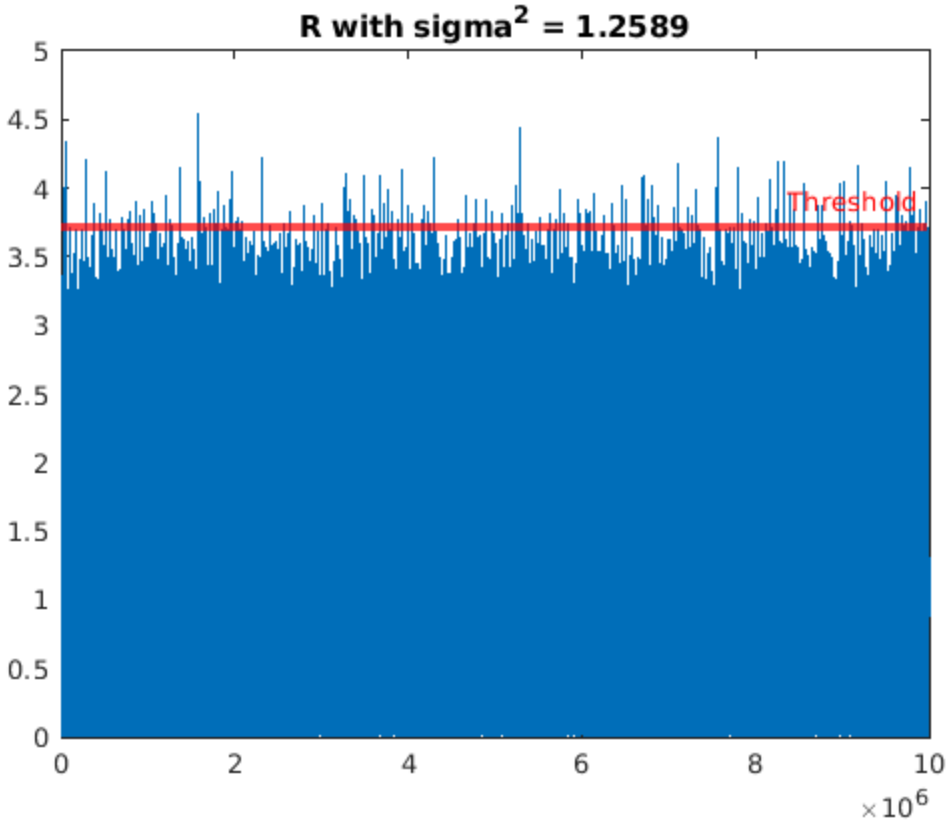
Question 4

```
syms r

eq1 = 10e-4 == exp(-r^2/2);

sol = solve([eq1], [r]);

threshold = double(sol(1));
n = 1e7;
sigma = [10; 10; 10] .^ [0; -1/10; 1/10];
p = exp(-threshold^2*ones(size(sigma))/2./sigma);
R =  sqrt(sigma/2) .* abs(randn(3,n) + 1j*randn(3,n));

percent = sum(R > threshold, 2)/length(R);

for i = 1:3
    figure;
    plot(R(i, :));
    yline(threshold, "-r", "Threshold", 'LineWidth', 3);
    title("R with sigma^2 = " + sigma(i));

    fprintf("Fraction above threshold for sigma^2 = %f: %f < %f\n", sigma(i),
 percent(i), p(i));

end
```

```
Fraction above threshold for sigma^2 = 1.000000: 0.000001 < 0.001000
Fraction above threshold for sigma^2 = 0.794328: 0.000000 < 0.000167
Fraction above threshold for sigma^2 = 1.258925: 0.000017 < 0.004140
```


R with sigma^2 = 1
Threshold
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
$\times 10^6$


R with sigma^2 = 0.79433
Threshold
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
$\times 10^6$



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