HW3

March 17, 2023

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ECE 6600

1 Homework 3

1.1 Problem 1

Differentiate between fade rate and fade duration.

Fade rate is the number of times a signal fades below a threshold.

Fade duration is how long it takes the signal power to be below a threshold.

1.2 Problem 2

Consider a wireless system that supports the following schemes:

a. BPSK with rate ½ coding for an overall useful data rate of 6 Mbps

b. QPSK with rate ¾ coding for an overall useful data rate of 18 Mbps

What is the duration of one symbol of the raw signal in each case (a and b).

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a.

BPSK 1/2 = 2 bits per symbol.

1/6Mbps = 1.667×10^-7 seconds per bit

2 bits * seconds / bit = 3.333×10^-7 seconds

b.

QPSK 3/4 = 2.666 bits per symbol

1/18Mpsb = 5.556×10^-8 seconds per bit

2.66 bits * seconds per bit = 1.47778×10^-7 seconds

1.3 Problem 3

If the symbol duration of a wireless system is the same as in problem 2, but the system employs 16-QAM, what should the code rate be for a useful data rate of 27 Mbps?

1/27Mbps = 3.704×10^-8 seconds per bit

a. 3.33e-7 seconds per symbol

bits/symbol = 8.99, so 4 bits in and 9 bits out ½ code rate

1/2 code rate

b. 1.47e-7 seconds per symbol

bits/symbol 4

1/1 code rate

1.4 Problem 4

If a wireless system employs direct sequence spread spectrum and the chip rate is 1.2288 Mcps and the bit rate associated with this chip rate is 9.6 kbps, what is the processing gain?

[ ]:
```
chip_rate = 1.2288e6
bit_rate = 9.6e3

gain = bit_rate/chip_rate
print(gain)
```

```
0.0078125
```

The processing gain is 0.0078125

1.5 Problem 5

Consider a 4 carrier OFDM system. Let the frequencies of the carriers be fc, fc+1/T, fc+2/T, and fc+3/T, where T =100/fc is the symbol duration. If BPSK is used on all carriers and fc = 1 MHz, plot one OFDM symbol where the bits carried by each carrier is "0". Assume that the amplitude of each carrier is 1.

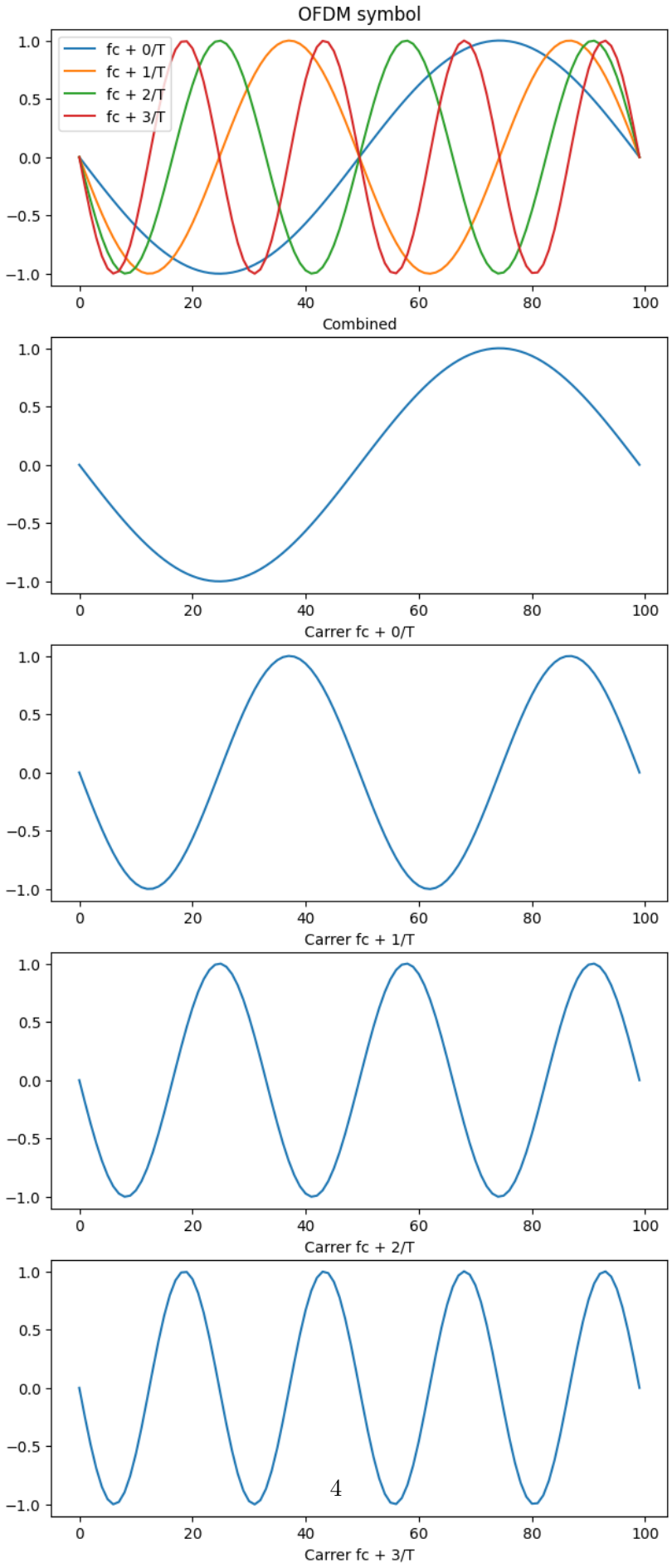
//TODO

[ ]:
```
import matplotlib.pyplot as plt
from numpy import linspace, sin, pi

fc = 1e6
T = 100/fc
plot_len = 100
```

```
carrier_freqs = [fc, fc + (1 / T), fc + (2 / T), fc + (3 / T)]
points = [linspace(0, 2*pi*freq, plot_len) for freq in carrier_freqs]
plt.figure()
plt.subplot(5, 1, 1)
for point in points:
    plt.plot(-sin(point))
plt.legend([f"fc + {index}/T" for index in range(len(carrier_freqs))])
plt.title("OFDM symbol")
plt.xlabel("Combined")

for index in range(len(carrier_freqs)):
    plt.subplot(5,1,index + 2)
    plt.plot(-sin(points[index]))
    plt.xlabel(f"Carrer fc + {index}/T")
plt.subplots_adjust(left=0.1, right=1, bottom=0.1, top=3)
plt.show()
```


OFDM symbol
fc + 0/T
fc + 1/T
fc + 2/T
fc + 3/T
Combined
Carrer fc + 0/T
Carrer fc + 1/T
Carrer fc + 2/T
Carrer fc + 3/T