CSC 478/678 Principles of Wireless Networks
Spring 2021

Homework #1

1. We compare wireless communication with radio or light propagation in this problem. Assume that wireless packets are 1,024 bytes long on an average and the distance between the sender and receiver is 300 meters.

a. What is propagation delay of sending a signal from the sender to receiver ($c=3x10^8$ m/s)?

propagation delay = d/c = $\frac{3 \times 10^2 \text{ m}}{3 \times 10^8 \text{ m/s}} = 1 \times 10^{-6} \text{ sec}$

b. What is the packet transmission delay if the wireless channel can send 10,000 bits per second, i.e., 10 kbps?

transmission delay = $1024 \text{ bytes} \times \frac{8 \text{ bits}}{1 \text{ byte}} \times \frac{1 \text{ sec}}{10000 \text{ bits}} = 0.8192 \text{ sec} = 819.2 \text{ ms}$

c. What is the packet transmission delay if the wireless channel can send 1,000,000,000 bits per second, i.e., 1 Gbps?

transmission delay = $1024 \text{ bytes} \times \frac{8 \text{ bits}}{1 \text{ byte}} \times \frac{1 \text{ sec}}{1{,}000{,}000{,}000 \text{ bits}} = 0.000008192 \text{ sec} = .008192 \text{ ms}$

d. What can you conclude from the two different types of delays, propagation delay and transmission delay?

Propagation delay is a function of distance while transmission delay is a function of connection speed

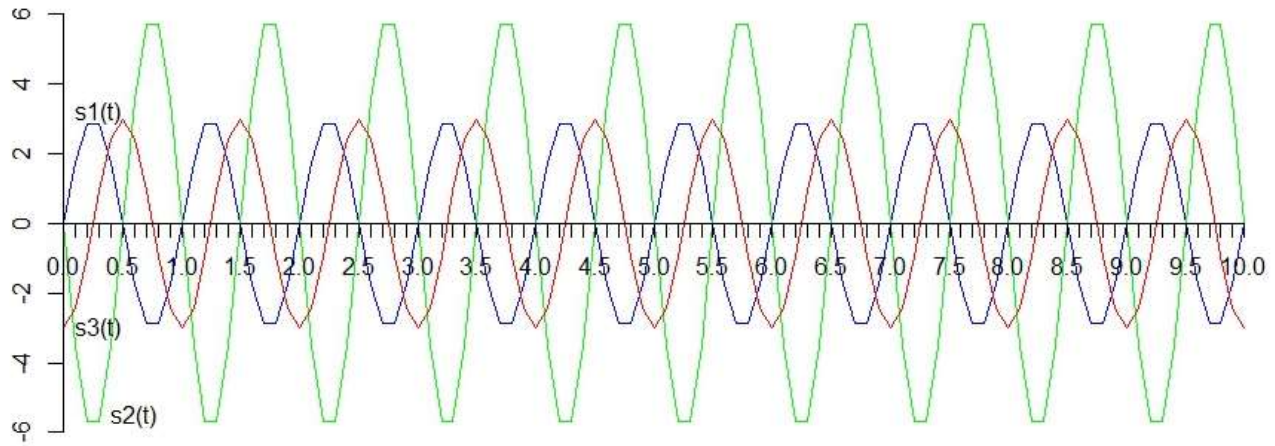
2. Draw each of the signals below in the same graph, with t=(0, 10) and intervals of 0.1.

$S_1(t) = 3 \sin(2\pi t)$

$S_2(t) = 6 \sin(2\pi t+\pi)$

$S_3(t) = 3 \sin(2\pi t-\pi/2)$

Please attach your code and insert the figure in your Word document for submission.



3. Suppose the original signal sent from the source is

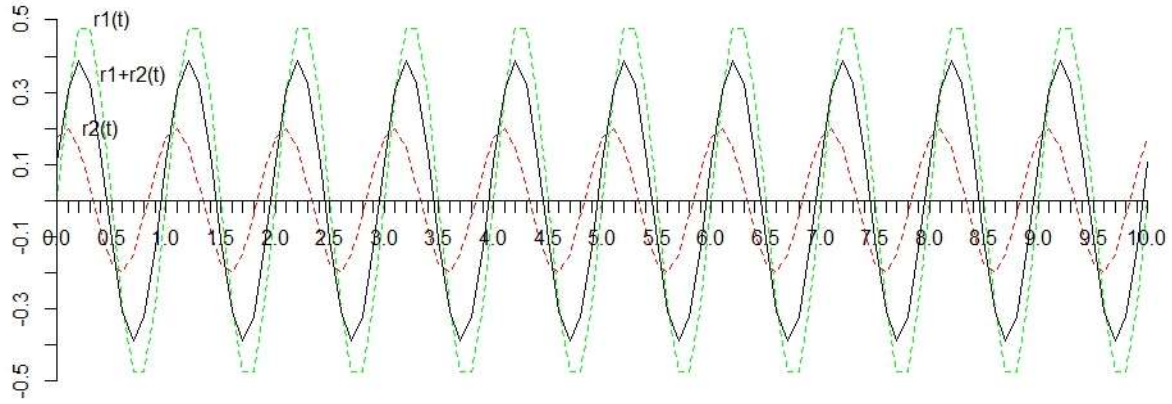
$S(t) = 3 \sin(2\pi t+\pi/2)$

At the destination, two copies of the signals with different attenuations and phases are received.

$R_1(t) = 0.5 \sin(2\pi t)$

$R_2(t) = 0.2 \sin(2\pi t+\pi/3)$

a. Draw the following signals, $R_1(t)$, $R_2(t)$, and $R_1(t)+R_2(t)$ for t=(0, 10) with interval of 0.1.

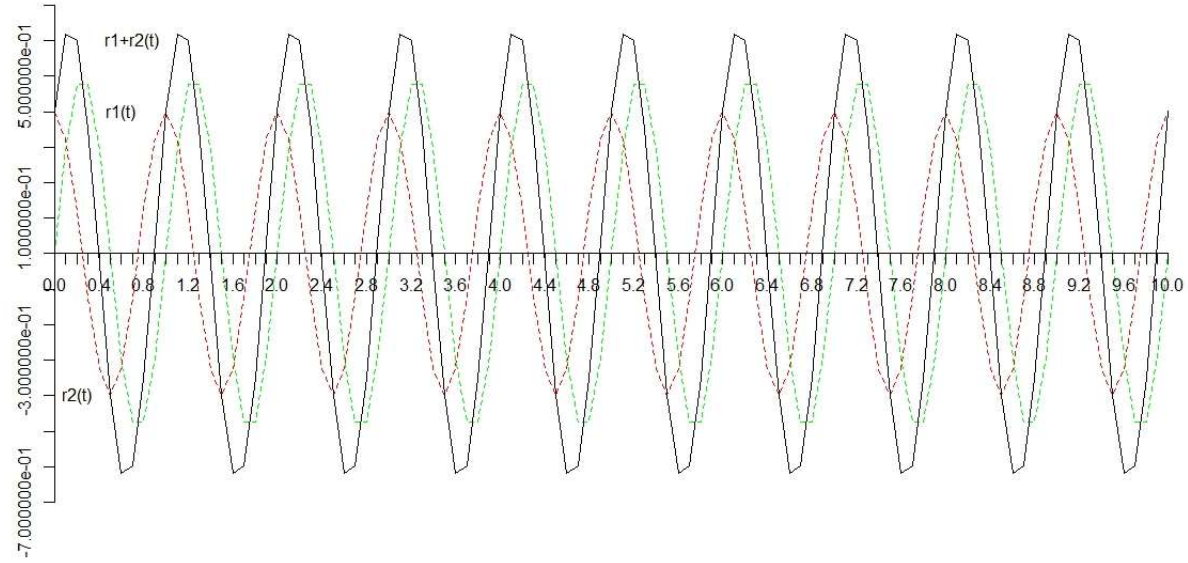


What is the overall amplitude of $R_1(t)+R_2(t)$?

0.389929

b. Choose two other values for the amplitude and phase shift of $R_2(t)$ and draw the signal of $R_1(t)+R_2(t)$ for t=(0, 10) with interval of 0.1.

$R_2(t) = 0.4 \sin(2\pi t+\pi/2)$



What is the overall amplitude of $R_1(t)+R_2(t)$?

0.6403

```r
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# CSC478-01
# Homework 1, Problem 2

# define functions
s1 <- function(t) (3 * sin(2*pi * t))
s2 <- function(t) (6 * sin(2*pi * t + pi))
s3 <- function(t) (3 * sin(2*pi * t - pi/2))

# plot functions
tStart <- 0
tEnd <- 10
tAmp <- 6
tInterval <- 0.1

plot.function (s1, tStart, tEnd, col="blue",
               main="Problem 2",
               axes=FALSE,
               xlab="",
               ylab="",
               ylim=c(-tAmp,tAmp))
plot.function (s2, tStart, tEnd, col="green",
               add=TRUE)
plot.function (s3, tStart, tEnd, col="red",
               add=TRUE)

# add axis
xtick <- seq(tStart, tEnd, by=tInterval)
axis(1, pos=0, at = xtick)

ytick <- seq(-tAmp, tAmp, by=2)
axis(2, pos=0, at = ytick)

# add labels
text(x=0.3, y=3.2, labels=c('s1(t)'))
text(x=0.6, y=-5.5, labels=c('s2(t)'))
text(x=0.3, y=-3, labels=c('s3(t)'))



# Homework 1, Problem 3a

# define functions
r1 <- function(t) (0.5 * sin(2 * pi * t))
r2 <- function(t) (0.2 * sin(2 * pi * t + pi / 3))
r3 <- function(t) (0.3889 * sin(2 * pi * t + 0.2806))

# plot functions
tStart <- 0
tEnd <- 10
tAmp <- 0.5
tInterval <- 0.1

plot.function (r1, tStart, tEnd, col="green",
               main="Problem 3a",
               axes=FALSE,
               xlab="", ylab="",
               lty=2,
               ylim=c(-tAmp,tAmp))
plot.function (r2, tStart, tEnd, col="red",
               lty=2,
               add=TRUE)

plot.function (r3, tStart, tEnd, col="black",
               lty=1,
               add=TRUE)
# add axis
xtick <- seq(tStart, tEnd, by=tInterval)
axis(1, pos=0, at = xtick)
```

```
70
71  ytick <- seq(-tAmp, tAmp, by=0.1)
72  axis(2, pos=0, at = ytick)
73
74  # add labels
75  text(x=0.5, y=0.5, labels=c('r1(t)'))
76  text(x=0.4, y=0.2, labels=c('r2(t)'))
77  text(x=0.7, y=0.35, labels=c('r1+r2(t)'))
78
79
80
81  # Homework 1, Problem 3b
82
83  # define functions
84  r1 <- function(t) (0.5 * sin(2 * pi * t))
85  r2 <- function(t) (0.4 * sin(2 * pi * t + pi / 2))
86  r3 <- function(t) (0.6403 * sin(2 * pi * t + 0.675))
87
88  # plot functions
89  tStart <- 0
90  tEnd <- 10
91  tAmp <- 0.7
92  tInterval <- 0.1
93
94  plot.function (r1, tStart, tEnd, col="green",
95                 main="Problem 3b",
96                 axes=FALSE,
97                 xlab="", ylab="",
98                 lty=2,
99                 ylim=c(-tAmp,tAmp))
100 plot.function (r2, tStart, tEnd, col="red",
101                lty=2,
102                add=TRUE)
103
104 plot.function (r3, tStart, tEnd, col="black",
105                lty=1,
106                add=TRUE)
107 # add axis
108 xtick <- seq(tStart, tEnd, by=tInterval)
109 axis(1, pos=0, at = xtick)
110
111 ytick <- seq(-tAmp, tAmp, by=0.1)
112 axis(2, pos=0, at = ytick)
113
114 # add labels
115 text(x=0.6, y=0.4, labels=c('r1(t)'))
116 text(x=0.2, y=-0.4, labels=c('r2(t)'))
117 text(x=0.7, y=0.6, labels=c('r1+r2(t)'))
118
```