ECE355L: Signals and Systems Labs

Project 1: Operations of signals

Report Due: 03/18/2024

- **Time Shifting**

To time-shift a signal by t_1, we replace t with $t - t_1$. Thus $f(t - t_1)$ represents $f(t)$ time-shifted by t_1 seconds. Consider a signal $f(t) = \sin(t)$ and the same signal delayed by 2 seconds and advanced by 3 seconds. To construct $f(t)$, enter the following

```
t = -2*pi:pi/100:2*pi;
f = sin(t);
fd = sin(t -2);
fa = sin(t +3);
subplot (3,1,1), plot(t, f), axis([-3*pi,3*pi, -1, 1]), grid on;
subplot (3,1,2), plot(t, fd), axis([-3*pi,3*pi, -1, 1]), grid on;
subplot (3,1,3), plot(t, fa), axis([-3*pi,3*pi, -1, 1]), grid on;
```

We can think of time-shifting a signal as shifting the time axis. Consider a signal $r(t) = u(t) - u(t - 1)$ and the same signal delayed by 1 second. To construct $r(t)$, enter the following which makes use of the *rectpuls* function. This function is zero for $|t| > 0.5$, one for $|t| < 0.5$, one at $t = -0.5$, and zero at $t = 0.5$.

```
t = -2:0.01:2;
r = rectpuls(t -0.5);
rd = rectpuls(t -1.5);
subplot (2,1,1), plot(t, r), axis([-3, 4, 0, 2]);
subplot (2,1,2), plot(t, rd), axis([-3, 4, 0, 2]);
```

- **Time Scaling**

To time-scale a signal by a factor a, we replace t with at. We will create $f(2t) = \sin(2t)$ and $f(t/3) = \sin(t/3)$ with $f(t) = \sin(t)$.

```
t = -6*pi:pi/100:6*pi;
f = sin(t);
f2 = sin(2*t);
f3 = sin(t/3);
subplot (3,1,1), plot(t, f), axis([-6*pi, 6*pi, -2, 2]);
subplot (3,1,2), plot(t, f2), axis([-6*pi, 6*pi, -2, 2]);
subplot (3,1,3), plot(t, f3), axis([-6*pi, 6*pi, -2, 2])
```

- **Time Inversion**

To time-invert a signal we replace t with $-t$.

```
fi = sin(-t);
subplot (2,1,1), plot(t, f);
subplot (2,1,2), plot(t, fi)
```

Ex) Plot the following functions on the same window, but separate graphs using the *subplot* command. Let $-2 \le t \le 4$ with a step size of 0.001 for $f(t)$.

(a)

(b) $f(t+2)$ (c) $f(-t)$ (d) $f(t/3)$

```
t = -2:0.001:4;
fa = exp(-2*t).*rectpuls(t  -0.5);
```

```
fb = exp(-2*(t + 2)).*rectpuls((t + 2) -0.5);
fc = exp(-2*(-t)).*rectpuls((-t) -0.5);
fd = exp(-2*(t/3)).*rectpuls((t/3) -0.5);
subplot(2,2,1), plot(t,fa), axis([-3,5,0,1]);
subplot(2,2,2), plot(t,fb), axis([-3,5,0,1]);
subplot(2,2,3), plot(t,fc), axis([-3,5,0,1]);
subplot(2,2,4), plot(t,fd), axis([-3,5,0,1]);
```

- **Exercise**

Please complete these exercises. Please submit the project report at D2L by 03/18/2024. The report should include the results and commands that you used in these exercises.

1. Plot the following functions on the same window, but separate graphs using the *subplot* command. Let $-25 \leq t \leq 25$ with a step size of 0.001 for $f(t)$.
(a) $(-1/18)t + (4/3), \quad -15 \leq t < 24$
(b) $f(t+6)$
(c) $f(-t)$
(d) $f(3t)$

2. Plot the following functions on the same window, but separate graphs using the *subplot* command. Let $-7 \leq t \leq 7$ with a step size of 0.001 for $f(t)$.
(a) $t, \quad 0 \leq t \leq 2$
(b) $f(t-4)$
(c) $f(t/1.5)$
(d) $f(-t)$
(e) $f(2t-4)$
(f) $f(2-t)$