# *BME 333 Biomedical Signals and Systems*

# *Some Review of Signals and Systems*

Lecture #1

1.1 – 1.3

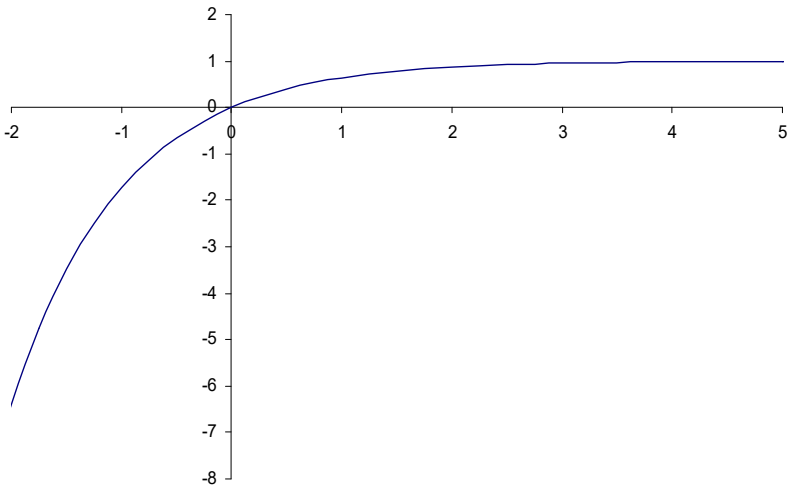
BME 333 Biomedical Signals and Systems
- J.Schesser

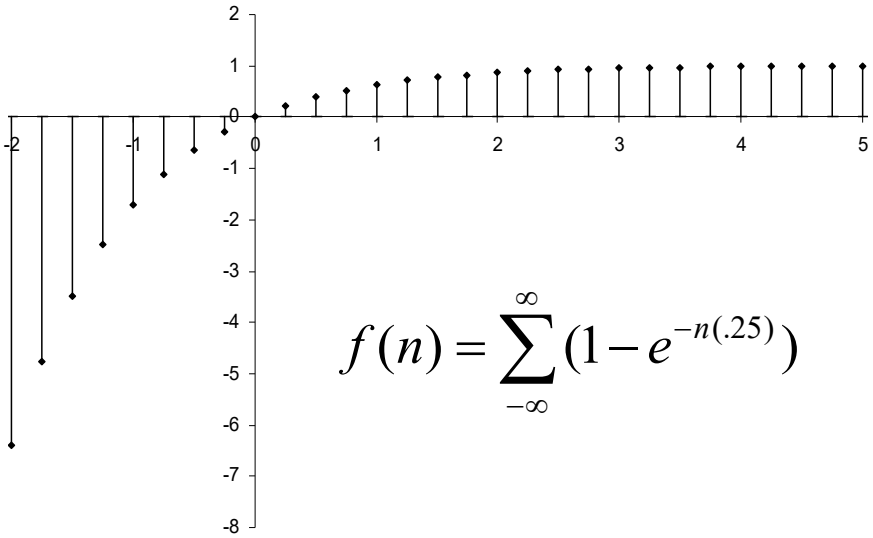
# *Homework*

1. Continuous and Discrete Signals Use Matlab to plot the signals; submit your code
    1. $f(t) = 1-e^{-t}$ is a continuous signal. Draw its waveform.
    2. Draw the discrete version of $f(t)$ for $T=0.25$.
2. Periodic Signals
    1. Show that *tan t* is periodic. What is its period?
    2. Is $e^{-t}$ periodic? Why not?
    3. Is $e^{-t}\ sin(t)$ periodic? Describe?
3. Bounded Signals
    1. Prove that $f(t) = e^{-t}$ is bounded for $t > 0$.
    2. What about $f(t) = e^{-t}$ for all $t$.
4. Biosignals
    1. For a typical EEG, EKG, and EMG signal, is the signal periodic? If so, what is it's period.
    2. For a typical EEG, EKG, and EMG signal, is the signal bounded? If so, describe why.
5. Symmetry
    1. Is *cos t* even or odd? *sin t*? *tan t*?
    2. What about *cos t x sin t* ? *tan t x cos t* ?
    3. What is the symmetry of the product of:
        1. Two even functions
        2. Two odd Functions
        3. Even and Odd function
4. CT.1.2.1,CT.1.2,3
5. DT.1.2.1,DT.1.2.3

# *Homework Answers*

1. Continuous and Discrete Signals
   1. *f(t) = 1-e^-t* is a continuous signal. Draw its waveform.
   2. Draw the discrete version of *f(t)* for *T=0.25*.

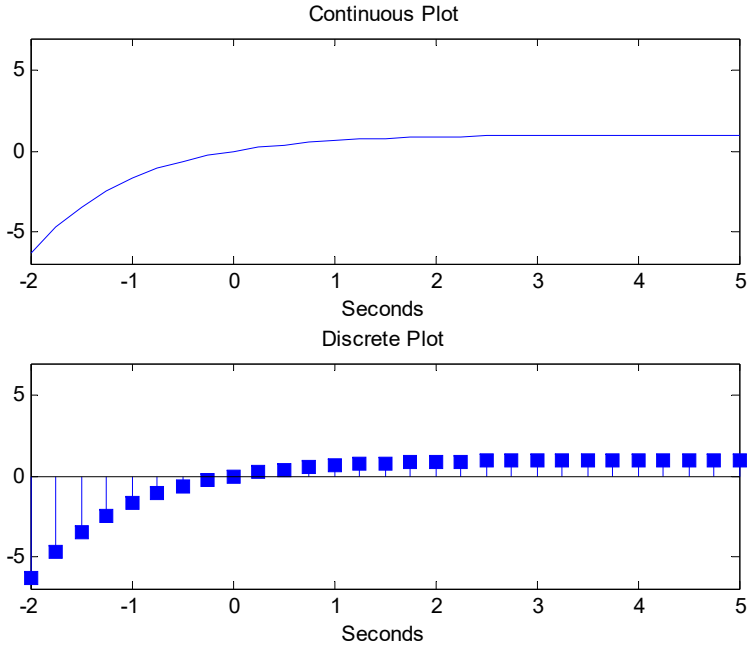



$$f(n) = \sum_{-\infty}^{\infty} (1 - e^{-n(.25)})$$

# *Matlab Code*

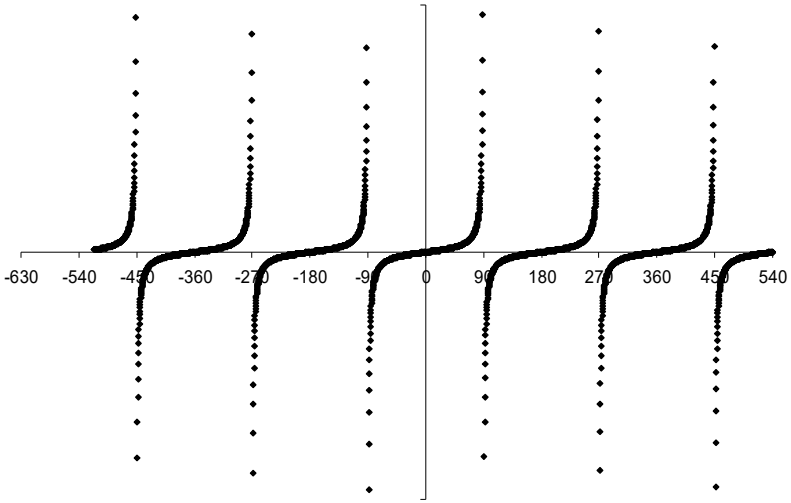
```
time=(-2:.25:5);
y=(1-exp(-time));
subplot(2,1,1)
plot(time,y);
title('Continuous Plot');
xlabel('Seconds');
axis([time(1) time(length(time)) min(y)*1.1 -min(y)*1.1]);
subplot(2,1,2)
stem(time,y,'Marker','square','MarkerFaceColor','b');
title('Discrete Plot');
xlabel('Seconds');
axis([time(1) time(length(time)) min(y)*1.1 -min(y)*1.1]);
```

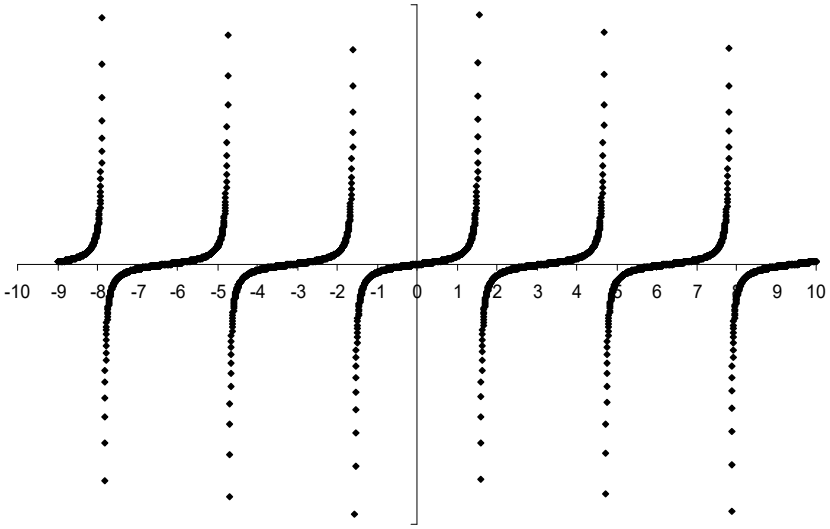


# *Homework Answers*

2. Periodic Signals

   1. Show that *tan t* is periodic. **YES** What is its period? **π radians or 180°**




   2. Is $e^{-t}$ periodic? **NO** Why not? **Because there is no *T* such that *f(t) = f(t+T)***
   3. Is $e^{-t}$ *sin(t)* periodic? **NO** Describe? **Because there is no *T* such that *f(t) = f(t+T)* and a non-periodic function times a periodic function is still non-periodic**

# *Homework Answers*

## 3. Bounded Signals

1. Prove that $f(t) = e^{-t}$ is bounded for $t > 0$.

To be bounded, $\int |f(t)|dt$ must approach a constant

$$\int_0^\infty |e^{-t}|dt = \int_0^\infty e^{-t}dt = -e^{-t}\Big|_0^\infty = -0-(-1) = 1$$ and, therefore, $f(t)$ is bounded

2. What about $f(t) = e^{-t}$ for all $t$.

To be bounded, $\int |f(t)|dt$ must approach a constant

$$\int_{-\infty}^\infty |e^{-t}|dt = \int_{-\infty}^\infty e^{-t}dt = -e^{-t}\Big|_{-\infty}^\infty = -e^{\infty}-(e^{-\infty}) \to -\infty$$ which is undefined and, therefore, $f(t)$ is not bounded

# *Homework Answers*

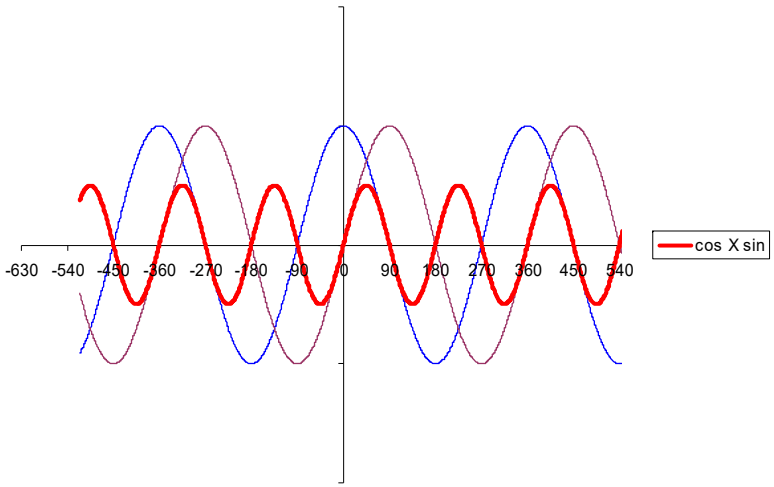
4. Biosignals
   1. For a typical EEG, EKG, and EMG signal, is the signal periodic? If so, what is it's period.
   2. For a typical EEG, EKG, and EMG signal, is the signal bounded? If so, describe why.

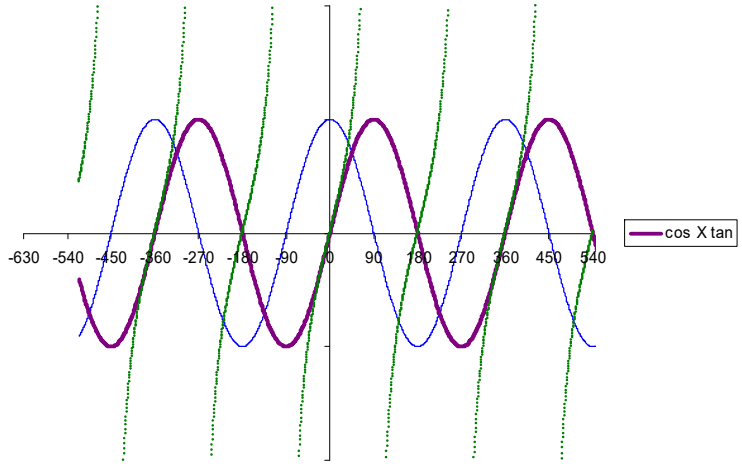
None of the Biosignals are truly periodic.

All of the Biosignals are bounded since the energy produced by the bodily function is finite.

# *Homework Answers*

5. Symmetry
   1. Is *cos t* even or odd? **EVEN** *sin t*? **ODD** *tan t*? **ODD**
   2. What about *cos t x sin t* ? **ODD** *tan t x cos t* ? **ODD**



# *Homework Answers*

6. Symmetry

3. What is the symmetry of the product of:

1. Two even functions **EVEN**

Product of two EVEN functions:
Let *h(t)* and *g(t)* be EVEN functions,
then define:

$$f(t) = h(t)g(t)$$

$$f(-t) = h(-t)g(-t) = h(t)g(t) = f(t)$$

Product of two EVEN functions is EVEN

2. Two odd Functions **EVEN**

Product of two ODD functions:
Let *h(t)* and *g(t)* be ODD functions,
then define:

$$f(t) = h(t)g(t)$$

$$f(-t) = h(-t)g(-t) = -h(t) \times -g(t) = h(t)g(t) = f(t)$$

Product of two ODD functions is EVEN

3. Even and Odd function **ODD**

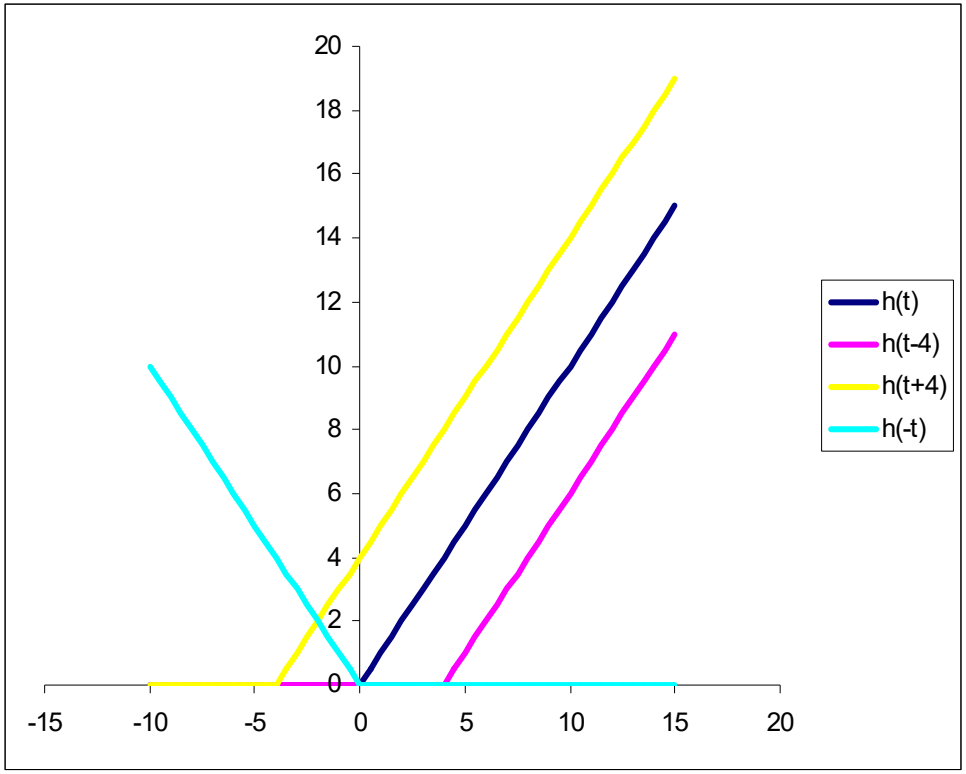
Product of an ODD and EVEN function:
Let *h(t)* be EVEN and *g(t)* be ODD,
then define:

$$f(t) = h(t)g(t)$$

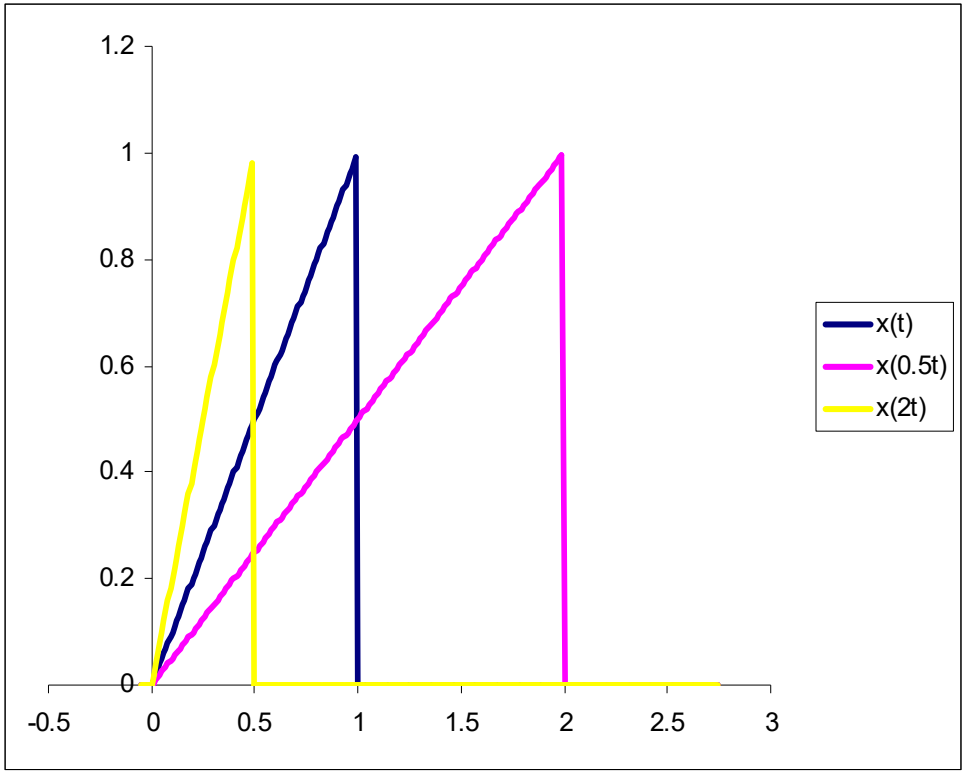
$$f(-t) = h(-t)g(-t) = h(t) \times -g(t) = -h(t)g(t) = f(t)$$

Product of an ODD and EVEN function is ODD

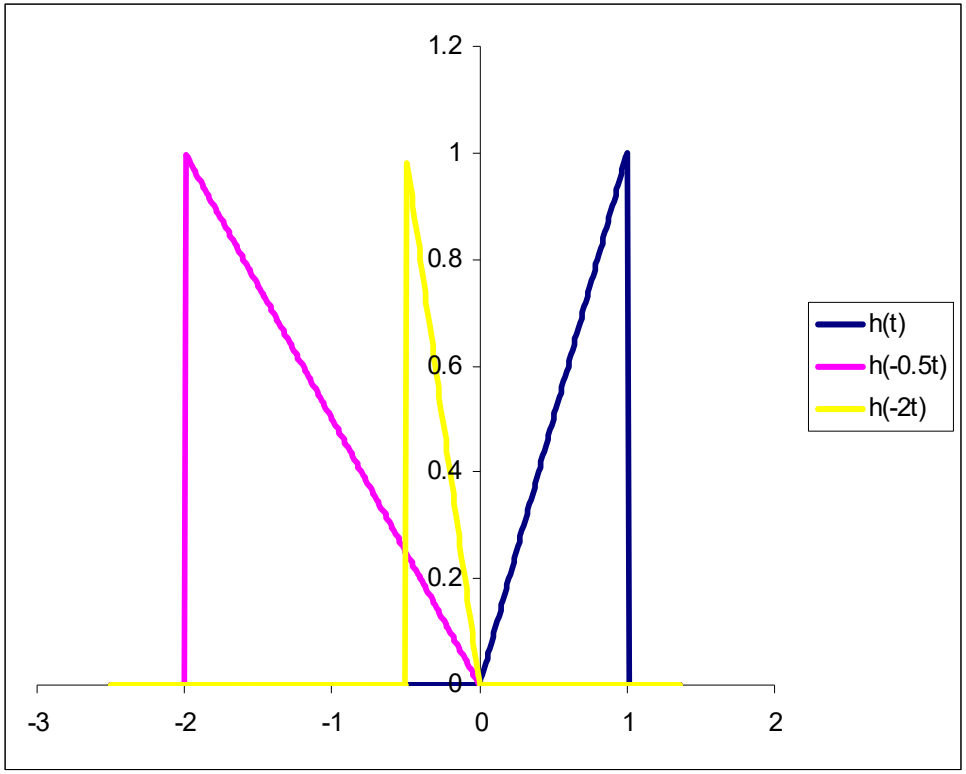
# *CT1.2.1*



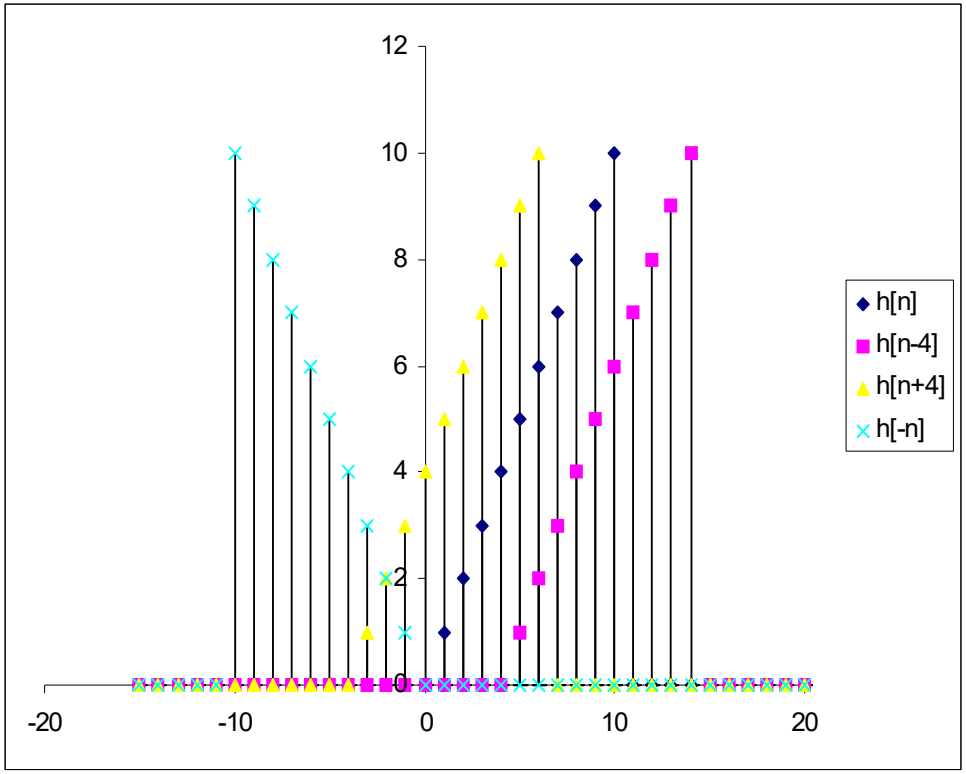
# *CT1.2.3*



# *CT1.2.4*



# *DT1.2.1*



# *DT1.2.3*