EE103 F2017 Signals and Systems

Lecture #2 Oct 2, 2017 1:20-2:25pm

Stevens 175

Organization: Lecture is webcast

Weekly homework

{ weekly Quiz (Mondays) 15 min. based on HW problems

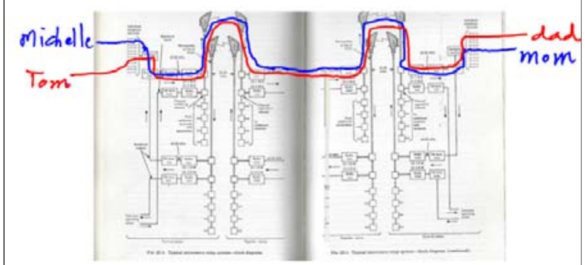
No makeup { 1 midterm exam (60 min)

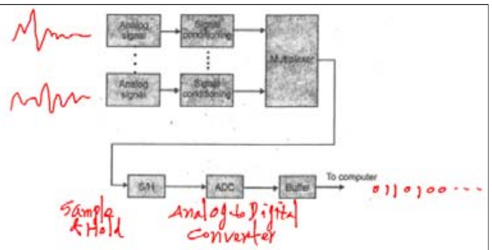
1 Final Exam (3 hrs)

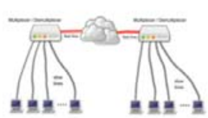
Grading { Quiz 20% (1 or 2 lowest excluded)

Midterm 30%

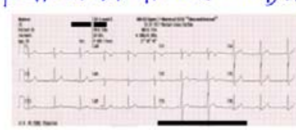
Final 50%



Electro Cardio Gram (ECG) signal

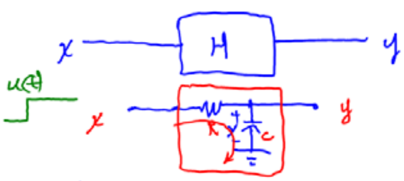


Heart rate?

Periodic or non peridic?

Healthy or non healthy?

} diagnosis through Signal Analysis




$i_C = C\frac{dy}{dt}$

$V_R = R\left(C\frac{dy}{dt}\right)$

$x = V_R + V_C\,(=y)$

$= RC\frac{dy}{dt} + y$

$\mathcal{L}$ (Laplace Transform) $\qquad \mathcal{L}^{-1}$

$X(s) = RC\left[sY(s) - y(0)\right] + Y(s) \xRightarrow[y(0)=0]{\text{for}} \boxed{Y(s) = \frac{X(s)}{RCs+1}}$

$\mathcal{L}[u(t)] = \frac{1}{s}$ for $x(t) = u(t)$

$Y(s) = \frac{X(s)}{RCs+1} = \frac{1}{s(RCs+1)}$

$= \frac{A=1}{s} + \frac{B}{RCs+1}$

$= \frac{ARCs + A + Bs}{s(RCs+1)}$

$s(ARC+B) = 0$

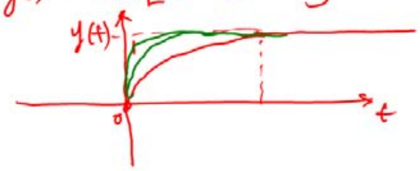
$A = 1$

$B = -ARC$

$\underset{A=1}{=} -RC$

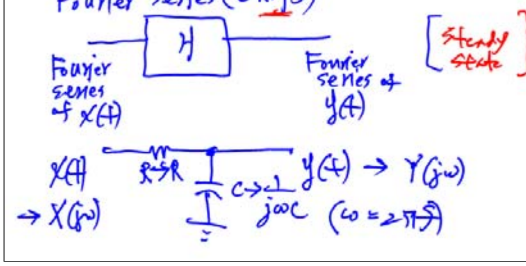
$\boxed{Y(s) = \frac{1}{s} - \frac{\cancel{RC}}{\cancel{RC}s+1/RC}} \xrightarrow{\mathcal{L}^{-1}} y(t) = u(t) - e^{-\frac{1}{RC}t}u(t)$

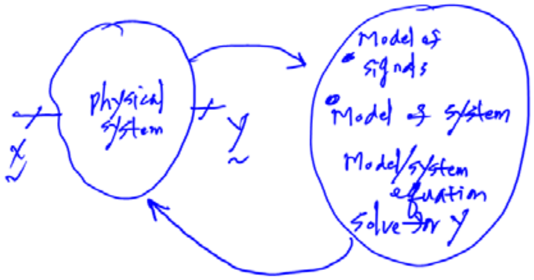
$$y(t) = u(t)\left[1 - e^{-t/RC}\right]$$



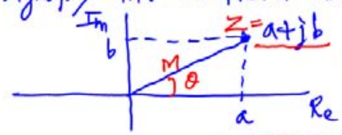

signal that is periodic


Fourier Series (chap 5)




signals / visit complex numbers




$j = \sqrt{-1}$

$$M = \sqrt{a^2 + b^2}$$

$$\theta = \tan^{-1} \frac{b}{a}$$

$$Z = a + jb = M e^{j\theta}$$

$Z_1 = a + jb$

$Z_2 = c + jd$

$$Z_1 Z_2 = (a+jb)(c+jd) = M_1 e^{j\theta_1} M_2 e^{j\theta_2} = M_1 M_2 e^{j(\theta_1+\theta_2)}$$

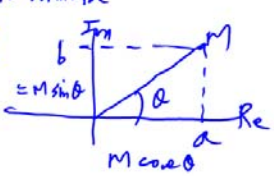
$$\frac{Z_1}{Z_2} = \frac{a+jb}{c+jd} = \frac{M_1}{M_2} e^{j(\theta_1 - \theta_2)}$$

$$M e^{j\theta} = a + jb = M(\cos\theta + j \sin\theta)$$

Euler's formula

$a = M \cos\theta$

$b = M \sin\theta$




$$e^{j\theta} = \cos\theta + j \sin\theta$$

$$e^{-j\theta} = \cos(-\theta) + j \sin(-\theta) = \cos\theta - j \sin\theta$$

$$e^{j\theta} + e^{-j\theta} = 2\cos\theta + 0$$

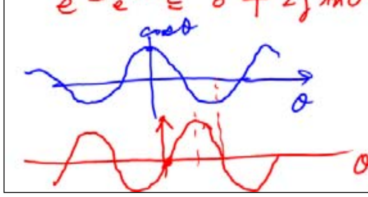
even function of θ

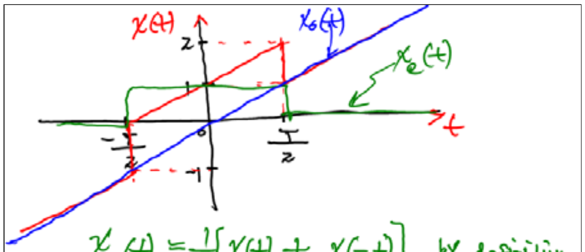
$$\boxed{\cos\theta = \frac{1}{2}\left(e^{j\theta} + e^{-j\theta}\right)}$$

$$e^{j\theta} - e^{-j\theta} = 0 + 2j\sin\theta$$

$$\boxed{\sin\theta = \frac{1}{2j}\left(e^{j\theta} - e^{-j\theta}\right)}$$

odd function of θ

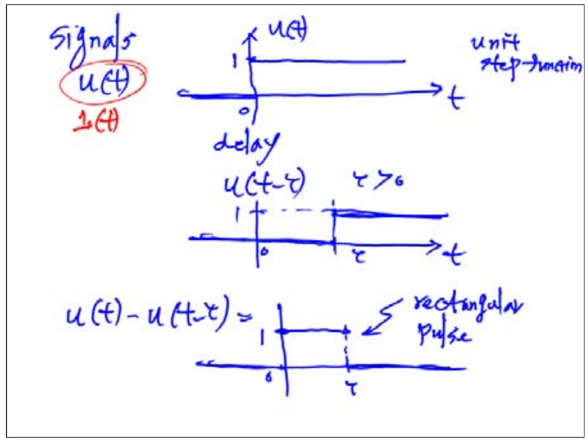


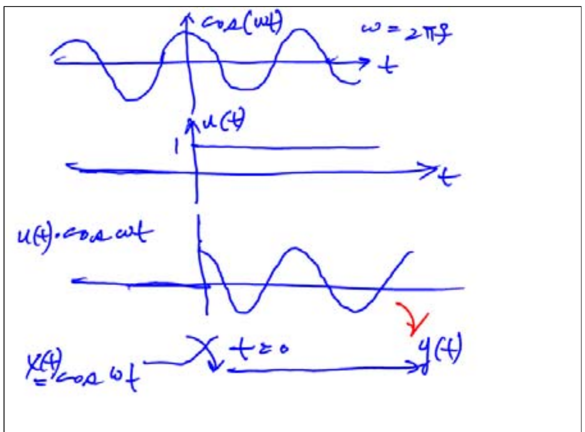



$x_e(t) = \frac{1}{2}[x(t) + x(-t)]$ by definition

$x_o(t) = \frac{1}{2}[x(t) - x(-t)]$

$x_e + x_o = x(t)$ $\quad x_e - x_o = x(-t) =$




HW#1 (4 Probs)

$\boxed{\text{For Quiz 1 Oct 9}}$

1. The signals in Figure P2.1 are zero except as shown.

**(a)** For the signal $x(t)$ of Figure P2.1(a), plot

**(i)** $x(-t/3)$ **(ii)** $x(-t)$
**(iii)** $x(3+t)$ **(iv)** $x(2-t)$

Verify your results by checking at least two points.

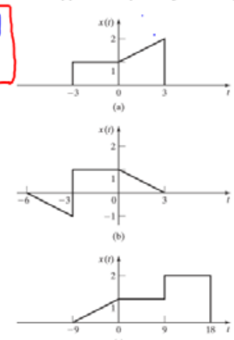


Figure P2.1

HW#1

2. The average value $A_x$ of a signal $x(t)$ is given by

$$A_x = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x(t)dt.$$

Let $x_e(t)$ be the even part and $x_o(t)$ be the odd part of $x(t)$.

**(a)** Show that

$$\lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x_o(t)dt = 0.$$

**(b)** Show that

$$\lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x_e(t)dt = A_x.$$

**(c)** Show that $x_o(0) = 0$ and $x_e(0) = x(0)$.

3. Given in Figure P2.11 are the parts of a signal $x(t)$ and its odd part $x_o(t)$, for $t \geq 0$ only; that is, $x(t)$ and $x_o(t)$ for $t < 0$ are not given. Complete the plots of $x(t)$ and $x_e(t)$, and give a plot of the even part, $x_e(t)$, of $x(t)$. Give the equations used for plotting each part of the signals.

4. Prove mathematically that the signals given are periodic. For each signal, find the fundamental period $T_0$ and the fundamental frequency $\omega_0$.

**(a)** $x(t) = 7\sin 3t$
**(b)** $x(t) = \sin(8t + 30°)$

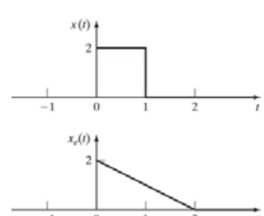


Figure P2.11