UNIVERSITY OF CALIFORNIA

College of Engineering
Department of Electrical Engineering
and Computer Sciences

Professor Fearing Spring 1996

EECS 120

FINAL EXAM

Friday, May 17, 1996, 5:00 - 8:00 p.m.

Name: ____________________________________ ID#: _____________

- Closed book. Three sides of notes. No calculators.
- There are 8 problems worth 200 points total. The problems on this exam may have several solution methods. One method may be much more time efficient compared to the others. Points are proportional to amount of time problem may take, using an efficient approach.

Problem	**Points**	**Your Score**	**Problem**	**Points**	**Your Score**
1	20		6	25	
2	10		7	35	
3	30		8	30	
4	25				
5	25				
Total	110			90	

In the real world, unethical actions by engineers can cost money, careers, and lives. The penalty for unethical actions on this exam will be a grade of zero and a letter will be written for your file and the Office of Student Conduct.

Problem 1 (20 points)

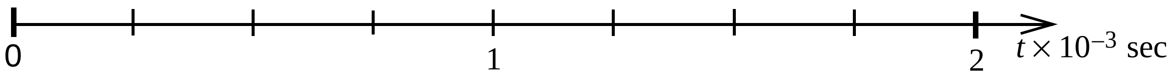
Classify the following systems. In each column, write “yes”, “no”, or “?” (use “?” if not decidable with given information). The input to the system is $x(t)$ and output is $y(t)$. (To discourage random guessing, +1 for correct, 0 for blank, $-\frac{1}{2}$ for incorrect.)

System	Causal	Linear	Time-invariant	BIBO stable
a. $y(t) = x(t) + u(t-1)$				
b. $y(t) = \int_{-\infty}^{t} \sqrt{\lvert x(\tau)\rvert}\, d\tau$				
c. $y(t) = x(t) * (\sin(\omega_0 t)u(t))$				
d. $y(t) = \int_{-\infty}^{t+1} x(\tau)\, d\tau$				
e. $y(t) = x(t) + \int_{-\infty}^{\infty} x(\tau)[e^{-(t-\tau)}u(t-\tau)]\, d\tau$				

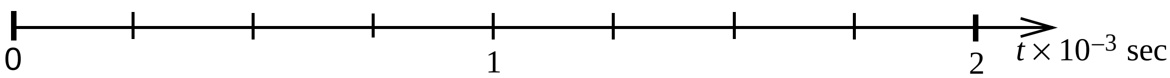
Problem 2 (10 points)

Sketch the following time functions, labelling maximum amplitude.

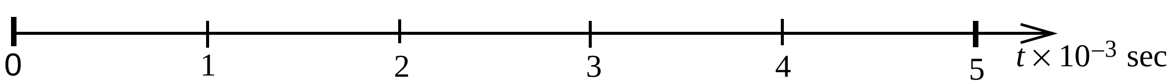
[2 pts.] **a)** $\cos(2000\pi t)$



[2 pts.] **b)** $\cos(2000\pi t + \pi/2)$

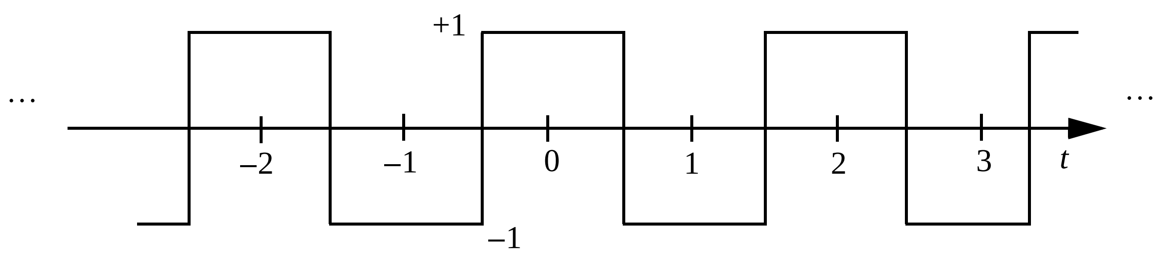


[6 pts.] **c)** $(1 + \cos(200\pi t))\cos 2000\pi t$

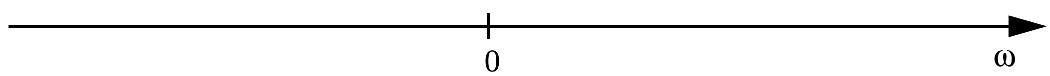


Problem 3 (30 points)

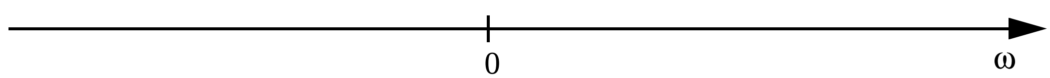
Consider a periodic signal $m(t)$ shown below:



[12 pts.] a) Sketch $M(\omega)$, labelling heights, center frequency, and spacing.



[10 pts.] b) Let $x(t) = (1 + 0.5m(t))\cos\omega_c t$, with $\omega_c = 200\pi$. Sketch $X(\omega)$, labelling heights, center frequencies, and spacing.



[2 pts.] c) What kind of modulation technique is used to generate $x(t)$? (Circle one.)

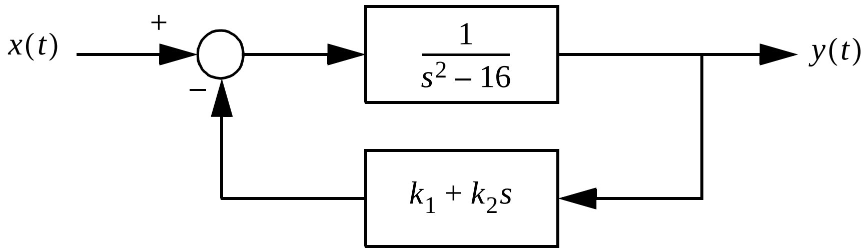
AM DSB — with carrier	upper sideband	
AM DSB — no carrier	lower sideband	
wideband frequency modulation	wideband phase modulation	interrupted continuous wave
narrowband frequency modulation	narrowband phase modulation	

[4 pts.] **d)** What is the ratio of power in the sidebands to power in the carrier for $x(t)$?

[2 pts.] **e)** Explain (assuming knowledge of EE40) what modulation is good for and why it is used in communications systems.

Problem 4   (25 points)

Consider the causal system shown in the block diagram below, with input $x(t)$ and output $y(t)$:



[7 pts.] **a)** Find the transfer function for the system.

$$H(s) = \frac{Y(s)}{X(s)} = \boxed{\quad}$$

[6 pts.] **b)** With $k_1 = 0, k_2 = 0$, what is the impulse response for the system? Is the system BIBO stable? Why or why not?

$$h(t) = \boxed{\quad}$$

[6 pts.] **c)** Find values of k_1 and k_2 such that the closed loop system has 2 poles at $s = -4$.

$k_1 =$

$k_2 =$

[6 pts.] **d)** For positive k_2, what is the minimum value of k_1 for the closed loop system to be BIBO stable?

$k_1 >$

Problem 5   (25 points)

Consider the following difference equation:

$$y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = 5x[n]$$

[5 pts.] **a)** For $x[n] = \delta[n-1]$, what is the zero state response?

$y_{\mathrm{ZSR}}[n] =$

[5 pts.] **b)** Assuming $y[-1] = 1$ and $y[-2] = 2$, what is the zero input response?

$y_{\mathrm{ZIR}}[n] =$

[5 pts.] **c)** Is the system BIBO stable? Why or why not?

[5 pts.] **d)** What is $\lim_{n \to \infty} y[n]$ if $x[n] = 3u[n]$?

$\lim_{n \to \infty} y[n] =$

[5 pts.] **e)** Assuming zero initial conditions, what is the steady state response to $x[n] = e^{j\pi n}$?

$y[n] =$

Problem 6 (25 points)

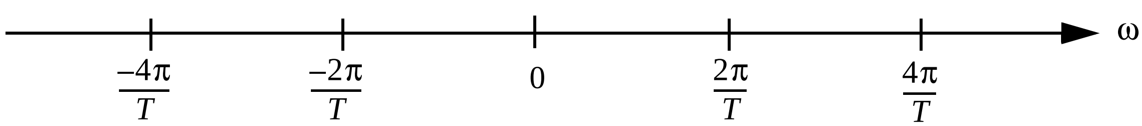
A continuous time filter has impulse response

$$h(t) = (e^{-t} - e^{-.5t})u(t)$$

[10 pts.] a) Find the corresponding digital filter $H(z)$ using impulse invariant techniques and sample time $T = 0.5$ sec where ($e^{-.5} \approx .61$ and $e^{-.25} \approx .78$).

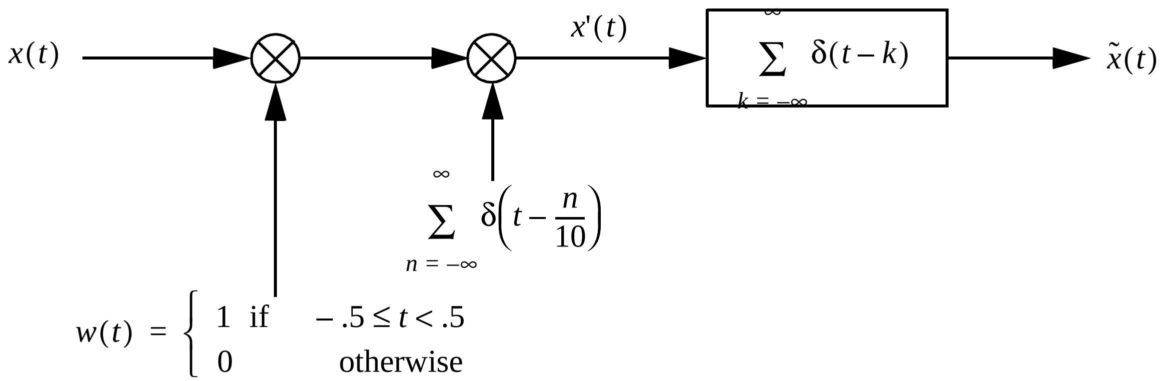
$H(z) =$

[15 pts.] b) Sketch $|H(e^{j\omega T})|$ in range $\frac{-4\pi}{T} < \omega < \frac{4\pi}{T}$, labelling maximum and minimum amplitude. (Maximum and minimum may be left as functions of e^x). $T = 0.5$ sec.

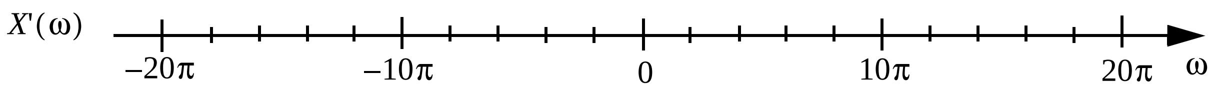


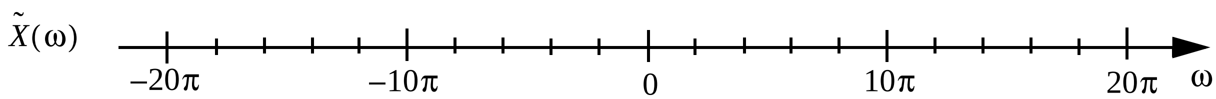
Problem 7 (35 points)

A system is described by the following block diagram:



[30 pts.] a) Let $x(t) = \cos 4\pi t$. Sketch $X'(\omega)$ and $\tilde{X}(\omega)$, labelling peak magnitude, zero crossing(s), and spacing. (Hint: $X'(\omega)$ and $\tilde{X}(\omega)$ should be real.)

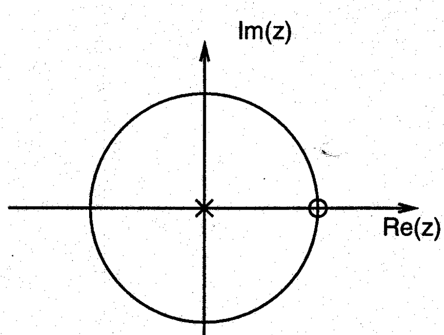




[5 pts.] **b)** What is the relationship between $\tilde{X}(\omega)$ and the 10 point DFT of $x[n] = X[k]$ (where $x[n] = x(0)\ldots x(.9)$)? Explain why. (What is the effect of not shifting the window $w(t)$ by $T/2$?)

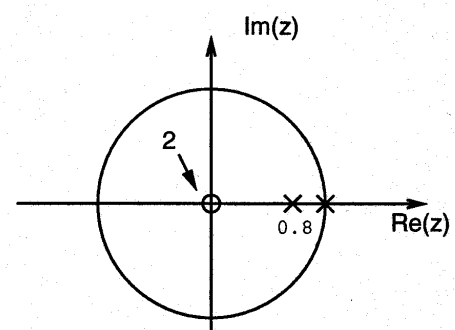
Problem 8 (30 points)

For each pole–zero diagram below, fill in the box with the letter of the corresponding frequency response and unit sample response from the next pages. All diagrams represent causal systems.



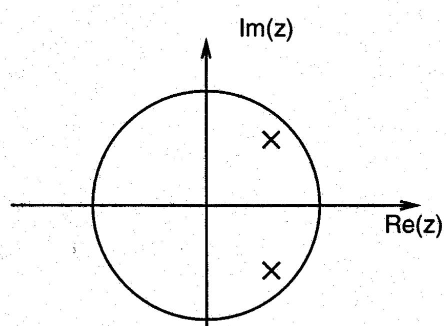
$|H(e^{j\omega T})|$ is sketch: ☐

h[n] is sketch: ☐



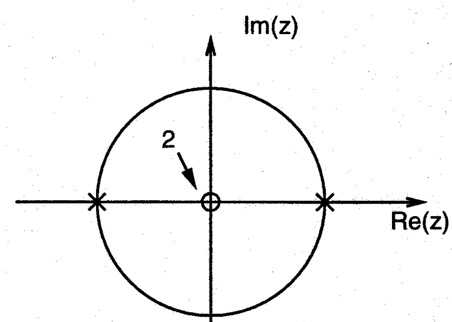
$|H(e^{j\omega T})|$ is sketch: ☐

h[n] is sketch: ☐



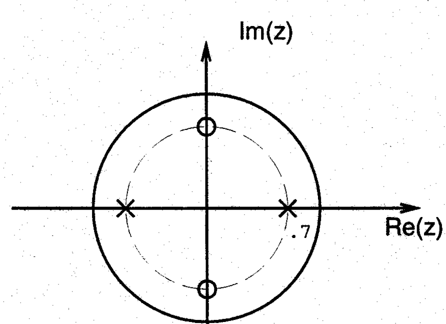
$|H(e^{j\omega T})|$ is sketch: ☐

h[n] is sketch: ☐



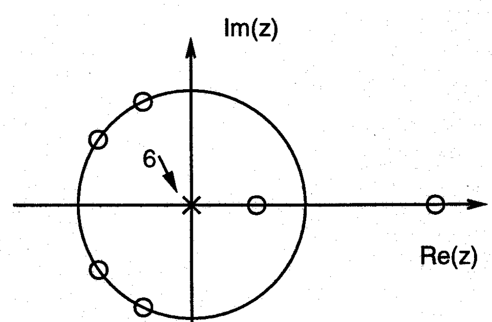
$|H(e^{j\omega T})|$ is sketch: ☐

h[n] is sketch: ☐



$|H(e^{j\omega T})|$ is sketch: ☐

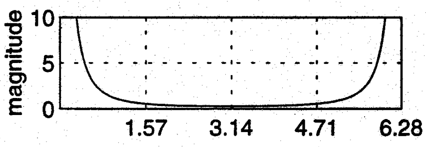
h[n] is sketch: ☐



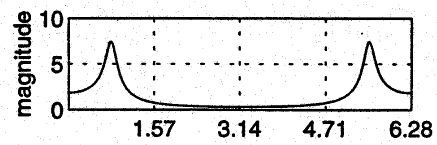
$|H(e^{j\omega T})|$ is sketch: ☐

h[n] is sketch: ☐

A



B



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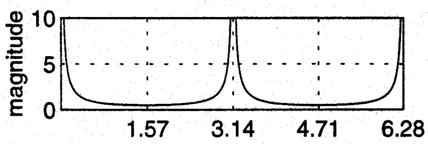

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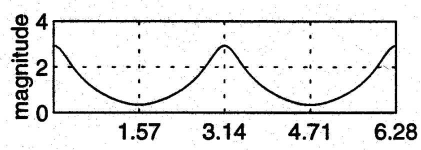

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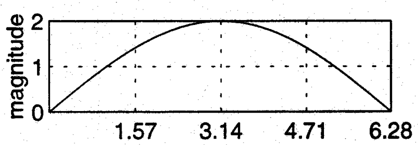

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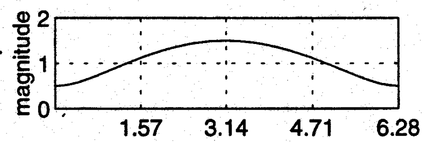
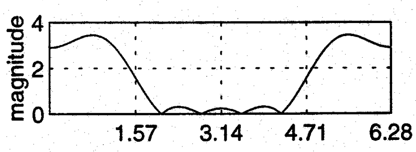
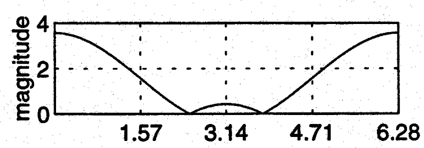


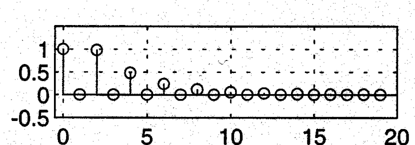
G



H



I



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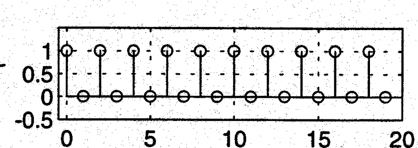

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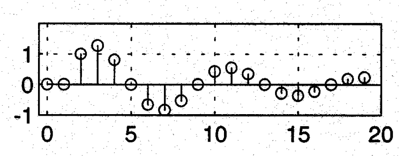

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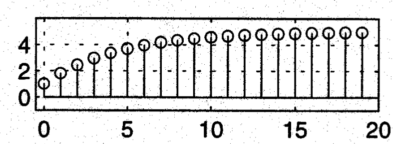
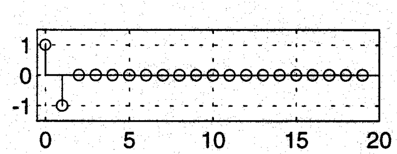


M



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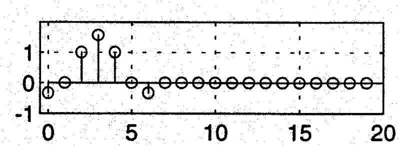

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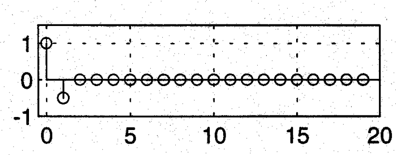

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