Name__________________________

**Rose-Hulman Institute of Technology**
**Electrical and Computer Engineering**

EC 380 - Exam 1 — Thursday, December 19th, 2002

**CLOSED BOOK**. Work each problem in the space provided on its sheet. Be sure the work you present is clear so I can understand what you have done. One 3" by 5" card and a calculator/computer are allowed. No other aids, animate or inanimate, are permitted. All problems have the same weight. Please do your own work. State answers in engineering form. **Box your answer, please, and don't forget units!**

**Problem 1 –** Given an LTI system with input $x[n] = \left(4\cos\left(\frac{2\pi n}{4}\right) + n\right)\left(u[n] - u[n-7]\right)$ and impulse response h[n] = u[n+1] - u[n-3]

A. Sketch x[n] and h[n] for all non-zero values. Label all significant values.

B. What is the output of the system, y[n]? Do your work on the back of this page. Sketch it on this page. Label the 5 regions of y[n] as discussed in mini project 2.

C. Is this a causal system? Why?

D. The system removed the cosine at frequency $\frac{2\pi}{4}$. What other frequency can it remove?

x[n] = cos( _______ n)

**Problem 2 –**

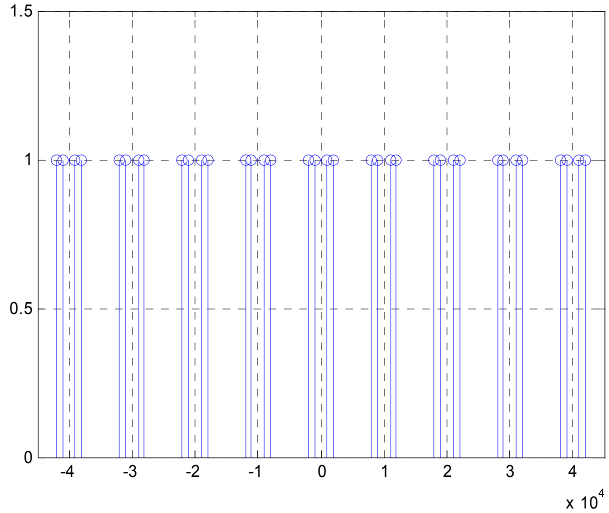
A. The general FIR filter is $y[n]=\sum_{k=0}^{M} b_k x[n-k]$. Is this system time-invariant? Prove your answer.

B. An FIR filter has $b_k$ = {1, 2, 3, 2, 1}. What is the impulse response of this filter?

C. What's your opinion on the use of PowerPoint in class? 1=Use it. 5 = Stick to the Marker board.

1 2 3 4 5

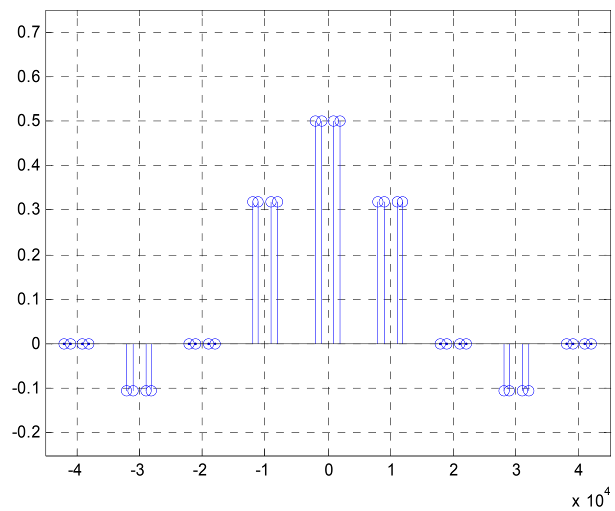
**Problem 3 –** Below are the spectra of the outputs of several samplers, all sampling the same input. Below each plot list the type of sampler, its sampling rate, and duty cycle (if applicable).



Sampling Type:

$\omega_s =$

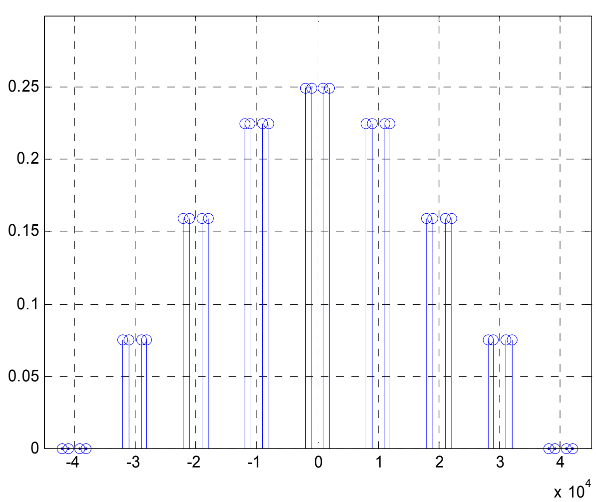
$T/T_s =$



Sampling Type:

$\omega_s =$

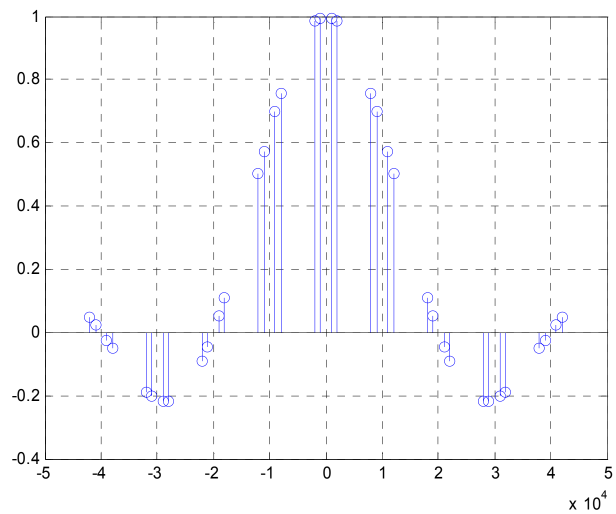
$T/T_s =$



Sampling Type:

$\omega_s =$

$T/T_s =$



Sampling Type:

$\omega_s =$

$T/T_s =$

**Problem 4 -**The signal *x(t)* = *2cos(2π1000t)* + *2cos(2π2000t)* is sampled by a pulse sampler at $\omega_s = 2\pi 10{,}000$ samples/sec with a duty cycle of 1/3. $x_s(t)$ is the output of the sampler.

a. Sketch $X(\omega)$. Be sure to label all important frequencies, amplitudes, areas, etc.

b. In class we found $X_s(\omega) = \frac{T}{T_s}\sum_{k=-\infty}^{\infty} \text{sinc}(\frac{T}{T_s}k)X(\omega - k\frac{2\pi}{T_s})$. What are T and $T_s$ for this example?

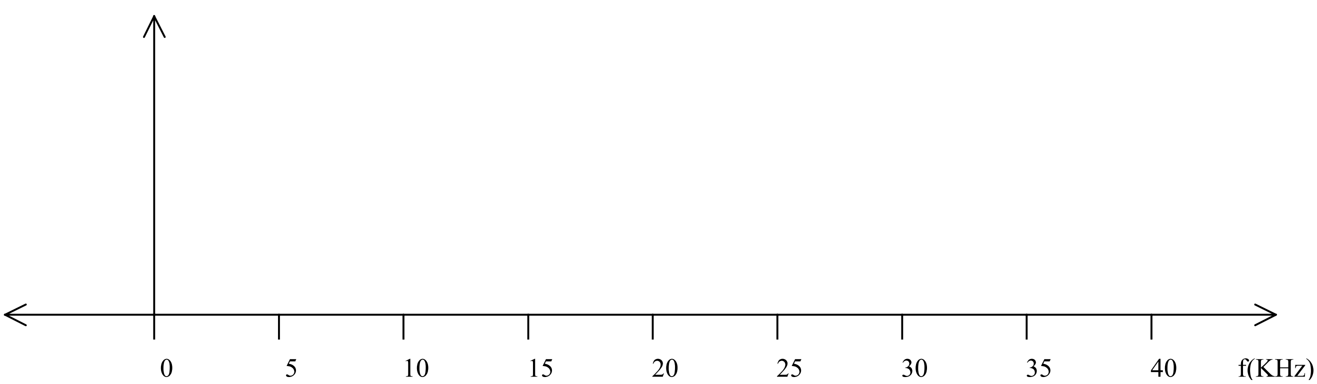
T =

$T_s$ =

c. Sketch $|X_s(\omega)|$ below. Be sure to label all important amplitudes, frequencies, etc Write the areas both in terms of

i. π and sinc and

ii. numeric values.




d. Is an anti-sinc filter needed to get the correct waveform back after sampling? Why or why not?

e. Bonus: Since you all had a chance to hear the Hatfield Hall organ, what brand is the organ? How many manuals does it have?