King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE 207 – Signals and Systems

Final Examination

June 8, 2005

Time Allowed 2 ½ Hours

Student Name (**CAPITAL)** : _____

Student ID Number : _____

Student Serial Number : _____

1. **NO CALCULATORS ARE ALLOWED**
2. **SHOW ALL WORK**
3. **Answer 5 Problems from the 6 problems only**

Problem	Max Score	Score
Problem 1	20	
Problem 2	20	
Problem 3	20	
Problem 4	20	
Problem 5	20	
Problem 6	20	
Total	100	

Problem 1 (20pts):

Figure 1 shows a non-linear system that consists of a squarer, and a linear time-invariant system whose transfer function *H(f)* is shown in fig. 2. If the input signal $x(t) = 1 + 2\sin(30\pi t)$ is applied to the system, find

1. the complex Fourier coefficients of *x(t).*
2. the complex Fourier coefficient of *v(t)*(*v(t)*= $x^2(t)$)
3. the output *y(t).*
4. The average powers in
   a. *x(t)*
   b. *v(t)*
   c. *y(t)*

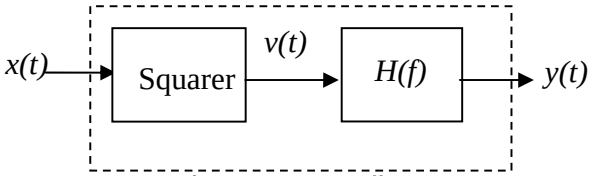


Figure 1: Non-linear system

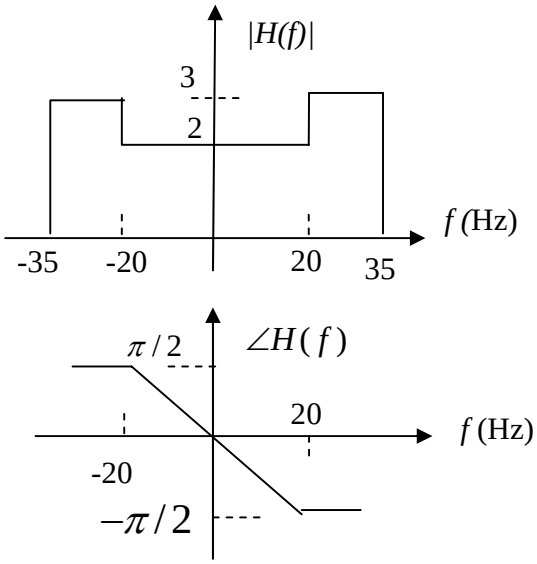


Figure 2: Amplitude & phase spectrum of the linear system.

Problem 2 (20pts):

A certain system has its impulse response $h(t) = \frac{1}{2W}\text{sinc}(2\text{W}(\text{t} - \text{t}_0)\cos(2\pi f_0 t)$.

Use Fourier transform properties to :

1. Find the transfer function *H(f)* of the system.
2. Draw the amplitude spectrum |*H(f)*|
3. Draw the phase spectrum $\angle H(f)$

Problem 3 (20 pts)

The signal

$$x(t) = 3 + 4\cos(10\pi t) + 5\cos(14\pi t) + 2\cos(20\pi t)$$

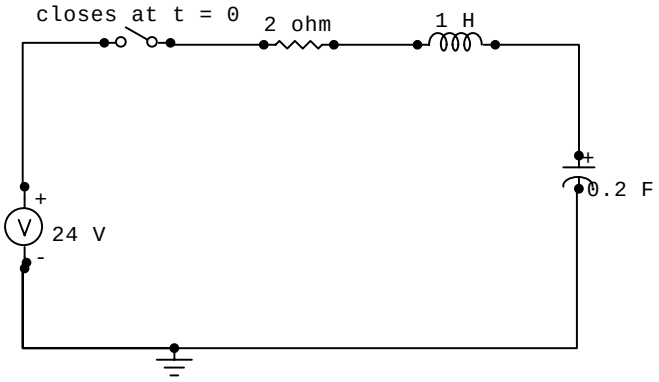
is sampled at a rate of 30 samples per second. Sketch the spectrum of the sampled signal showing all components for $|f| < 80$. Fully explain how x(t) can be reconstructed from the samples.

Problem 4 (20 pts)

For the circuit below, the switch is in open position before t = 0, then closed instantaneously at t =0.

The initial capacitor voltage is 50 V, and the initial inductor current is 2 A.

Determine the current across the capacitor, i(t), using s-domain analysis.

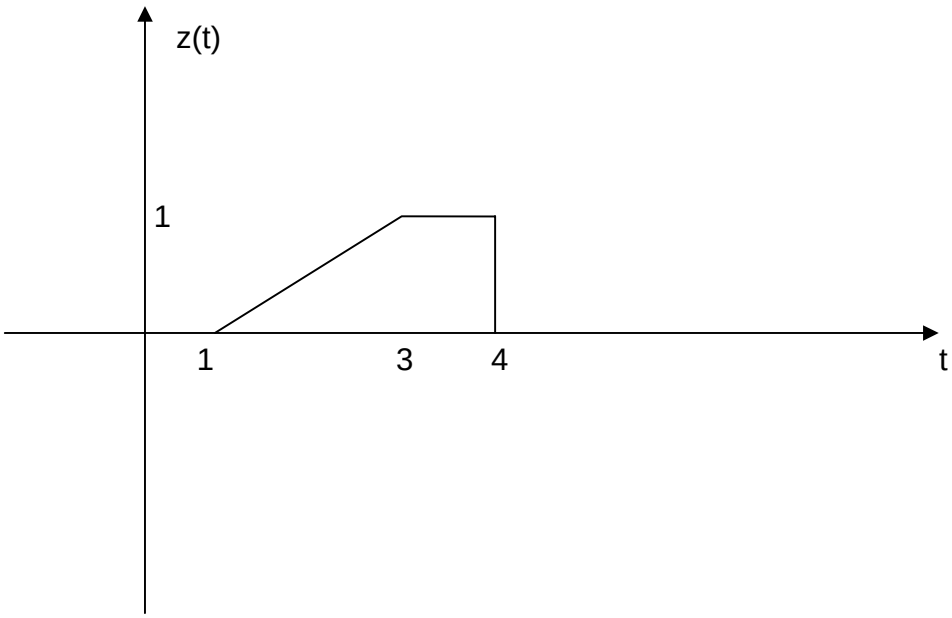


Problem 5 (20 pts)

1. Determine the inverse Laplace transform of each of the following functions:

$$X(s) = \frac{16s + 43}{(s-2)(s+3)^2}$$

2. Determine the Laplace transform of the following function
(hint: use the Laplace Transform properties)



Problem 6 (20 pts)

A linear fixed (time-invariant) system has the following **step** response

$$a(t) = e^{-2t}u(t+1)$$

a. Sketch the step response as function of time.
b. Is this system causal or non-causal? Justify your answer.
c. Find the impulse response, *h*(*t*)?
d. What is the output if the input is $x(t) = \delta(t-2) + 5u(t+5)$

e. If the input is now given by $x(t) = \Pi(\frac{t-1}{4})$, what would be the output of the system.

Hint: recall that $\Pi(t)$ *is the unit pulse function*.