Name_____

Rose-Hulman Institute of Technology
Electrical and Computer Engineering

EC 300 - Final Exam Wednesday, February 26, 1996

CLOSED BOOK. Work each problem in the space provided on its sheet. Be sure the work you present is clear so the grader can understand what you have done. One 8.5" x 11" page and a calculator 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 – During Lab 8 you sampled a cosine with a 10% duty cycle pulse train with f_s=20kHz.. Assume signal to be sampled is *x(t)* and the sampling function is *p(t)* as given below:

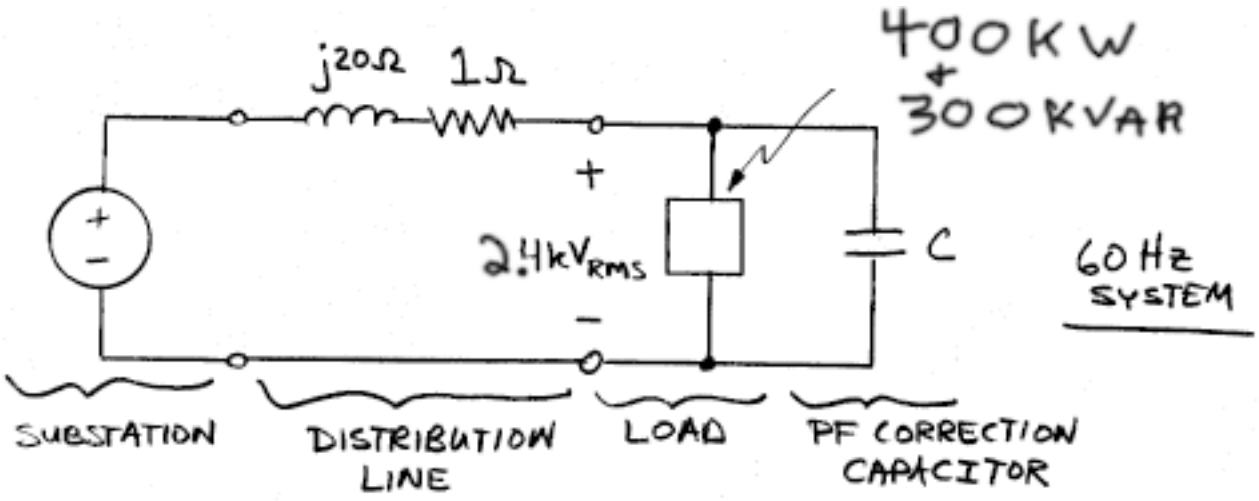
$$x(t) = 2\cos(2\pi 1000t)$$

$$p(t) = rect\left(\frac{t}{T}\right)\sum_{k=-\infty}^{\infty}\delta(t - kT_s)$$

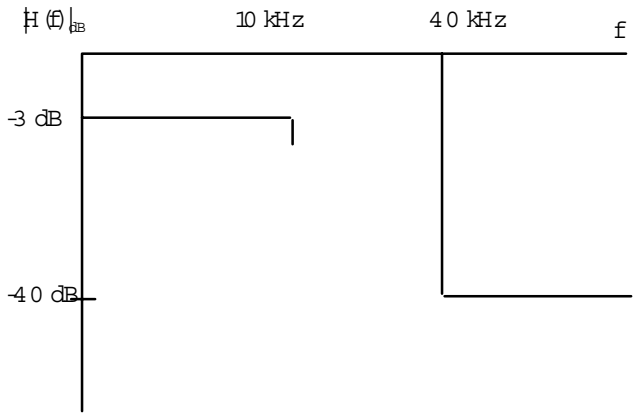
Then $x_s(t) = x(t)p(t)$. Find $X_s(f)$.

If the spikes at ±1 kHz are at -17 dB, what's the amplitude (in dB) of the spikes at 39 and 41 kHz?

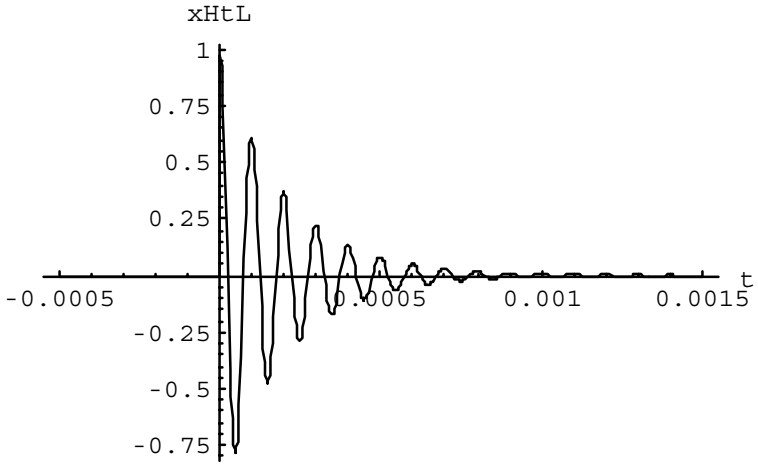
Problem 2 – Find the value of *C* required to correct the power factor to 0.93 lagging.



Problem 3 – Design a Chebyshev low-pass, passive, filter that meets the following specs. Set the source resistance to 500Ω. Provide the prototype circuit diagram, **and** the final circuit diagram with source and load resistances.

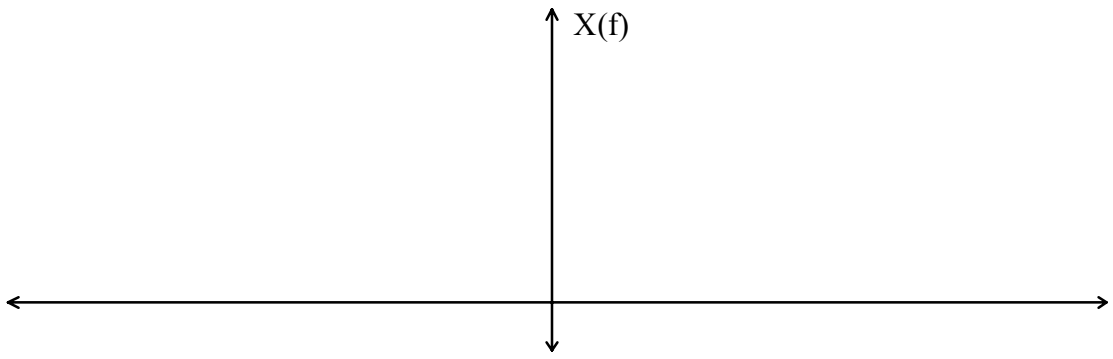


Problem 4 – $x(t) = e^{-5000t}\cos(2\pi 10000t)u(t)$ is the transient output of a overdamped second-order circuit.

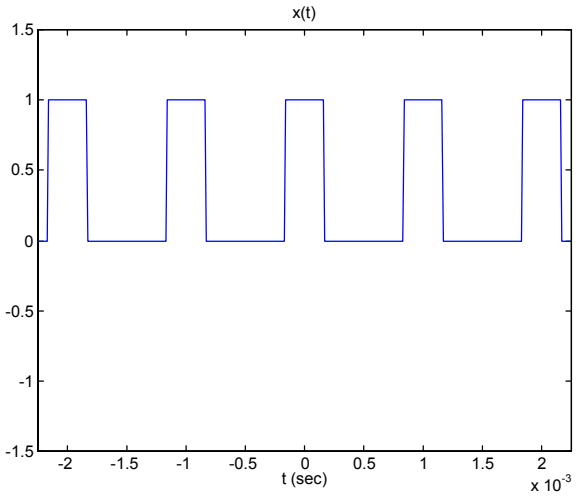


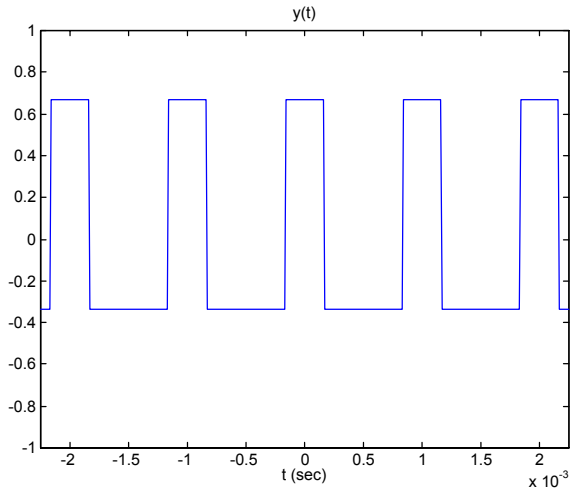
Using the properties of the Fourier Transform, find and sketch X(f) given x(t).

X(f) =



Problem 5 - In class we found the Fourier Series coefficients of, x(t), below to be $c_k = \frac{1}{k\pi}\sin\left(k\pi\frac{T}{T_0}\right)$





a. Express c_k of x(t) in terms of a sinc() function.

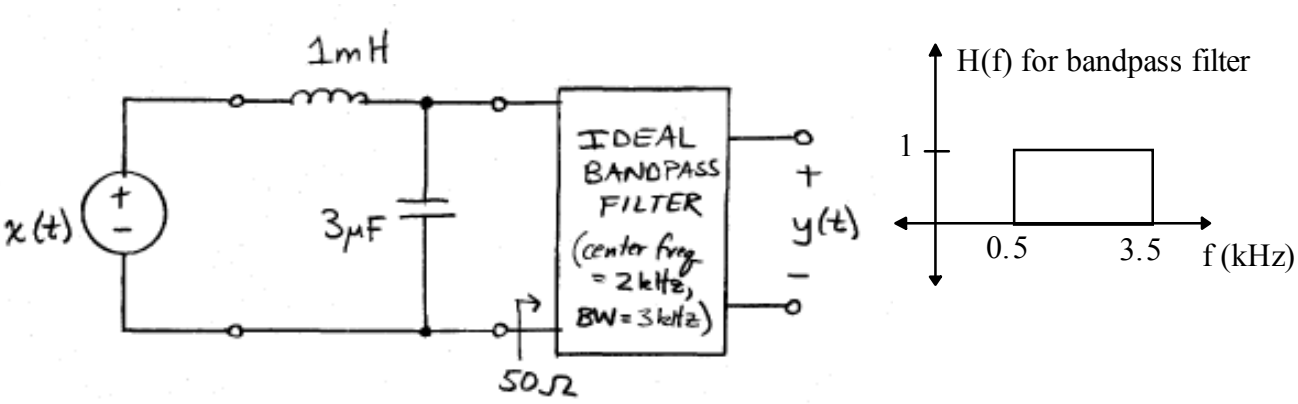
b. What are T and T_0 for x(t)?

c. Sketch the double-sided spectrum of *x(t)* for *k* = *-4* to *4*. Label the amplitude and phase for each *k*.

d. Sketch the double-sided spectrum of *y(t)* for *k* = *-4* to *4*. (Hint: what is the dc value of *y(t)*?) Label the amplitude and phase for each *k*.

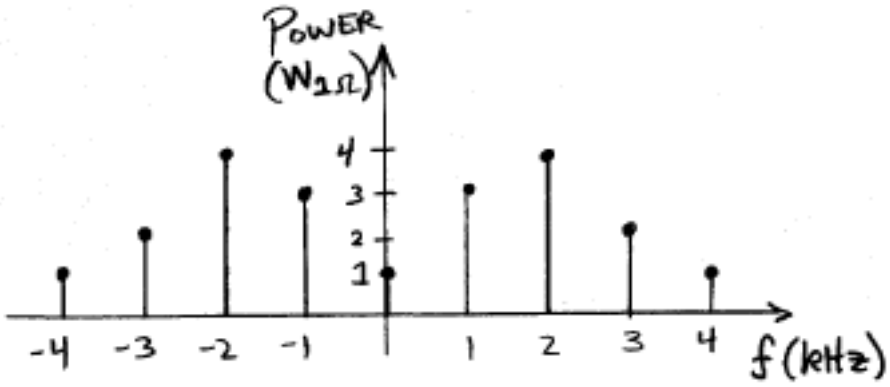
e. Sketch the spectrum of $z(t) = y(t) + \cos(2\pi 500t) + \cos(2\pi 1500t)$ for *k* = *-8* to *8*. Label the amplitude and phase for each *k*.

Problem 6 - Given x(t) = 10 + 6cos(2π1000t) - 3cos(2π3000t + 30°) + cos(2π5000t + 60°) V and



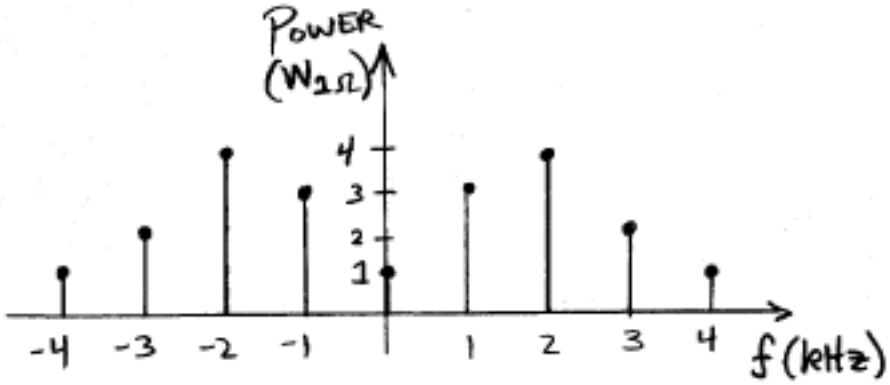
Find *y(t)*. Note: The bandpass filter looks like a 50 Ω resistor to the inductor/capacitor portion of the circuit.

Problem 7 - A signal *x(t)* has the power spectrum:

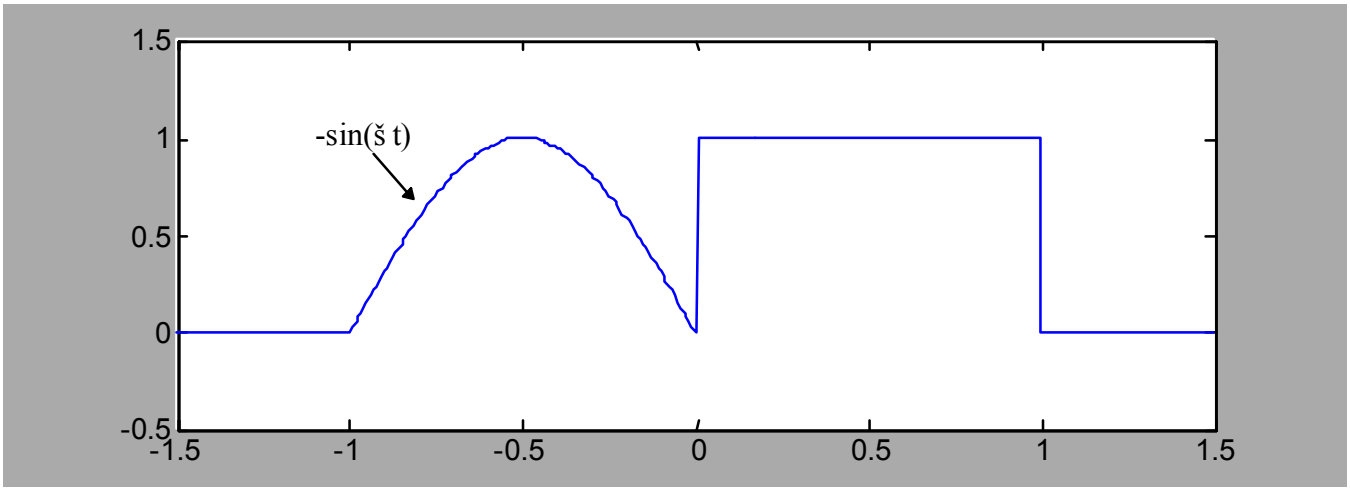


a. Find the total power contained in the signal.

b. Sketch (on the plot below) the frequency response of a simple low pass filter that will pass approximately 75% of the power in *x(t)*.



Problem 8 - Given *x(t)* as shown below:



a. Write a time-domain equation for *x(t)*. Express *x(t)* in a form that makes it easy to compute its Fourier Transform using properties. No need to compute the transform.

b. *y(t)* is a sampled version of *x(t)*. Write a time-domain equation for *y(t)*. Express *y(t)* in a form that is easy to compute its Fourier Transform using properties. No need to compute the transform.