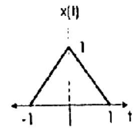
ECE310 - December 1999 Final Exam

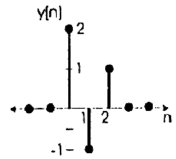
20 Marks **1.** (a) A triangular pulse signal x(t) is defined as:



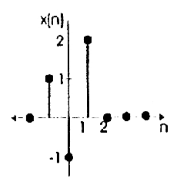
Neatly sketch the following two signals:

5 Marks i) x(3t+2) ii) x(2(t-2))

5 Marks (b) A discrete-time system is both linear and time invariant. The impulse response of the system (i.e., the response to the input x[n]=δ[n]) is defined as follows:



Neatly sketch the output that will result when the input x[n] is as shown below:

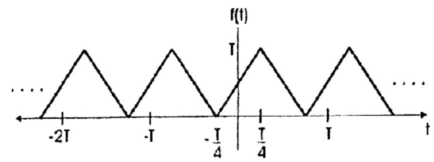


5 Marks (c) Let u(t) be the unit step function. Evaluate the following continuous-time convolution:

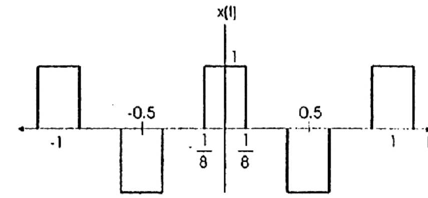
$$y(t) = e^{-t}u(t) * [u(t+2) - u(t-1)]$$

and show y(t) in a neat sketch.

5 Marks (d) Determine the Fourier Series coefficients for the triangular wave shown below:



20 Marks **2.** A signal has the following time-domain representation:



5 Marks (a) Find the Fourier Series coefficients for x(t) and plot them.

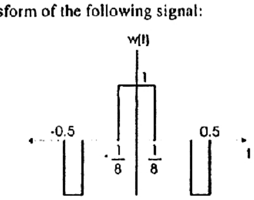
5 Marks (b) What is the Fourier Transform of x(t)?

5 Marks (c) An LTI system has impulse response defined by:

$$h(t) = \frac{2\sin(\pi t)}{\pi t}\cos(4\pi t)$$

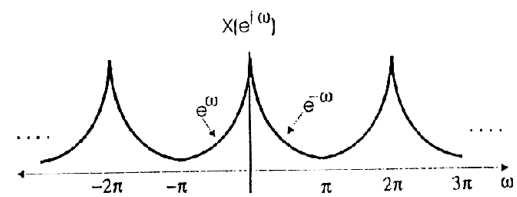
Determine the output y(t) if the input to h(t) is x(t) in part (a).

5 Marks (d) What is the Fourier Transform of the following signal:

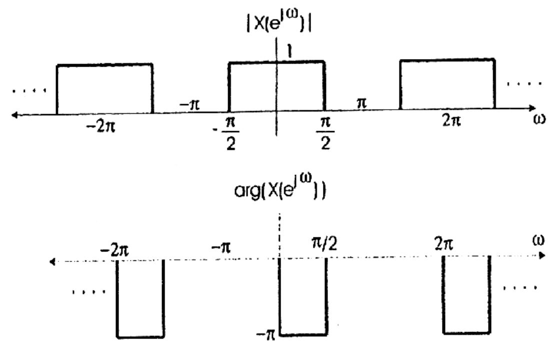


20 Marks **3.** Find the time-domain signal corresponding to the following spectra and plot them.

10 Marks (a)



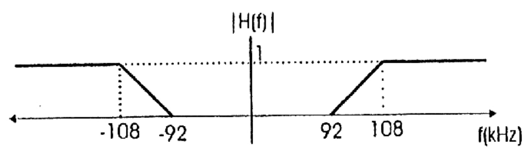
0 Marks (b)



20 Marks **4.** Consider a message signal $m(t)=A\cos 2\pi(6000t) + B\cos 2\pi(10000t)$.

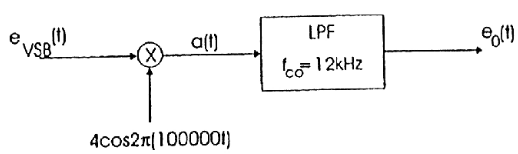
5 Marks (a) Now, $m(t)$ is multiplied by a carrier: $\cos 2\pi(100000t)$ to form the Double Sideband (DSB) signal $e_{DSB}(t)$. Express $e_{DSB}(t)$ as a sum of sinusoids (i.e., with no product terms) and sketch the two-sided DSB signal spectrum.

5 Marks (b) Let $e_{DSB}(t)$ be filtered by a vestigial-sideband filter whose frequency response is defined as:

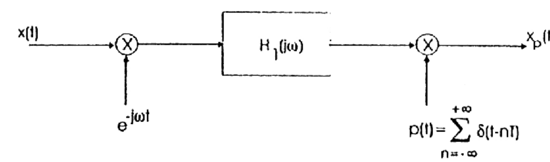


Sketch the frequency response of the resulting signal and give the corresponding time-domain signal $e_{VSB}(t)$.

larks (c) Show that the following system can be used to demodulate $e_{VSB}(t)$ by sketching the frequency spectrum of $a(t)$ and finding $e_0(t)$.

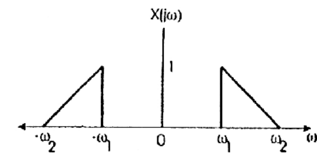


20 Marks **5.** The system depicted below consists of complex modulation followed by sampling:



With $x(t)$ real and with $X(j\omega)$ nonzero only when $\omega_1 < |\omega| < \omega_2$, the modulation frequency $\omega_0=0.5(\omega_1 + \omega_2)$, and the lowpass filter $H_1(j\omega)$ has a cut-off frequency of $0.5(\omega_1 - \omega_2)$.

5 Marks (a) For $X(j\omega)$ as shown below, sketch $X_p(j\omega)$.



5 Marks (b) Determine the maximum sampling period T, such that $x(t)$ is recoverable from $x_p(t)$.

10 Marks (c) Determine a system to recover $x(t)$ from $x_p(t)$.