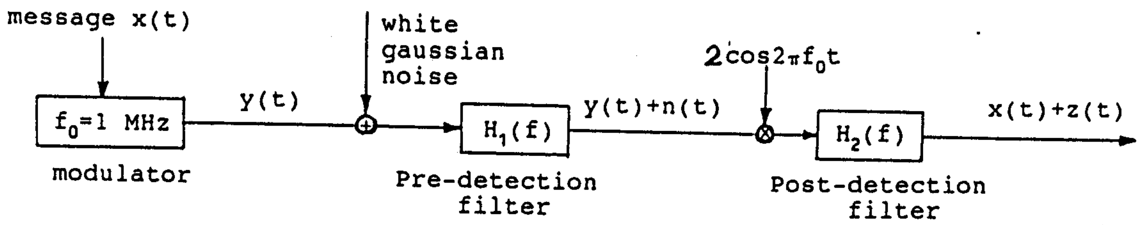
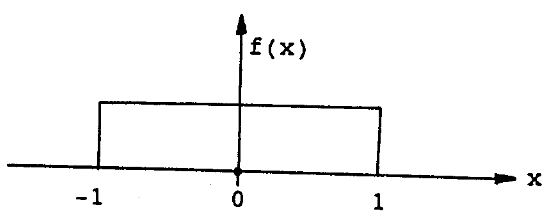
1. Explain the following terminolgies: (20%)

   (a) Aliasing and Nyquist frequency.
   (b) Random process.
   (c) SSB and VSB.
   (d) NRZ, BRZ, and Bandwidth efficiency.
   (e) ISDN

2. A modulation-demodulation system is shown as below



The white gaussian noise has flat one-side power spectral density 0.05 Watt/Hz in all frequency band. The message x(t) has bandwidth 2 KHz, and its probability density function f[x(t)] depicted as below



(a): (1) Compute f(0). (2%)
     (2) Find the message average power, $E[x^2(t)] = \overline{x^2}$. (2%)

(b): Let $y(t) = (1 + 0.5x(t))(16\cos 2\pi f_0 t)$

     (3) Find $\overline{y^2}$. (2%)
     (4) Describe the ideal pre-detection filter, $H_1(f)$. (2%)
     (5) Find the received noise power right after $H_1(f)$. (2%)
     (6) Describe the ideal post-detection filter, $H_2(f)$. (2%)
     (7) Compute signal-to-noise power ratio (dB) after $H_1(f)$. (2%)
     (8) Compute signal-to-noise power ratio (dB) after $H_2(f)$. (2%)

(c): Let $y(t) = 8\,x(t)\cos 2\pi f_0 t$.

     (9) Find $\overline{y^2}$. (2%)
     (10) Compute signal-to-noise power ratio (dB) after $H_2(f)$. (2%)

3. The transfer function for a channel $H_c(f)$ is shown as Figure 3(a).

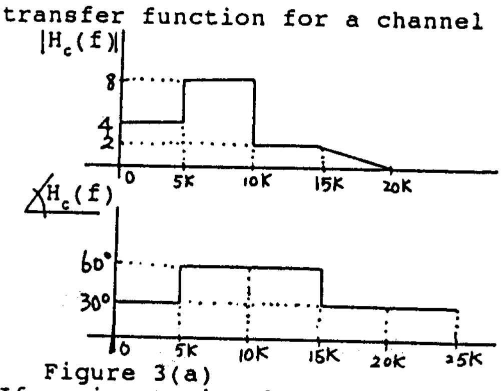


Figure 3(a)

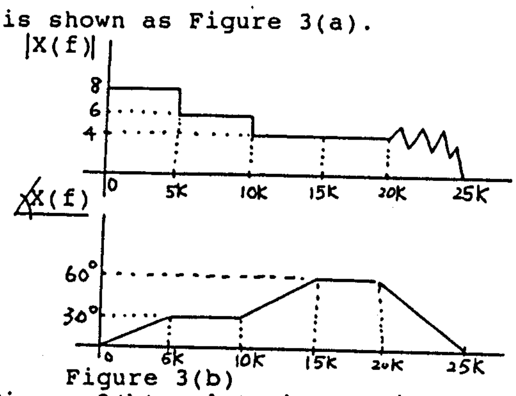
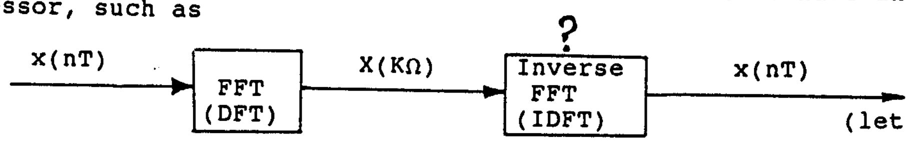


Figure 3(b)

(a) If an input signal, X(f) is shown as Figure 3(b), plot the magnitude and phase of the channel output. (5%)

(b) Plot the magnitude and phase of the transfer function of an ideal equalizer for the above channel for bandwidth f ‹ 15 KHz. (5%)

4. Give the general formula of DFT and Inverse DFT. If we have an FFT processor, such as



(let T=1 and Ω=1)

show that the inverse FFT processor [i.e. known X(KΩ) to find x(nT)] can be constructed by using this FFT processor worked with other simple functions such as multiplier, ..., etc. (10%)

5. Twenty-five audio input signals, each band-limited to 3.3 KHz and sampled at a 8 KHz rate, are time-multiplexed in a PAM system.
   (a) Determine the minimum clock frequency of the system. (5%)
   (b) Find the maximum pulse width for each channel. (7%)
   (c) If above PAM time-multiplexed signal is shifted in frequency by multiplying it by a carrier, $\cos\omega_c t$, thus forming a PAM/AM signal. What is the minimum bandwidth? (8%)

6. Four 6-bit binary messages are to be transmitted using the following codewords

$$C_1 = [1\ 0\ 1\ 1\ 1\ 0\ 1\ 0\ 1\ 0]$$
$$C_2 = [1\ 1\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 1]$$
$$C_3 = [0\ 1\ 1\ 1\ 0\ 1\ 0\ 1\ 0\ 0]$$
$$C_4 = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0]$$

(a) What is the minimum distance of this code set? How many errors can be corrected? (4%)

(b) If a digital modulation, for example the coherent FSK, is used, the probability of bit error is $p_e = 0.5\exp(-E_s/2N_0)$. If $E_s/N_0 = 10$, what is the probability of the received codeword being in error and not corrected? (6%)

(c) Compare the probability of error/message bit for the coded message and the uncoded message (with the same message bit rate as the coded case) if the same modulation system as in Part (b) is used. (10%)