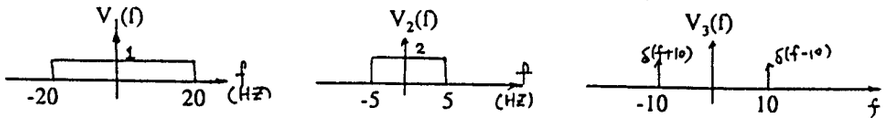
1. Briefly explain the following terminologies: (15%) (should not be more than 20 Chinese characters for each one)
   (a) Channel equalizer
   (b) DPCM
   (c) QPSK
   (d) Coherent detection
   (c) AM threshold effect

2. If $v(t) = t^2 + 2t + \sin(20\pi t) + 3$, find : (a) $\int_0^{\infty} v(t)\delta(t+4)dt = ?$; (b) $\int_{-\infty}^{\infty} V(f)df = ?$ (10%)
   where V(f) is the Fourier transform of v(t).

3. If $V_1(f)$, $V_2(f)$, and $V_3(f)$ shown as the Figure 3 are the Fourier transforms of signals, $v_1(t)$, $v_2(t)$, and $v_3(t)$ respectively,



   Find the Fourier transform of $p(t)=[\, v_1(t) * v_2(t) \,]\, v_3(t)$. (10%)

4. Draw the block diagram of a PLL system. In the diagram, you should indicate the basic components and briefly describe their functions. Use your diagram to explain how the PLL tracks the phase of the input signal and. (10%)

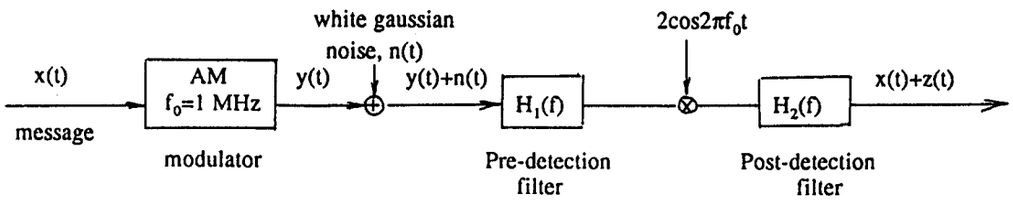
5. $x_C(t) = 3\cos\omega_c t + 4\cos(\omega_c+\omega_i)t$ is received and demodulated by (a) synchronous AM detector; (b) FM frequency discriminator where ω_c is the carrier frequency. What is the output of each detector if its detection gain is K_D. (10%)

6. If a binary sequence is given as {0110100011}, please depict the signal waveforms of: (a) Unipolar RZ; (b) Unipolar NRZ; (c) AMI code; (d) Manchester code; (e) Four-level Gray code. (5%)
   If the binary sequence is at rate of 2kbps, what is the minimum bandwidth required for transmitting the waveforms.(5%)
   Note: you should line-up these five waveforms together with binary data on the top separating by dash lines, the corresponding bandwidth on the right, and the name of the waveform on the left.

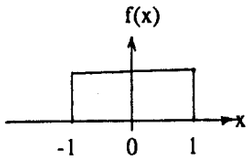
7. If the (4, 2) error correct code is constructed as {00 <--> 0000, 01 <--> 0011, 10 <--> 1100 , and 11<-->1111 } to be used in a BSC channel with $P_e=10^{-4}$.
   (a) How many error bits can be detected or corrected in a codeword? (5%)
   (b) What is the probability of undetectable error in a codeword? (5%)

8. A stationary random signal, x(t) is uniformly distributed between [-1 , 1]. If the other stationary random signal y(t) is independent of x(t) and $E[y(t)]=1.0$ and $E[y^2(t)]=4.0$. Please calculate the following statistics,
   (a) $E[x(t) + y(t)]$; (b) $Var[3x(t) +2y(t)]$ where $E[\cdot]$ and $Var[\cdot]$ denote the expectation and variance respectively.

9. 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 depicted as below



   (a) Find the message average power, $E[x^2(t)] = ?$. (3%)
   (b): Let $y(t) = (1+ 0.5x(t))\,(2\cos2\pi f_0 t)$
      (i) Describe the ideal pre-detection filter, $H_1(f)$. (2%)
      (ii) Find the received noise power right after $H_1(f)$. (2%)
      (iii) Describe the ideal post-detection filter, $H_2(f)$. (2%)
      (iv) Compute signal-to-noise power ratio (dB) after $H_1(f)$. (3%)
      (v) Compute signal-to-noise power ratio (dB) after $H_2(f)$. (3%)
   Note: To describe a filter, you should identify if the filter is a lowpass, highpass, or bandpass filter and you should give the bandwidth, center frequency, and cutoff frequencies of the filter.