1. (10%) (a) Explain why by multiplying $\cos(2\pi f_c t)$ to a signal $x(t)$ will raise the frequencies of $x(t)$? You may use any method mentioned in the lecture notes.

   (b) Let $x(t)\cos(2\pi f_c t)$ be the modulated signal. How does the demodulator recover the original baseband signal $x(t)$?

   (c) Suppose the bandwidth of $x(t)$ is W. What is the bandwidth of the sent signal?

2. (10%) (a) Explain what it means by single side band? What is the advantage of using signal side band?

   (b) Give a method to implement single side band.

3. (10%) Consider the following two circuits.
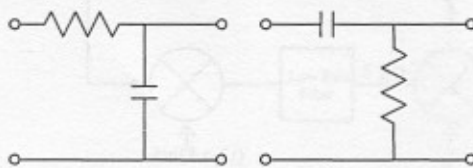
   (a) Explain which circuit is a low-pass filter and which one is a high-pass filter.

   (b) Explain how a band-pass can be constructed based upon these filters.

4. (10%) Can you send a voice signal wirelessly without any modulation? Explain.

5. (10%) (a) In the baseband pulse transmission, signals are transmitted by digital signals only. Yet we still say that this system has a bandwidth. Give this bandwidth and explain why we have such a bandwidth.

   (b) In the ASK system, a cosine function is used to modulate the digital signals. The Fourier transform of a cosine function is the delta function which has no bandwidth associated with it. Yet we still say that there is a bandwidth associated with this system. Give this bandwidth and explain why.

6. (10%) (a) Explain what the M-ary PSK system is.

   (b) Illustrate the modulation and demodulation of a typical 8PSK system.

7. (20%) Consider the following figures.

1

Modulation of OFDM

Demodulation of OFDM
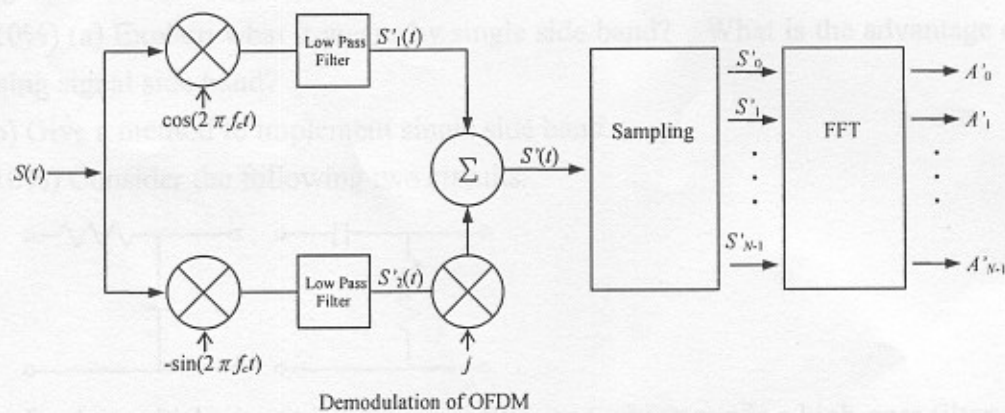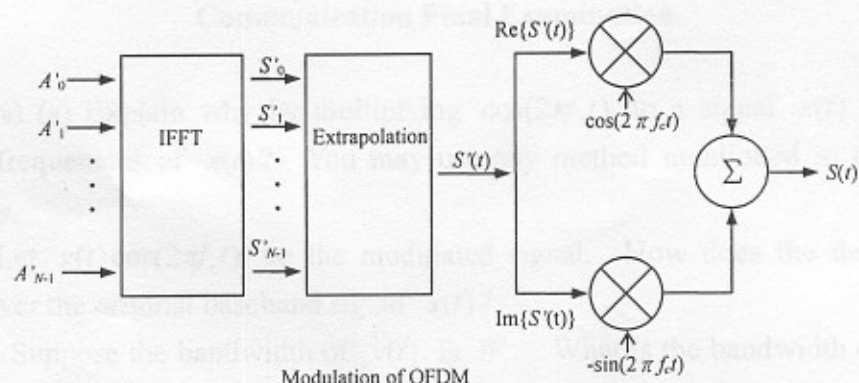
Explain why these systems are related to the OFDM system.

8. (10%) In a CDMA system, there are three users and their codes are as follows:

    User 1: (1,1,1,1,-1,-1,-1,-1)

    User 2: (1,-1,1,-1,-1,1,-1,1)

    User 3: (1,-1,-1,1,1,-1,-1,1)

The sent signal is (1,1,-1,3,1,-3,-1,-1).   Determine the bit sent by each user.

9. (10%) Explain why voice signal can still be sent by TDMA technique.