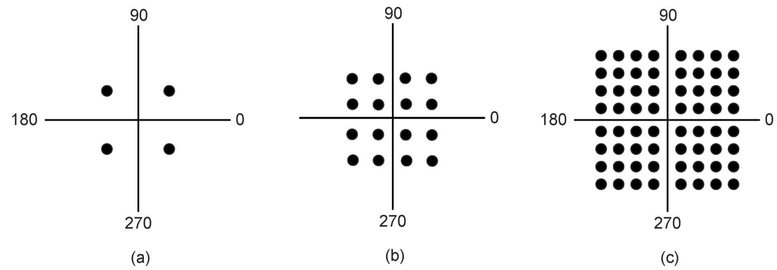
Problem 1

A modem constellation diagram has data points as show in the figure below. How many bps can a modem with these parameters achieve at 1200 symbols/second?



10 points

Basically the QAM idea dicates that the number of bits per symbol is $log_2(\#\ of\ symbols)$. The overall bit rate is baud rate $\times$ bit per symbol. Thus for (a), the bit rate $= 1200 * log_2(4) = 2400bps = 2.4kbps$, For (b), it will be 4.8kbps. For (c), it will be 7.2kbps. As you can see, the speed does increase but due to the log factor, the rate of increase isn't as dramatic as the increase of the number of symbols.

Problem 2

How many frequencies does a full-duplex QAM-64 modem use? Justify your answer.

10 points

Two, one for upstream and one for downstream. The modulation scheme itself just uses amplitude and phase. The frequency is not modulated.

Problem 3

Sixteen signals, each requiring 4000hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400Hz wide.

10 points

There are sixteen 4000Hz signals. We need 15 guard bands to avoid any interference. The minimum bandwidth required is 4000x16+400x15=70kHz.

Problem 4

Suppose that A, B, and C are simultaneously transmitting 0, 1, and 0 bits, using a CDMA system with the chip sequence below. What is the resulting chip sequence?

A = (–1 –1 –1 +1 +1 –1 +1 +1)

B = (–1 –1 +1 –1 +1 +1 +1 –1)

C = (–1 +1 –1 +1 +1 +1 –1 –1)

D = (–1 +1 –1 –1 –1 –1 +1 –1)

10 points

If A, B, and C sent 0, 1, and 0, then basically A and C send the invert of their sequences and B sends its sequence. D doesn't send anything. THe result will thus be $\overline{A} + B + \overline{C} =$

Problem 4 continued on next page. . .

$$\overline{A}(+1+1+1-1-1+1-1-1)$$
$$B(-1-1+1-1+1+1+1-1)$$
$$\overline{C}(+1-1+1-1-1-1+1+1)$$
$$=(+1-1+3-3-1+1+1-1)$$

Problem 5

A CDMA receiver gets the following chips.: (-1 +1 -3 +1 -1 -3 +1 +1). Assuming the chip sequence is the same as in the Fig above, which stations transmitted, and which bits did each one send?

10 points

Use vector product after normalization, we can find that

- if the result is +1, then that host sends a 1
- if the result is -1, then that host sends a 0
- if the result is 0, then that host sends nothing.

Thus for this problem, $|A^T \times Result| = (+1+1+1-1-1+1-1-1)^T \times (-1+1-3+1-1-3+1+1)/8 = 1$. Thus A sends a 1. Similarly, B sends a 0, C sends nothing, and D sends a 1.