

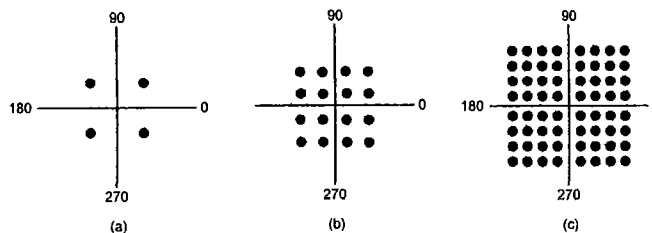
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Problem 1

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?



- (a) QPSK 2 bit/symbols * 1200 symbols/second = 2400bps
 (b) QAM-16 4 bit/symbols * 1200 symbols/second = 4800bps
 (c) QAM-64 6 bit/symbols * 1200 symbols/second = 7200bps

Problem 2

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

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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.

$$16 * 4000\text{Hz} + 15 * 400\text{Hz} = 64000 + 6000 = 70,000\text{Hz}$$

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?

$$A = (-1 -1 -1 +1 +1 -1 +1 +1)$$

$$B = (+1 -1 +1 -1 +1 +1 +1 -1)$$

$$C = (-1 +1 -1 +1 +1 +1 -1 -1)$$

$$D = (-1 +1 -1 -1 -1 -1 +1 -1)$$

$$\bar{A} (+1 +1 +1 -1 -1 +1 -1 -1)$$

$$\bar{B} (+1 +1 -1 +1 -1 -1 -1 +1)$$

$$\bar{C} (+1 -1 +1 -1 -1 +1 +1 -1)$$

← B don't have to be negated since it sends a 1.

if transmit 0 bits negation of its chip sequence (+3 +1 +1 -3 -1 -1 +1)

1 bits the chip sequence (-3 -1 -1 +1 +3 +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?

$$D \quad A \times (+1 -1 +3 +1 -1 +3 +1 +1) / 8 = 1$$

$$B \times (+1 -1 -3 -1 -1 -3 +1 +1) / 8 = -1$$

$$C \times (+1 +1 +3 +1 -1 -3 -1 -1) / 8 = 0$$

$$D \times (-1 +1 -3 -1 -1 -3 +1 +1) / 8 = -1$$

A and D send 1 bits

B send -1 bits

C No send