

EE 302 PS 24 - SOLUTIONS

Chapter 11

Questions: 44, 47

Problems: 9

Critical Thinking: None

Additional Problems: 1-3

Question 44

Yes. When QPSK is used, two bits are conveyed with each symbol. If the baud rate is X symbols/s, then the bit rate is $2X$ bps.

Question 47

Amplitude and phase modulation.

Problem 9

$$\text{BER} = \frac{4 \text{ errors}}{500,000 \text{ bits}} = 8 \times 10^{-6} \text{ errors/bit}$$

Additional Problem 1

1.a. Because the phase of the original carrier is unknown, there are two possibilities. On one hand, the signal may be **10110100**. Note that this goes from LSB (earliest transmitted bit) to MSB (last transmitted bit). On the other hand, the signal may be **01001011**.

1.b.

$$T_b = 2.5 \text{ ms per bit} \longrightarrow f_b = \frac{1}{T_b} = 400 \text{ bps}$$

1

Additional Problem 2

2.a. 8 different phase positions.

2.b.

$$N = \log_2 S = \log_2 8 = 3 \text{ bits per symbol}$$

Additional Problem 3

3.a. See Table 1.

TABLE 1. Calculated transmission speeds (bps) for a 1 MHz channel for selected modulation modes. Transmission speed is the product of spectral efficiency and bandwidth. Spectral efficiency is found on page 412 of the course textbook.

Modulation Mode	Spectral Efficiency (bps/Hz)	Transmission speed (bps)
4-PSK	2	2×10^6
8-PSK	3	3×10^6
8-QAM	3	3×10^6

3.b. See Table 2.

TABLE 2. Calculated number of errors expected during a transmission of 10 Mb of data. BER values are read from Figure 11-31 in the course textbook with an entering argument of $C/N = 15$ dB. The number of errors is the product of the BER and the number of bits transmitted.

Modulation Mode	BER	Errors
4-PSK	2×10^{-8}	1 or less
8-PSK	7×10^{-4}	7000
8-QAM	2×10^{-4}	2000

3.c. Assuming cost is not an issue, 8-QAM is preferred because it is less prone to error than 8-PSK at any given C/N ratio.