



Faculty of Engineering

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Data Com Lab

"Homework 3"

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Q1: What is the required bandwidth for the following cases if we need to send 4kbps?
Let $d=1$.

- 1) ASK
- 2) FSK with $2\Delta f = 4 \text{ KHz}$
- 3) QPSK
- 4) 16-QAM

Q.1) 4kbps $\xrightarrow{N}$ $d=1$ اليوم : العرس

1) ASK

$$B = (1+d) S \xrightarrow{\frac{N}{r}}$$
$$B = (1+1) \frac{N}{r}$$
$$r = \log_2 2$$
$$\boxed{r=1}$$
$$B = 2 \cdot 4000 = \boxed{8000 \text{ Hz}}$$

2) FSK with $2\Delta f = 4 \text{ KHz}$

$$B = \underbrace{(1+d) S}_{8000} + 2\Delta f \xrightarrow{4000}$$
$$8000 + 4000 = \boxed{12000 \text{ Hz}}$$

3) QPSK

$$B = (1+d) S \xrightarrow{\frac{N}{r}}$$
$$r = \log_2 4 = \boxed{2}$$
$$B = 2 \times \frac{4000}{2}$$
$$= \boxed{4000 \text{ Hz}}$$

4) 16-QAM

$$r = \log_2 16 = \boxed{4}$$
$$B = (1+d) S \xrightarrow{\frac{N}{r}}$$
$$B = 2 \times \frac{4000}{4} = \boxed{2000 \text{ Hz}}$$

Q2: The telephone line has 16 KHz bandwidth. What is the maximum number of bits we can send using each of the following techniques? Let $d = 0$.

a. ASK

b. QPSK

c. 16-QAM

Bandwidth B

Q2) 16 KHz maximum number
 $d=0$

1) ASK

$B = (1+d)S$ $S = 16 \text{ KHz}$

$N = Sr = \underline{16r}$

$r = \log_2 2 = \underline{1}$ $2^1 = 2$

$N = 16000 \times 1 = \underline{16 \text{ KPs}}$

b) QPSK? $N = 16000r$ $2^2 = 4$

$N = 16000 \times 2$ $r = \log_2 4 = \underline{2}$

$= 32000$

$= \underline{32 \text{ KPs}}$

c) 16-QAM $N = 16000r$ $2^4 = 16$

$N = 16000 \times 4 = 64000$ $r = \log_2 16 = \underline{4}$

$= \underline{64 \text{ KPs}}$

Q3: We need to send data 3 bits at a time at a bit rate of 3 Mbps. The carrier frequency is 10 MHz. Calculate the number of levels (different frequencies), the baud rate, and the bandwidth.

Q3

Bit Rate = ~~3 bits~~ 3 Mbps

Bits per symbol = 3 bits

$f_c = 10 \text{ MHz}$

1) Number of levels?

Bits per symbol = $\log_2(L)$

$3 = \log_2(L)$

$L = 2^3 = \boxed{8 \text{ level}}$

2) Baud Rate

$R_s = \frac{\text{Bit rate}}{\text{symbol}} = \frac{3 \text{ Mbps}}{3} = \boxed{1 \text{ Mbaud}}$

3) Band width

$d = 0 \text{ baud}$

$B = \frac{L}{1+d} \cdot R_s$

~~$B = \frac{L}{1+d} \cdot R_s$~~

$B = 8 \cdot 1 = \boxed{8 \text{ MHz}}$

	0	1	0	1	1
ASK					
BFSK					
BPSK					

Q4))

1) ASK

0 $\rightarrow$ 0 Low
1 $\rightarrow$ A High

0 1 0 1 1
↓ ↓ ↓ ↓ ↓
0 A 0 A A

2) BFSK

0 $\rightarrow$ S_0 Low
1 $\rightarrow$ S_1 High

0 1 0 1 1
↓ ↓ ↓ ↓ ↓
 $S_0 S_1 S_0 S_1 S_1$

3) BPSK

0 $\rightarrow$ 0°
1 $\rightarrow$ 180°

0 1 0 1 1
↓ ↓ ↓ ↓ ↓
 $+A \cos(\omega_b t)$ $-A \cos(\omega_b t)$
 $-A \cos(\omega_b t)$ $+A \cos(\omega_b t)$
 $-A \cos(\omega_b t)$ $-A \cos(\omega_b t)$ $+A \cos(\omega_b t)$
0 180° 0 180° 180°