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1. Define digital-to-analog conversion and analog-to-analog conversion:

- Digital to analog conversion is the process of changing one of the characteristics of an analog based on the information in the digital data, accomplished in several ways such as, ASK, FSK, PSK, and QAM.
- Analog to analog conversion is the representation of analog information by analog signal. The conversion is needed if the medium bandpass in nature or if only a bandpass bandwidth is available to us, it can be accomplished in three ways: AM, FM and PM.

2. Which of the four digital to analog conversion techniques (ASK, FSK, PSK, or QAM) is the most susceptible to noise?

ASK is the most susceptible. Because ASK a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave and the amplitude is more affected by noise than the phase or frequency. Like AM radio usually has much more static than FM radio.

3. Which characteristics of an analog signal are changed to represent the lowpass analog signal in each of the following analog to analog conversions?

- (a) AM(Amplitude Modulation): amplitude
- (b) FM(Frequency Modulation): frequency
- (c) PM(Phase Modulation): phase

4. Find the bandwidth of the following situations if we need to modulate a 5-kHz voice.

(a) AM

Following formular $B_{am} = 2*B$ and we have $B = 5 \text{ kHz}$

Therefore: $B_{am} = 2 * 5 = 10 \text{ kHz}$

(b) FM ($\beta = 5$)

Following formular $B_{fm} = 2*(1+\beta)*B$

Therefore: $B_{fm} = 2*5*5 = 50 \text{ kHz}$

(c) PM ($\beta = 1$)

Following formular $B_{pm} = 2*(1+\beta)*B$

Therefore: $B_{pm} = 2*(1+1)*5 = 20 \text{ kHz}$

5. What is the required bandwidth for following case if we need to send 4000 bps? Let $d = 1$

a) ASK

Following formula $B_{ASK} = (1+d)*S$ and $S = N/r$ ($N = 4000$ bps, $r = 1$)

$$\Rightarrow S = 4000/1$$

$$\text{Therefore: } B_{ASK} = (1+1)*4000 = 8000 \text{ Hz}$$

b) FSK with $2\Delta_f = 4$ kHz

Following formula $B_{FSK} = (1+d)*S + 2\Delta_f$ and $\Delta_f = 4$ kHz = 4000 Hz

$$\text{Therefore: } B_{FSK} = (1+1)*4000 + 2*4000 = 16000 \text{ Hz}$$

c) QPSK

Following formula $B_{QPSK} = (1+d)*S = (1+d)*N/r$ and ($N = 4000$ bps, $r = 2$)

$$\text{Therefore: } B_{QPSK} = (1+1)*(4000/2) = 2*2000 = 4000 \text{ Hz}$$

d) 16-QAM

Following formula $B_{QAM} = (1+d)*S = (1+d)*N/r$ and ($N = 4000$ bps, $r = \log_2 16 = 4$)

$$\text{Therefore: } B_{QAM} = (1+1)*(4000/4) = 2000 \text{ Hz}$$