

1. A digital signalling system uses some distinct signal elements to encode 8-bit data items. What bandwidth is necessary to support a data rate of 300 kbps over a transmission channel?

If the channel has a SNR measured at 40 dB, determine whether or not the system can still be used to transmit data with the desired data rate. Comment on your results if the SNR in dB is doubled.

2. Calculate the minimum and maximum modulation rate for (a) NRZ-L, and (b) Manchester coding schemes, assuming a bit rate of 96 kbps.
3. A PCM encoder accepts an analog signal which has the highest frequency component of the form: $s(t) = 25.6 \sin (3850 t)$ Volts, where t is the time in seconds. The signal is sampled in accordance with the sampling theorem and then quantized uniformly to 10 bits per sample to form a PCM signal for transmission.
- What is the minimum required sampling rate?
 - Find the step size of the quantization levels.
 - What is the data rate for PCM output signal?
 - Given that the PCM signal is encoded with NRZ-L. What is the minimum channel bandwidth required for transmitting the digital signal?
4. Suppose that a modem uses a QAM technique described by the table given below.

Bit values	Amplitude of generated signal ($A_1 > A_2$)	Phase shift of generated signal (with reference to the previous signal)
000	A_1	0
001	A_2	0
010	A_1	$1 / (4f)$
011	A_2	$1 / (4f)$
100	A_1	$1 / (2f)$
101	A_2	$1 / (2f)$
110	A_1	$3 / (4f)$
111	A_2	$3 / (4f)$

- Assume that the initial analog signal is a sine waveform given by $A_1 \sin(2\pi ft)$ where f is its frequency. Draw the QAM analog signal that transmits the following bit string:
 001010100011101000011110 .
 (You need draw only one complete cycle for each modulation change.)
- Draw the signal constellation diagram for a modem that uses the QAM defined by the above table.
- The QAM signal obtained from (a) is transmitted across a line with a modulation rate of 9,600 baud. What is the data rate?