

## **Tutorial 10 – Digital Modulation**

1. A long series of ...1010... binary sequences is to be transmitted by:
  - (a) binary ASK
  - (b) binary FSK with frequency deviation 375 Hz
  - (c) binary PSK

The data rate is 1 kb/s and can be assumed to be in unipolar NRZ format with amplitude of 1 volt. The carrier frequency is 1 MHz. For each of these digital carrier modulation scheme sketch the amplitude spectrum from 998,500 Hz to 1,001,500 Hz. Amplitude of components need not be shown.

2. A binary data at rate 3 kb/s is transmitted over a passband channel using BPSK. The carrier amplitude at the receiver is 10 mV, and the single-sided power spectral density of the channel AWGN is 2 nanowatt/Hz. Calculate the bit error rate, assuming that an integrate-and-dump correlation receiver is used.
3. Figure T10.1 shows the block diagram of a DPSK transmitter. The binary input is in unipolar NRZ format, at a bit rate of 2400 b/s. The carrier is  $A\sin\omega_c t$  where  $\omega_c = 4800\pi$  rad/s. Assume that input is a long sequence of ...101010... Sketch the waveforms at points A to C as indicated in Figure T10.1 for a 1010 frame. Assume a distortionless transmission path. Also assume that the encoder's output is binary 0 prior to the 1010 frame.

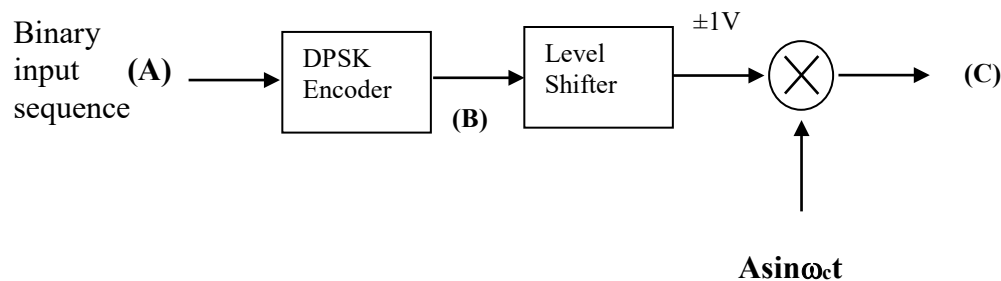


Figure T10.1 DPSK

4. Rank, from low to high, the following modulation schemes in terms of BER, bandwidth efficiency and equipment complexity: BPSK, DPSK, QPSK, 4-QAM, 8-PSK and 8-QAM.