1. $n(t)$ is a stationary narrowband noise,

$$n(t) = n_c(t)\cos(w_0 t + \theta) - n_s(t)\sin(w_0 t + \theta),$$

where $n_c(t)$ and $n_s(t)$ are the quadrature components, w_0 is carrier frequency, θ is the phase. We assume that $n(t)$ is a Gaussian process with mean $\overline{n(t)} = 0$ and variance $\overline{n^2(t)} = N$. The power spectral density of $n(t)$ is symmetrical about $w = w_0$.

1. (8 %) Show the operations involved in producing $n_c(t)$ and $n_s(t)$.

2. (8 %) Find the joint probability density function $f(n_c, t; n_s, t + \tau)$ of $n_c(t)$ and $n_s(t)$ for any delay τ.

3. (9 %) If $n'(t)$ denotes the derivative of $n(t)$, $n'(t) = dn(t)/dt$, show that $n(t)$ and $n'(t)$ are independent.

2.

(A) A continuous data signal is quantized and transmitted using a PCM system. If each data sample at the receiving end of the system must be known to within ±0.5% of the peak-to-peak full-scale value,

(1) How many binary symbols must each transmitted digital word contain?

(2) Assume that the message signal is speech and has a bandwidth of 4 kHz. Estimate minimum required bandwidth of the resulting PCM signal. (15%)

(B) The analog waveform shown in the figure is to be delta modulated. The sampling period and the step size are indicated by the grid on the figure. The first DM output and the staircase function for this period are also shown. Show the rest of the staircase function and give the DM output. Indicate regions where slope overload distortion exists. (10%)
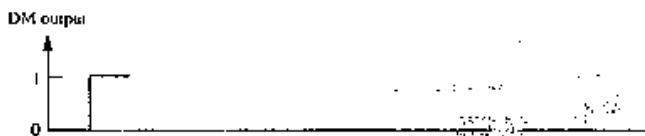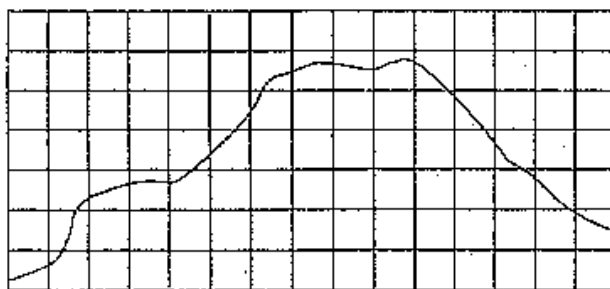
3. A source has seven outputs denoted (a0,a1,a2,a3,a4,a5and a6) with respective probabilities (0.4, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1)

5% (A) Calculate the entropy

15% (B) Determine the codeword using Huffman code

5% (C) Calculate the efficiency

10% 4. (A) A QPSK system with data Rate 64 KB/S. Find the transmission bandwidth

5% (B) Repeat problem (A) if a MSK system is operated

5% (C) If the carrier frequency of the MSK is 50MHz, what is the instantaneous frequency for data sequence 111111.......

5% (D) Repeat problem (C) for data sequence 010101......