

1. Consider to transmit a message of data rate 9.6 kbps through a particular channel without ISI (Intersymbol Interference).
 - (a) What is the theoretic minimum system bandwidth needed for using baseband 8-ary PAM modulation? (5%)
 - (b) Repeat part (a) for using 8PSK modulation. (5%)
 - (c) If the passband of the channel is from 600 to 4,200 Hz and has the form of raised cosine spectrum, determine the maximum roll-off factor for using 16QAM modulation. (5%)

2. An additive white Gaussian noise (AWGN) with two-sided power spectral density (PSD) = $N_0/2$ is passed through an ideal LPF with one-sided bandwidth = 100 Hz.
 - (a) Determine the power of the output. (5%)
 - (b) Determine the probability density function (pdf) of the amplitude of the output. (5%)
 - (c) Determine the autocorrelation function of the output. (5%)
 - (d) Determine the joint pdf of the outputs at time t_0 and 1 sec later (i.e., $t_0 + 1$). (5%)

3.
 - (a) If the amplitude of a baseband signal $x(t)$ is uniformly distributed over $(-2, 2)$, design an optimal 16-level quantizer for this signal and determine the signal to quantization noise ratio S/N_q . (10%)
 - (b) If the output of the quantizer designed in part (a) is transmitted at a rate of 64 kbps, what is the maximum bandwidth of $x(t)$ without aliasing distortion? (5%)

4.
 - (a) A carrier voltage given by $v_c = 10 \cos(2\pi \times 10^6)t$ is modulated by a signal voltage given by $v_m = 2.0 \cos(2\pi \times 10^4)t$. For amplitude modulation obtain an expression for the modulated output and sketch its spectrum giving all relevant values. Give also a value for the modulation factor. (10%)
 - (b) If the carrier is now frequency modulated by the signal, using a modulation index equal to the above modulation factor, give an expression for the output waveform and sketch the new spectrum giving all relevant values. (10%)

5.
 - (a) Calculate the power, in dBm, for 100 μ V across 50- Ω . How much is this in dBW? (5%)
 - (b) The input power to a 50- Ω receiver is 200 pW. Determine the receiver gain required to produce +3 dBm at the detector. (5%)
 - (c) Determine the noise power delivered to a receiver input at 300 °K and noise bandwidth of 20 kHz. (5%)

6.
 - (a) What is the symbol rate for a 2100-bps data stream using a QPSK modulator? And that using an 8-QAM modulator? (5%)
 - (b) Draw the vector or constellation diagram representing the possible symbols at the output of the 8-PSK modulator? And that of the 8-QAM modulator? (5%)
 - (c) Plot the bit error rate as functions of signal-noise ratio for QPSK, 8-PSK, 16-PSK, 8-QAM and 16-QAM in the same figure. Indicate clearly the relative positions between the above curves. (5%)