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MANIPAL INSTITUTE OF TECHNOLOGY Manipal University



SIXTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION MAY/JUNE 2016 SUBJECT: DIGITAL COMMUNICATION (ECE – 302)

TIME: 3 HOURS

Instructions to candidates

MAX. MARKS: 50

- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.
- 1A. Derive an expression for probability of error for detecting two equally likely signals $S_1(t) = \sqrt{\frac{2E}{T}} \cos \omega_o t$ and $S_2(t) = \sqrt{\frac{E}{2T}} \cos(\omega_o t + \pi)$ in AWGN channel using correlator receiver. Assume $\varphi(t) = \sqrt{\frac{2}{T}} \cos \omega_o t$.
- 1B. Twenty-four voice signals are sampled uniformly and then time division multiplexed. The sampling operation uses the flat-top samples with 1microsec duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of sufficient amplitude having 1µsecond pulse width. Assuming a sampling rate of 8KHz, calculate the spacing between successive pulses of the multiplexed signal.
- 1C. A low pass filtered pulse signal has a shape given by $x(t) = \frac{\sin(6283t)}{\pi t}$. If this signal is to be sampled, find the Nyquist sampling frequency and sampling intervals.

(5+3+2)

- 2A. Prove that mean square error of reconstructed message is zero for wide sense stationary message process whose power spectral density band-limited.
- 2B. A PCM system uses a uniform quantizer (mid-riser) followed by a 7-bit binary encoder. The bit rate of the system is 56Mega bits/sec. Find the output signal-to-quantization noise ratio when a sinusoidal wave of 1MHz frequency is applied to the input.
- 2C. An analog signal is sampled at the Nyquist rate of $f_s = 20K$ and quantized (mid-riser) into L=1024 levels. Find bit-rate and the time duration Tb of one bit of the binary encoded signal.

(5+3+2)

- 3A. A source output consists of 3 symbols m1, m2 and m3 with prior probabilities $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{4}$ respectively. Encode the 2nd order extension of the source using Shannon Fano coding. Also find the efficiency of the resulting code.
- 3B. What are the digital modulation techniques used in MODEMs for data transmission over voice grade channels?

3C. The message signal for a delta modulator is given by $m(t) = 4Sin2\pi 10t + 5Sin2\pi 20t$. Determine the minimum sapling rate f_s required to prevent slope overload with $\delta = 0.05\pi$.

(5+3+2)

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- Obtain the expression for probability of bit error Pe in FSK. Give signal space diagram. 4A.
- 4B. i) Determine the ideal system bandwidth required for transmitting digital data at the rate of 10Mbps using 16-ary (M=16) PAM without ISI.

ii) If the allowed system bandwidth is equal to 1.375 MHz, What is the roll off factor required to avoid ISI?

- 4C. A Gaussian channel has 1.5 MHz bandwidth. If the signal power to noise power spectral density ratio is $(S_n) = 10^4$, determine the channel capacity C.
- 5A. Three signal sets $S_1(t)$, $S_2(t)$ and $S_3(t)$ are given by

$$S_{1}(t) = A \qquad 0 \le t \le T$$

$$S_{2}(t) = A \qquad \frac{T}{2} \le t \le T$$

$$S_{3}(t) = \begin{cases} A \qquad 0 \le t \le T/2 \\ -A \qquad T/2 \le t \le T \end{cases}$$

- a) Find the basis signals using Gram Schmidt ortho-normalization procedure.
- b) Represent the signals as vectors.
- c) Show the signals on the signal space diagram.
- 5B. A PN sequence is generated with a feedback shift register of length N = 15 which is clocked at 10 MHz. Find
 - (a) The chip duration.
 - (b) PN sequence length.
 - (c) Period of PN sequence.
- For a (6, 3) systematic linear block code, the parity check bits are generated as follows: 5C.

 $c_4 = m_1 + m_3$; $c_5 = m_1 + m_2 + m_3$; $c_6 = m_1 + m_2$; Write the Generator matrix

6A.
A signal
$$s(t) = A_1 \sqrt{\frac{T}{T}} \cos \omega_c t$$
 is transmitted over an interval $0 \le t \le T$. Show that matched filter

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demodulator can be used for signal detection with the output sampled at t = T.

- The temperature at a particular place varies between 14^oC and 34^oC for the purpose of transmitting 6B. the temperature record of that place, the record is sampled at an approximate sampling rate and the samples are quantized. If the error in the representation of the samples due to quantization is not to exceed $\pm 1\%$ of the dynamic range, what is the minimum number of quantization levels that can be used?
- 6C. One period of a periodic binary sequence is given 10000111010111. Identify whether this is a maximum length sequence. Give reasons for your answer.

(5+3+2)