M.E. Sem II Advanced Communication Theory 30/5/08

Con. 3262-08. Etrx.

BB-4738

(4 Hours) **[Total Marks : 100**

N.B.(1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.

1. Answer **all** the questions briefly :—
   (a) Explain the procedure for coding and decoding of cyclic codes. What is the condition to be satisfied for a valid generator polynomial. **6**
   (b) Define the following : Frequency-selective channel, frequency-non-selective channel, slowly-fading channel, Doppler frequency spread of the channel. **6**
   (c) A shortwave ionospheric radio channel is characterized by a multipath spread of $T_m = 5$ ms and a Doppler spread of $B_d = 0{\cdot}1$ Hz. (i) Determine the coherence bandwidth and coherence time of the channel. (ii) A signal transmitter over this channel has a bandwith of W = 50 Hz and a time duration of $T \approx 1/W = 20$ ms. Is this a frequency non-selective channel ? Is the channel slowly fading ? Explain. **8**

2. (a) Discuss the characteristics of a band-limited channel. State and prove the Nyquist criterion for a band limited channel with zero ISI. **10**
   (b) (i) Justify the statement :"raised-cosine spectrum has desirable spectral properties and is widely used in practice". Sketch the raised-cosine pulse, x(t) and its frequency spectrum X(f) and define roll-off factor' and 'excess-bandwidth'. **6**
   (ii) Consider the transmission of data via PAM over a channel that has a bandwidth of 1500 Hz. Show how the symbol rate, varies as a function of the excess bandwidth, by determining the symbol rate for excess bandwidth of 25%, 33%, 50%, 67%, 75%, and 100%. **4**

3. (a) Consider a systematic block code whose Parity-check equations are :
   $p_1 = m_1 + m_2 + m_4$
   $p_2 = m_1 + m_3 + m_4$
   $p_3 = m_1 + m_2 + m_3$
   $p_4 = m_2 + m_3 + m_4$
   (i) Find the generator matrix and Parity check matrix for the code. **3**
   (ii) Find the min. distance of the code, error-detecting and error-correcting capabilities. **3**
   (iii) Are trhe vectors 10101010 and 01011100, valid codewords ? **4**
   (b) Consider the (15, 11) cyclic code generated by $g(x) = 1 + x + x^4$
   (i) Design an encoder and decoder for this code. **2**
   (ii) Using the above encoder, find the codeword for the message vector 11001101011 (right most bit is the earliest bit entering the encoder), by tracing the path of the bits through the shift register. **4**
   (iii) Considering the codeword generated in (ii) as the received code, r(x), illustrate the decoding procedure, using the decoder. **4**

4. (a) A convolutional code is described by— **12**
   $g_1 = [1\ 1\ 0]$; $g_2 = [1\ 0\ 1]$; $g_3 = [1\ 1\ 1]$
   (i) Draw the encoder and state diagram of the code.
   (ii) Find the transfer functi0n, T(D) of the code and the minimum free distance of the code.
   (iii) Assume that a msg has been encoded by this code and transmitted over a binary symmetric channel with an error probability of $p = 10^{-5}$. If the received sequence is r = (110 110 110 111 010 101 101). Use the Viterbi algorithm to find the transmitted bit sequence.
   (b) Explain the Viterbi algorithm for decoding convolutional code. **8**

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5. (a) What is Linear equalization ? Draw a neat sketch of linear transversal filter and explain its working. Explain briefly, the two criteria used widely in optimizing the equalizer coefficients. **8**

   (b) The transmission of a signal pulse with a raised-cosine spectrum through a channel results in the following (noise-free) sampled output from the demodulator : **12**

$$X_K = \begin{cases} -0{\cdot}5 & (k=-2) \\ 0{\cdot}1 & (k=-1) \\ 1 & (k=0) \\ -0{\cdot}2 & (k=+1) \\ 0{\cdot}05 & (k=2) \\ 0 & (\text{otherwise}) \end{cases}$$

   (i) Determine the tap-coefficients of a three-tap linear equalizer based on the zero forcing criterion.

   (ii) For the coefficients determine in (1), determine the ouput of the equalizer, for the case of the isolated pulse (q_K for $K = \pm 1, +2$), thus, determine the residual ISI and its span in time.

6. (a) Explain adaptive equalization, with a neat diagram. **10**

   (b) Draw a neat sketch of FHSS transmitter and receiver. How do you achieve synchronization in this scheme. **10**

7. (a) Write shorte notes on (any **three**) :— **15**

   (i) FFT-based multicarrier system
   (ii) Trellis coded Modulation
   (iii) Decision feedback equalizer
   (iv) Time synchronization in spread spectrum
   (v) Diversity techniques.

   (b) An M = 19 ML shift register is used to generate the PN sequence in a DS-SS system. The chip duration is $T_C = 1\ \mu s$ and the bit duration is $T_b = NT_C$, where N is the length of the 'M' sequence. **5**

   (i) Determine the processing gain (in dB) of the system

   (ii) Derermine the jamming margin if the required $(E_b/J_0) = 10$ and the Jammer is a tone Jammer with an average power, Jav.

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