Total No. of printed pages = 4

19/5th Sem/UECE503

2021

DIGITAL COMMUNICATION SYSTEMS AND STOCHASTIC PROCESS

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) State 'Sampling Theorem' for a band limited low-pass signal. What is meant by 'aperture effect' in flat-top sampling? 3+3=6

   (b) Show that the output quantization SNR in a binary PCM is given by $SNR|_{Q,dB} = 1.8+6\times n$; where 'n' is the number of bits in a code word. 10

   (c) Discuss briefly the operation of a binary PCM. 4

[Turn over

2. (a) Discuss the operation of a delta modulator. What are the two sources of noise in the delta modulator ? Discuss briefly. 6+2+2=10

(b) A DM transmitter with a fixed step size of 0.5 V is given a sinusoidal message signal. If the sampling frequency is twenty times the Nyquist rate, find

(i) the maximum permissible amplitude of the message signal avoiding slope-overload

(ii) the maximum destination SNR.

5+5=10

3. (a) Prove that a 1st order predictor in a DPCM is a unit-delay block. 5

(b) Show that the error probability for digital baseband signalling is given by $P_e = Q\left(\frac{d}{2}\right)$; where 'Q' is the Q-function given by $Q(k) = \frac{1}{\sqrt{2\pi}} \int_k^\infty e^{-x^2/2}\, dx$. 10

(c) Show that the signal 'p(t)' and the matched filter impulse response are mirror images of each other. 5

4. (a) A baseband binary system transmits the signal $s_1(t)$ for binary '1' and $s_2(t)$ for binary '0', where

$$S_1(t)=\begin{cases} A; & 0\le t\le T/2 \\ A/2; & T/2\le t\le T \\ 0, & \text{elsewhere} \end{cases}$$

and

$$S_2(t)=\begin{cases} A/2; & 0\le t\le T/2 \\ -A/2; & T/2\le t\le T \\ 0, & \text{elsewhere} \end{cases}$$

The channel may be assumed to be AWGN with noise PSD of '$N_0/2$' and the symbols are equi-probable. Find the energy of the two transmitted signals and hence find the average energy per bit. Also find the probability of bit error 'P_e'. 15

(b) Explain why polar signals are preferred over uni-polar signals for a given value of input SNR at the front end of a receiver. 5

5. (a) Show that the BER (average error probability) for a polar NRZ signal using matched filter technique is given by $P_e|_{Polar,NRZ} = Q\left[\sqrt{\frac{2E_b}{\eta}}\right]$; where the symbols have their usual meaning. 10

(b) If a signal '$x(t) = A \times \cos(\omega_0 t + \theta)$' is periodic with '$T_0$'; then prove that its auto-correlation '$R_{xx}(\tau)$' is also periodic with 'T_0'. 4

(c) White noise with 2-sided PSD of '$N_0/2$' passes through an ideal LPF with a bandwidth of 'W' Hz. Determine the output noise power. 6

6. Write short notes on any *two* of the following : 10×2=20

(a) Line codes for binary signal.

(b) PCM bandwidth.

(c) First order and second order (strict sense) stationary process.

(d) Matched filter.