Digital Communication VTU CBCS Question Paper Set 2018

USN | | | | | | | | | | |

10EC/TE61

Sixth Semester B.E. Degree Examination, June/July 2013

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the sampling theorem for low pass signals and derive the interpolation formula. **(09 Marks)**

b. With a neat block diagram, explain the scheme for signal reconstruction for practical sampling. **(06 Marks)**

c. Let E denote the energy of a strictly band limited signal g(t). Show that E may be expressed interms of the sample values of g(t), taken at the Nyquist rate as, $E = \frac{1}{2w}\sum_{n=-\infty}^{\infty}\left|g\left(\frac{n}{2w}\right)\right|^2$ where w is the highest frequency component of g(t). **(05 Marks)**

2 a. Derive the expression for signal to quantization noise ratio (SNR) and show that for uniform quantization, each bit in the codeword of a PCM contributes 6 dB to SNR. **(08 Marks)**

b. Six independent message sources of bandwidths w, w, 2w, 2w, 3w and 3w hertz are to be transmitted on TDM. Set up a scheme to accomplish this requirement, with each message signal sampled at its Nyquist rate. **(05 Marks)**

c. The signal m(t) = 6 sin (2πt) Volts, is transmitted using 4-bit binary PCM system. The quantizer is of midriser type with a step size of 1 Volt. The sampling frequency is 4 Hz with samples taken at $t = \pm\frac{1}{8}, \pm\frac{3}{8}, \pm\frac{5}{8}, \ldots$ sec. Sketch the PCM wave for one complete cycle of the input. **(07 Marks)**

3 a. With a neat block diagram, explain the delta modulation system and illustrate its quantization error. **(08 Marks)**

b. Derive the expression for power spectral density of NRZ bipolar format. **(07 Marks)**

c. Explain T_1 carrier system with its compounding characteristics. **(05 Marks)**

4 a. Explain the Nyquist criterion for distortionless baseband binary transmission and obtain the ideal solution for zero ISI. **(08 Marks)**

b. For a binary sequence 10110001, construct (i) RZ polar format, (ii) Manchester format. **(04 Marks)**

c. The binary data 011100101 is applied to the input of a modified duobinary system.

i) Construct the modified duobinary coder output and receiver output with a precoder.

ii) Due to transmission error, the level produced by the third digit is zero, construct the new receiver output. **(08 Marks)**

PART – B

5 a. Obtain the expression for probability of symbol error of coherent binary FSK. **(09 Marks)**

b. Compare the probability of symbol errors for basic digital modulation formats and explain how the probability of error depends on the distance between the message points in signal space diagram. **(04 Marks)**

c. With a neat block diagram, explain the differential phase shift keying. Illustrate the generation of differentially encoded sequence for the binary data 1100100010. **(07 Marks)**

6 a. With the conceptualized model of a digital communication system, explain the Gram-Schmidt orthogonalization procedure. **(10 Marks)**

b. Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ shown in Fig.Q6(b). Express each of these signals in terms of the set of basis functions. **(10 Marks)**

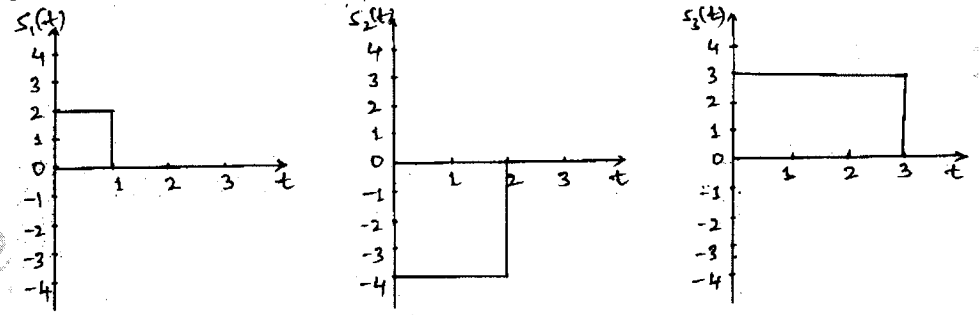


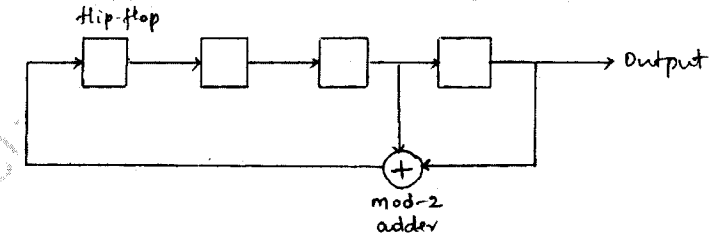
Fig.Q6(b)

7 a. Explain the maximum likelihood detection process and obtain the decision rule. **(10 Marks)**

b. Derive the impulse response of a matched filter receiver and explain any two properties of matched filter. **(10 Marks)**

8 a. Explain frequency hoop spread m-ary frequency shift keying with a neat block diagram and illustrate the slow frequency hopping. **(08 Marks)**

b. Find the output sequence of the shift register shown in Fig.Q8(b). The initial state of the register is 1000. Demonstrate the balance property and run property of a PN sequence. Calculate and plot the autocorrelation function of the PN sequence. **(07 Marks)**



c. In a DS/BPSK system, the feedback shift register used to generate the PN sequence has length m = 19. The system is required to have a probability of error due to externally generated interfering signals that doesn't excess 10^{-5}. Calculate the processing gain and antijam margin in decibels. Use erf(3) = 0.99998. **(05 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, June/July 2014

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain natural sampling with relevant waveforms. Give all the necessary time-domain and frequency-domain equations. **(10 Marks)**

b. What is aliasing error? Give two corrective measures to remove the effect of aliasing in practice. **(04 Marks)**

c. Consider the analog signal $x(t) = 5\cos(2000\pi t) + 10\cos(6000\pi t)$.

i) What is the Nyquist rate and Nyquist interval?

ii) Assume that if we sample the signal using sampling frequency $f_s = 5000$ Hz, what is the resulting discrete time signal obtained after sampling?

iii) Draw the spectrum of the sampled signal. **(06 Marks)**

2 a. Explain regenerative repeater in a PCM system with a block diagram. **(05 Marks)**

b. The bandwidth of a signal is 3.4 kHz. If this signal is converted to PCM bit stream with 1024 levels, determine the number of bits per second (bps) generated by the PCM system. Assume that the signal is sampled at the rate of 20% above the Nyquist rate. **(06 Marks)**

c. Derive an expression for the output SNR of a uniform quantizer in terms of step size of the quantizer. Hence show that for mid-tread type uniform quantizer the SNR is $(SNR)_{output} = 6n - 7.2$ dB, where 'n' is the number of bits per sample. Assume a loading factor of 4. **(09 Marks)**

3 a. Explain with block diagrams DPCM transmitter and receiver. **(09 Marks)**

b. Explain briefly the basic optical fiber link used for the transmission of digital data. **(06 Marks)**

c. Show that for the bipolar format, the autocorrelation function $R_a(n)$, that is $E[A_K A_{K-n}]$ is zero for $n > 1$, where A_K is the K^{th} random variable representing K^{th} bit of the input binary sequence. Assume statistically independent and equally likely message bits. **(05 Marks)**

4 a. Explain raised cosine spectrum solution to reduce ISI. **(10 Marks)**

b. The binary data 001101001 are applied to the input of the duobinary system.

i) Construct the duobinary coder output and the corresponding receiver output without a precoder.

ii) Suppose that due to error during transmission, the level at the receiver input produced by the second digit is reduced to zero. Construct the new receiver output. **(10 Marks)**

PART – B

5 a. Explain the generation and demodulation of DPSK wave with block diagrams. **(08 Marks)**

b. Binary data are transmitted over a microwave link at the rate of 10^6 bps and the PSD of the noise at the receiver input is 10^{-10} Watts per hertz. Find the average carrier power required to maintain an average probability of error $Pe \leq 10^{-4}$ for coherent binary FSK. What is the required channel band width? (Take $erfc(2.7) = 2 \times 10^{-4}$) **(06 Marks)**

c. Explain briefly phase tree and phase Trellis in MSK. **(06 Marks)**

6 a. What is a signal vector? Show that the energy of a signal is equal to the squared length of the signal vector representing it. **(08 Marks)**

b. Explain the Gram-Schmidt orthogonalization procedure to obtain the orthonormal basis functions for the linearly independent set of signals. **(12 Marks)**

7 a. Show that the output SNR of a metched filter is proportional to the ratio of the signal energy to the PSD of input noise. **(06 Marks)**

b. Explain the noncoherent quadrature receiver using correlators. **(06 Marks)**

c. Consider the signal s(t) as shown in the Fig.Q7(c). Determine the impulse response of the filter matched to s(t). Plot the impulse response and matched filter output as a function of time.

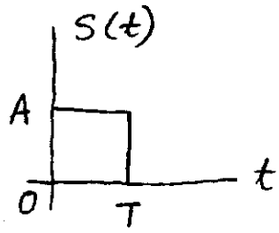

Fig.Q7(c) **(08 Marks)**

8 a. Define processing gain and jamming margin. **(04 Marks)**

b. What is the role of PN sequence in spread spectrum communication? For the given PN sequence 0011101 verify the properties of it. **(08 Marks)**

c. Discuss briefly the applications of spread spectrum technique to (i) CDMA, (ii) Multipath suppression. **(08 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, June/July 2015
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. State sampling theorem. Write the equations for the spectrum of finite energy g(t) sampled at 1/2W sec. and g(f), if W is the highest frequency content of g(t). Sketch g(f) and sampled signal $g_s(f)$. **(08 Marks)**

b. The signal $g(t) = 10 \cos(20\pi t) \cos(200\pi t)$ is sampled at the rate of 250 samples per second.
   i) Determine the spectrum of the resulting sampled signal.
   ii) Specify the cutoff frequency of the ideal reconstruction filter so as to recover g(t) from its sampled version.
   iii) What is Nyquist rate for g(t). **(04 Marks)**

c. Explain how practical sampling is different from ideal sampling. Derive an expression for the flat top sampled signal. **(08 Marks)**

2 a. Derive an expression for output SNR of the quantizer and show that $(SNR)_0 = 6u - 7.2$ in decibels if a sinusoidal signal is quantized. **(08 Marks)**

b. Explain the need for non-uniform quantization. Also explain μ-law and A-law companding. **(07 Marks)**

c. A signal $M_1(t)$ is band limited to 3.6kHz and three other signals $M_2(t)$, $M_3(t)$ and $M_4(t)$ are band limited to 1.2 kHz. These signals are to be transmitted by means of TDM.
   i) Set up a scheme for realizing this multiplexing requirement, with each sampled signal at its Nyquist rate
   ii) What must be the speed of the commutator in samples/sec?
   iii) Determine the minimum bandwidth of the channel. **(05 Marks)**

3 a. For the given binary sequence 101000110101, draw the digital format waveform corresponding to i) ON-OFF signaling; ii) RZ bipolar signaling; iii) Manchester code; iv) NRZ polar signaling; v) NRZ bipolar signaling. **(05 Marks)**

b. What is the differences between PCM and DPCM? Briefly explain the operation of DPCM system with neat block diagram along with relevant expressions. **(08 Marks)**

c. Derive an expression for power spectral density of bipolar NRZ format and plot the same with respect to frequency. **(07 Marks)**

4 a. Explain the following terms with related equations and diagram with respect to baseband data transmission: i) ISI ii) Raised cosine spectrum. **(10 Marks)**

b. Draw and explain modified duo binary techniques. Specify how the error propagation is eliminated. **(07 Marks)**

c. A multilevel digital communication system transmits one of the sixteen possible levels over the channel every 0.8 μs.
   i) What is the minimum number of bits corresponding to each level?
   ii) What is baud rate?
   iii) What is bit rate? **(03 Marks)**

PART – B

5 a. Draw the block diagram for QPSK transmitter and receiver. From the basic principles prove that BER for QPSK is $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_o}}\right)$. **(10 Marks)**

b. Explain in detail along with the block diagram a coherent FSK tansmitter and receiver. **(06 Marks)**

c. The data transferred in PSK is with data rate of 1Mbps. It is desired to have $P_e \leq 10^{-4}$ with PSD at 10^{-12} N/Hz. Determine average carrier power required at the receiver input if the detector is coherent. erfc(3.5) = 0.002. **(04 Marks)**

6 a. With a conceptualized model of digital communication system, explain Gram-Schmidt orthogonalization procedure. **(10 Marks)**

b. Three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ are as shown in Fig.Q.6(b) below. Apply Gram-Schmidt procedure to obtain an orthonormal basis for signals. Express the signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ in terms of orthonormal basis function. Also give the signal constellation diagram. **(10 Marks)**

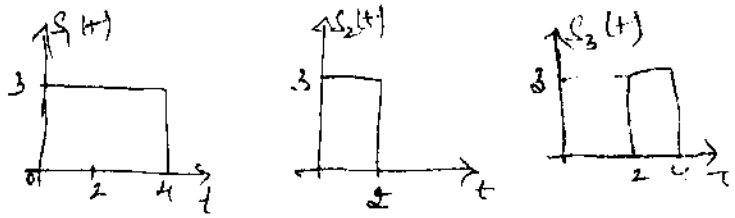

Fig.Q.6(b)

7 a. Explain the properties of matched filter. **(10 Marks)**

b. Consider a signal s(t) defined by,

$s(t) = \begin{cases} 1 & ; \ 0 \leq t \leq T \\ 0 & ; \ \text{elsewhere} \end{cases}$. It is proposed to approximate the matched filter for this signal by a lowpass RC filter defined by the transfer function $H(f) = \frac{1}{1 + j(f/f_o)}$, where $f_o = \frac{1}{2\pi RC}$ is the cutoff frequency of RC filter.

i) Determine optimum value of f_o for which the RC filter becomes the best approximation for matched filter.

ii) Determine the peak o/p signal to noise ratio assuming noise is AWG of zero mean and power density $N_o/2$.

iii) Determine by how many decibels the transmitted energy be increased so that the performance becomes same as that of perfectly matched filter. **(10 Marks)**

8 a. Explain the properties of maximum length sequence for a sequence generated from 3-voltage shift register with linear feedback. Verify these properties for the PN sequence 01011100101110 and also determine the period of the given PN sequence. **(08 Marks)**

b. Explain the principle of direct sequence spread spectrum system. **(05 Marks)**

c. Explain with neat block diagram the working of frequency hop transmitter and receiver. **(07 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, June/July 2016

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain sampling theorem of low pass signals and derive the interpolation formula. **(08 Marks)**

b. A low pass signal x(t) has spectrum X(f) given by,

$$X(f) = \begin{cases} 1 - \frac{|f|}{200}; & |f| < 200 \\ 0 & \text{Elsewhere} \end{cases}$$

Sketch the spectrum $X_\delta(f)$ for $|f| < 200$ Hz if x(t) is ideally sampled at $f_s = 300$ Hz. **(06 Marks)**

c. A band pass signal g(t) with a spectrum shown in Fig.Q1(c) is ideally sampled. Sketch the spectrum of sampled signal at $f_s = 25$ Hz and $f_s = 45$ Hz. Indicate if and how the signal can be recovered.

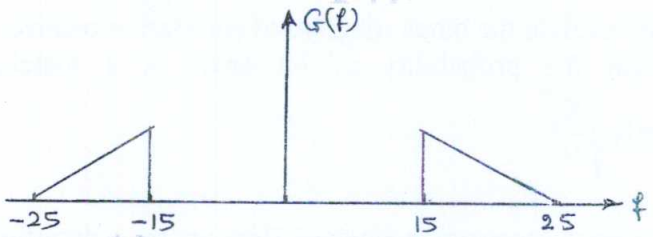

Fig.Q1(c) **(06 Marks)**

2 a. Derive the expression for signal to quantization noise ratio (SNR) and show that for uniform quantization, each bit in the codeword of a PCM contributes 6 dB to SNR. **(08 Marks)**

b. For a binary PCM signal, determine L if the compression parameter $\mu = 100$ and the minimum $[SNR]_0$ dB = 45 dB. Determine the $[SNR]_0$ dB with this value of L. **(06 Marks)**

c. With a neat block diagram and waveform, explain time division multiplexing. **(06 Marks)**

3 a. Explain the principles of delta modulator. With relevant figure and mathematical expressions, explain the functioning of DM transmitter and receiver. **(08 Marks)**

b. For a binary sequence 111000110101 draw the digital format waveforms corresponding to:
i) Bipolar NRZ waveform and ii) 8-ary signaling waveform. **(06 Marks)**

c. Derive an expression for power spectral density of bipolar NRZ format and plot the same with respect to frequency. **(06 Marks)**

4 a. What is correlative coding? Explain duo binary coding with and without precoding. **(08 Marks)**

b. The binary data 011100101 are applied to the input of a modified duo binary system:
i) Construct the modified duo binary coder output and corresponding receiver output without a precoder.
ii) Suppose that due to error in transmission, the level produced by the third digit is reduced to zero. Construct a new receiver output. **(07 Marks)**

c. With a neat block diagram, explain the concept of adaptive equalization. **(05 Marks)**

PART – B

5 a. With neat block diagram, explain DPSK transmitter and receiver. Illustrate the generation of differentially encoded sequence for the binary input sequence 00100110011110. **(12 Marks)**

b. A binary data is transmitted over an AWGN channel using binary phase shift keying at the rate of 1 Mbps. It is desired to have average probability of error $P_e \leq 10^{-4}$. Noise power spectral density is $N_{0/2} = 10^{-12}$ W/Hz. Determine the average carrier power required at the receiver input, if the detector is of coherent type. Take erfc(3.5) = 0.00025. **(08 Marks)**

6 a. Write a note on Gram-Schmidt orthogonalization procedure. **(08 Marks)**

b. Consider the signal $s_1(t)$, $s_2(t)$, $s_3(t)$ and $s_4(t)$ as given below in Fig.Q6(b).

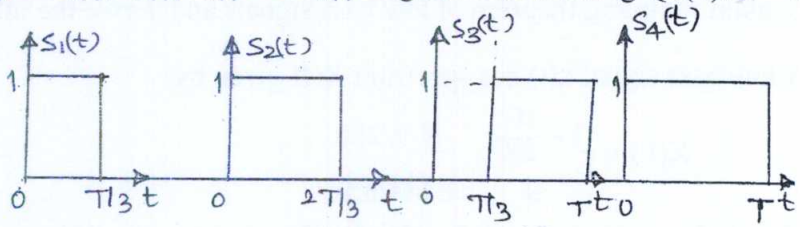

Fig.Q6(b)

Find an orthonormal basis for these set of signals using Gram-Schmidt orthogonalization procedure. **(12 Marks)**

7 a. Draw and explain the block diagram of correlation receiver. **(08 Marks)**

b. Show that the probability of bit error of a matched filter receiver is given by $P_e = \frac{1}{2}\text{erfc}\sqrt{\frac{E_b}{N_o}}$. **(12 Marks)**

8 a. What is spread spectrum technique? How are they classified? **(08 Marks)**

b. Explain properties of PN sequence. **(06 Marks)**

c. A slow FH/MFSK system has the following parameters:
The number of bits/MFSK symbol = 4
The number of MFSK symbols per hop = 6
Calculate processing gain of the system. **(06 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, June/July 2017

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What are the merits and demerits of digital communication? **(06 Marks)**

b. Find the Nyquist rate for the signal $g(t) = \cos^2 400\pi t \cos 1000\pi t$. Plot the spectrum of the signal for n = 0, 1 considering the sampling rate of 1400. **(08 Marks)**

c. Derive the time domain and frequency domain expressions for natural samples. Draw the spectrum of sampled signal. **(06 Marks)**

2 a. What is TDM? Draw the block diagram of TDM and explain its working with waveform. **(08 Marks)**

b. Derive the signal to quantization noise ratio expression for PCM system. Considering midtread uniform quantization, show that $(SNR)_{QdB} = 6n - 7.2$. **(08 Marks)**

c. A telephone signal with cutoff frequency of 4kHz is digitized into 8 bit PCM, sampled at Nyquist rate. Calculate transmission BW and SNR_Q. Assume mid raiser quantization with normalized signal power. **(04 Marks)**

3 a. With neat block diagram, explain the working of DPCM transmitter and receiver. **(08 Marks)**

b. For the binary data 10110010, give the following binary data formats:
i) Polar format (NRZ)
ii) Bipolar format (NRZ)
iii) Manchester format
iv) Differential encoding **(04 Marks)**

c. Derive the power spectral density expression for NRZ bipolar format and draw the PSD curve. **(08 Marks)**

4 a. Define ISI and explain how it arises. **(06 Marks)**

b. The binary data 011100101 is applied to the input of a modified duobinary system. Construct the modified duobinary coder output and corresponding receiver output without a precoder. **(10 Marks)**

c. What do you mean by equalization? Give the structure of tapped delay line filter and briefly explain how it acts as equalizer. **(04 Marks)**

PART – B

5 a. Derive the expression for probability of bit error considering coherent binary frequency shift keying (FSK) signal. **(12 Marks)**

b. What is the difference between BPSK and DPSK? Given the binary data 10010011 draw BPSK and DPSK waveforms. **(08 Marks)**

6 a. What is Gram Schmidt orthogonalization procedure? Explain briefly. **(06 Marks)**

b. Show that it is possible to construct a set of N orthonormal basis functions from linearly independent signals. **(08 Marks)**

c. What is signal space diagram? Obtain the signal space diagram of QPSK by indicating the signals and basic functions. **(06 Marks)**

7 a. What is maximum likelyhood detector? Explain how the decision is made in detecting the signal in ML detector. **(06 Marks)**

b. State the properties of matched filter and prove any two properties. **(09 Marks)**

c. Explain in brief about correlation receiver. **(05 Marks)**

8 a. What are the advantages of spread spectrum communication? Mention types of SSS. **(05 Marks)**

b. Test all three properties of ML sequence after generating PN sequence for a 3 stage feedback shift register. (Assume 100 as initial state) **(10 Marks)**

c. Define processing gain and jamming margin. What is the relationship between them? **(05 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, Dec.2013/Jan.2014

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. With a block diagram, explain the generation and reconstruction of quadrature sampling of band pass signal. **(08 Marks)**

b. The signal $g(t) = 4\cos(4\pi t)\cos(400\pi t)$ is sampled at the rate of 500 sample/sec.
i) Determine the spectrum of the resulting sampled signal.
ii) What is the Nyquist rate for g(t)?
iii) What is the cut-off frequency of ideal reconstruction filter? **(08 Marks)**

c. List the advantages of digital communication over analog communication. **(04 Marks)**

2 a. Derive an expression for output SNR of the quantizer and show that $(SNR)_0 = 1.8 + 6n$ in decibels if a sinusoidal signal is quantized. **(08 Marks)**

b. For a binary PCM signal, determine 'L' if the compression parameter $\mu = 100$ and the minimum $[SNR]_{0,dB} = 45$ dB. Determine the $[SNR]_{0,dB}$ with this value of L. **(04 Marks)**

c. What is the necessity of non-uniform quantization? Explain two compounding methods used in practice. **(08 Marks)**

3 a. What is slope overload distortion and granular noise in delta modulation and how it can be reduced? **(08 Marks)**

b. A binary data sequence is 0110011.... Sketch the waveform for the following formats:
i) NRZ unipolar
ii) RZ polar
iii) NRZ bipolar **(06 Marks)**

c. Obtain an expression for power spectral density of NRZ polar waveform. **(06 Marks)**

4 a. What is ISI? Derive an expression for Nyquist pulse shaping criterion for distortionless baseband binary transmission. **(08 Marks)**

b. Discuss the performance of the data transmission using eye pattern. **(06 Marks)**

c. What is the necessity of equalization in digital transmission? What is adaptive equalization? **(06 Marks)**

PART – B

5 a. Derive an expression for the average probability of symbol error of coherent binary FSK system. **(10 Marks)**

b. With a block diagram, explain noncoherent differential phase shift keying transmitter and receiver and give that the average probability of error for DPSK is $P_e = \frac{1}{2}\exp\left(-\frac{E_b}{N_o}\right)$. **(10 Marks)**

6 a. Write a short note on Gram-Schmidt orthogonalization. **(06 Marks)**

b. Three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ are as shown in Fig.Q6(b). Apply Gram-Schmidt orthogonalization to obtain orthonormal basis functions for signals. Express the signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ in terms of orthonormal basis functions.

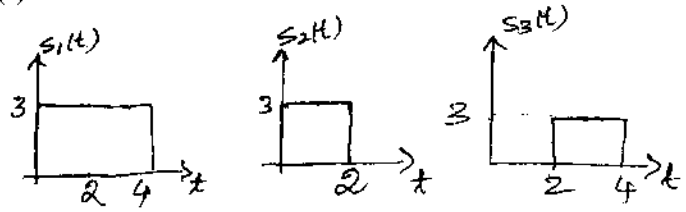

Fig.Q6(b) **(06 Marks)**

c. With necessary illustration, explain the geometric representation of signals for the case when N = 2 and M = 3. **(08 Marks)**

7 a. Show that the probability of bit error of a matched filter is given by $P_e = \frac{1}{2}\text{erfc}\sqrt{\frac{E_b}{N_o}}$. **(08 Marks)**

b. Write a note on correlation receivers. **(08 Marks)**

c. A binary data is transmitted using ASK. Over a AWGN channel at a rate of 2.4 Mbps. The carrier amplitude at the receiver is 1 mV. The noise spectral density $\frac{N_o}{r} = 10^{-15}$ Watt/Hz. Find average probability of error if the detection is coherent (where erfc(5) = 3×10^{-6}). **(04 Marks)**

8 a. What is spread spectrum? Explain the principle of direct sequence spread spectrum system. **(08 Marks)**

b. The direct sequence spread spectrum communication system has following parameters:

Data sequence bit duration, $T_b = 4.095$ ms

Pin chip duration, $T_c = 1$ μs

$\frac{E_b}{N_o} = 10$ for average probability of error less than 10^{-5}.

Calculate processing gain and jamming margin. **(04 Marks)**

c. Explain the principle of slow frequency hopping, and list advantages and disadvantages of FH-SS system. **(08 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the quadrature sampling of band pass signal with related block diagram, spectra and equations. **(06 Marks)**

b. A low pass signal has the spectrum given by,

$$G(f) = \begin{cases} 1-|f|, & |f|<1 \\ 0, & |f|>1 \end{cases}$$

Assume that g(t) is sampled at 1.5 Hz and then applied to a low pass reconstruction filter with cut off frequency at 1 Hz. Plot the spectrum of the resulting signal. **(06 Marks)**

c. What is flat top sampling? Derive an expression for the flat top sampled signal. **(08 Marks)**

2 a. A PCM system uses a uniform quantizer followed by n-bit encoder. Show that rms signal to quantization noise ratio is approximately given by SNR = 1.8 + 6n dB. Assume that input to PCM system is a sinusoidal signal. **(06 Marks)**

b. The output signal to noise ratio of a 10 bit PCM was found to be 30 dB, the desired SNR is 42 dB. To increase the SNR to desired value by increasing the number of quantization levels. Find the fractional increase in transmission band width required for this increase in SNR. **(06 Marks)**

c. What is the necessity of non uniform quantization and explain companding? **(08 Marks)**

3 a. Explain differential pulse code modulation transmitter and receiver with relevant equations and show that the quantized version of the signal is sum of original sample value and quantization error. **(06 Marks)**

b. With reference to delta modulation system shown in Fig. Q3 (b), show that the optimum step size $K_{opt} = \frac{2\pi A}{(f_s/f_m)}$

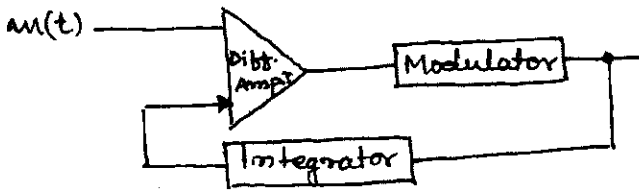

Fig. Q3 (b)

where A is amplitude of sine wave m(t), f_s is sampling frequency and f_m is the frequency of sine wave.

For K = 4 mV and K = 60 mV, does the slope overload occurs? If so in which case? Given $m(t) = 0.1\sin(2\pi \times 10^3 t)$ **(08 Marks)**

c. For a given binary sequence 0 1 0 1 1 1 0 0 1 0 1 1, draw the digital format waveform corresponding to ,

i) Split phase manchester coding waveform.
ii) Bipolar NRZ waveform and
iii) 8- ary signalling waveform. **(06 Marks)**

4 a. What is ISI? Derive an expression for Nyquist pulse shaping criterion for distortionless base band binary transmission. **(06 Marks)**

b. What is correlative coding? Explain duobinary coding with and without precoding. **(06 Marks)**

c. The binary data 0 1 1 1 0 0 1 0 1 are applied to the input of a modified duo binary system.
i) Construct the modified duo binary coder output without precoder.
ii) Suppose that due to error in transmission, the level produced by the third digit is reduced to zero. Construct a new receiver output. **(08 Marks)**

PART – B

5 a. With neat block diagram, explain the DPSK transmitter and receiver. **(10 Marks)**

b. For the binary sequence 0 1 1 0 1 0 0 0 explain the signal space diagram for coherent QPSK system. **(04 Marks)**

c. Derive an expression for probability of error for coherent binary PSK system. **(06 Marks)**

6 a. With block diagram, explain the principle of detection and estimation. **(06 Marks)**

b. Suppose $S_1(t)$, $S_2(t)$ and $S_3(t)$ are represented with reference to two basis functions $\phi_1(t)$ and $\phi_2(t)$. The co-ordinates of these signals are,

$S_1 = (S_{11}, S_{12}) = (3, 0)$

$S_2 = (S_{21}, S_{22}) = (-2, 3)$

$S_3 = (S_{31}, S_{32}) = (-3, -3)$

Draw the constellation diagram and express $S_1(t)$, $S_2(t)$ and $S_3(t)$ as linear combination of the basis functions. **(06 Marks)**

c. Consider the signal $S_1(t)$, $S_2(t)$, $S_3(t)$ and $S_4(t)$ as given below:

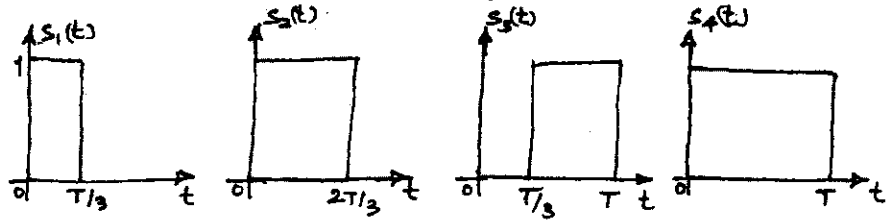

Fig. Q6 (c)

Find an orthonormal basis function for these set of signal using Gram-Schmidt orthogonalization procedure. **(08 Marks)**

7 a. Explain the function of correlation receiver. **(06 Marks)**

b. Show that the probability of bit error of a matched filter receiver is given by $Pe = \frac{1}{2}\text{erfc}\sqrt{\frac{E_b}{N_o}}$. **(08 Marks)**

c. A binary data is transmitted using ASK over a AWGN channel at a rate of 2.4 Mbps. The carrier amplitude at the receiver is 1mV. The noise power spectral density, $\frac{N_0}{2} = 10^{-15}$ watt/Hz. Find the average probability of error if the detection is coherent. Take $\text{erfc}(5) = 3 \times 10^{-6}$. **(06 Marks)**

8 a. Explain the working of direct sequence spread spectrum transmitter and receiver. **(08 Marks)**

b. Explain properties of PN sequence. **(06 Marks)**

c. Distinguish between slow frequency hopping and fast frequency hopping. **(06 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. With neat sketches explain flat top sampling. **(07 Marks)**

b. What is Aperture effect? Explain how it can be compensated. **(05 Marks)**

c. A signal $g(t) = 10\cos(20\pi t)\cos(200\pi t)$ is sampled at the rate of 250 samples/sec.
i) Sketch spectrum of sampled signal.
ii) Specify the cutoff of ideal reconstruction filter so as to recover g(t) from $g_\delta(t)$. **(08 Marks)**

2 a. Explain the block diagram of regenerative repeater. **(05 Marks)**

b. A PCM system uses a uniform quantizer followed by a v bit encoder. Show that rms signal to quantization noise ratio is approximately given by $(1.8 + 6v)$ db. **(06 Marks)**

c. With neat sketch explain companding in PCM. Also explain μ-law and A-law companding. **(09 Marks)**

3 a. Explain the following with neat sketch:
i) Slope overload distortion.
ii) Granular noise. **(05 Marks)**

b. A delta modulator is designed to operate at five times the Nyquist rate for a signal with 3 kHz bandwidth. Determine the maximum amplitude of a 2 kHz I/P sinusoid for which delta modulator does not have slope overload. Quantizing step size is 250 mV. **(05 Marks)**

c. For the binary bit stream 10011011 draw the waveforms for the following cases:
i) Polar NRZ ii) Manchester RZ iii) Gray code NRZ **(05 Marks)**

d. With neat sketch explain power spectra of discrete PAM signals. **(05 Marks)**

4 a. What is ISI? Derive an expression for Nyquist pulse shaping criterion for distortionless base band binary transmission. **(06 Marks)**

b. What is correlative coding? Explain duobinary coding with and without precoding. **(06 Marks)**

c. The binary data 011100101 are applied to the I/P of a modified duo binary system.
i) Construct modified duo binary coder O/P without precoder.
ii) Suppose that due to error in transmission, the level produced by the third digit is reduced to zero. Construct a new receiver output. **(08 Marks)**

PART – B

5 a. With neat block diagram, explain the DPSK transmitter and receiver. **(08 Marks)**

b. Obtain the expression for probability of symbol error of coherent binary FSK. **(07 Marks)**

c. Binary data are transmitted over a microwave link at the rate of 10^6 bps and the PSD of the noise at the receiver input is 10^{-10} W/Hz. Find the average carrier power required to maintain an average prob. of error $P_e \leq 10^{-4}$ for coherent binary FSK. What is the required channel B.W? (Take erfc (3.71) = 10^{-4}) **(05 Marks)**

6 a. Explain the Gram Schmidt orthogonalization procedure to obtain the orthonormal basis function for linearly independent set of signals. **(12 Marks)**

b. Three signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ are as shown in Fig. Q6 (b). Apply Gram Schmidt procedure to obtain an orthonormal basis for the signals. Express the signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ in terms of orthonormal basis functions. Also give signal constellation diagram. **(08 Marks)**

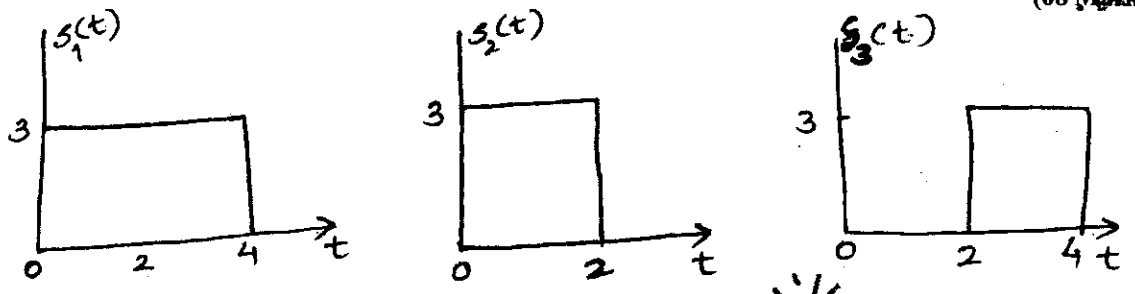

Fig. Q6 (b)

7 a. Show that the output SNR of a matched filter is proportional to ratio of signal energy to PSD of input noise. **(06 Marks)**

b. Explain the function of correlation receiver. **(06 Marks)**

c. Determine the impulse response of matched filter. **(08 Marks)**

8 a. Explain properties of PN sequence (max length sequence). **(06 Marks)**

b. Explain the working of direct sequence spread spectrum transmitter and receiver with BPSK. **(08 Marks)**

c. The direct sequence spread spectrum communication system has following parameters:
Data sequence bit duration $T_b = 4.095$ ms, PN chip duration $T_C = 1$ μs.
$\frac{E_b}{N_0} = 10$ for average probability of error less than 10^{-5}.
Calculate processing gain and jamming margin. Also find jamming margin in db. **(06 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State and prove sampling theorem for low pass signals assuming train of impulses for sampling. **(08 Marks)**

b. Explain the principle of quadrature sampling of band pass signals. **(06 Marks)**

c. The signal $g(t) = 4\cos(4\pi t)(\cos 400\pi t)$ is sampled at the rate of 500 samples per second:
i) Determine the spectrum of the resulting sampled signal.
ii) What is Nyquist rate for g(t)?
iii) What is cut off frequency of ideal reconstruction filter? **(06 Marks)**

2 a. With a suitable block diagram, explain the functioning of PCM system. **(10 Marks)**

b. Three independent message source of bandwidths 1 kHz, 1 kHz and 2 kHz respectively are to be transmitted using TDM scheme. Determine
i) The commutator segment arrangement.
ii) The speed of commutator if each signal is sampled at its Nyquist rate.
iii) Minimum transmission bandwidth. **(05 Marks)**

c. The bandwidth of signal input to PCM is restricted to 4 kHz. The input varies from −3.8 to 3.8 V and has average power of 30 mW. The required signal to noise ratio is 20 dB. The modulator produces binary output. Assume uniform quantization
i) Calculate the number of bits required per sample.
ii) Output of 30 such PCM coders are time multiplexed. What is the minimum required transmission bandwidth for multiplexed signal? **(05 Marks)**

3 a. With neat diagram, explain the operation of DPCM. **(06 Marks)**

b. Derive the expression for output signal to quantization noise ratio of a delta modulator. **(10 Marks)**

c. Assume a speech signal with a minimum frequency of 3.4 kHz and a maximum amplitude of 1 V. The speech signal is applied to a delta modulator with its bit rate at 25 kbps. Discuss the choise of an appropriate step size for a delta modulator. **(04 Marks)**

4 a. Describe Nyquist criteria for distortionless baseband transmission. **(06 Marks)**

b. A binary data sequence is 10110100. Sketch the waveforms for the following formats:
(i) Unipolar NRZ (ii) Unipolar RZ (iii) Polar NRZ (iv) Polar RZ
(v) Manchester coding (vi) Bipolar NRZ. **(06 Marks)**

c. With a neat structure explain concept of adaptive equalization process. **(08 Marks)**

PART – B

5 a. Show that probability of symbol error for frequency shift keying is $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{\varepsilon_b}{2N_0}}\right)$. **(12 Marks)**

b. With a block diagram of QPSK transmitter and receiver explain generation and demodulation of a QPSK wave. **(08 Marks)**

6 a. Explain the importance of geometric interpretation of signals. Illustrate the geometric interpretation of signals for the case of 2-dimensional signal space with 3 signals. **(08 Marks)**

b. Three signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ are as shown. Apply Gram-Schmidt procedure to obtain an orthonormal basis for the signals. Express the signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ in terms of orthonormal basis functions. Also give the signal constellation diagram. **(12 Marks)**

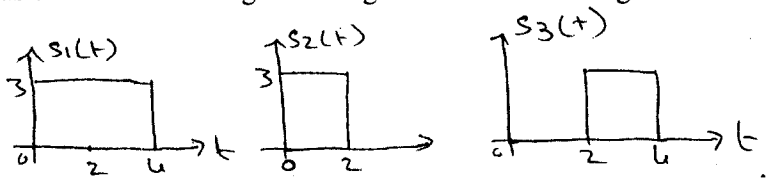

Fig. Q6 (b)

7 a. Derive the expression for maximum signal to noise power ratio of a matched filter. **(12 Marks)**

b. Explain the working of a correlation receiver with block diagram of a detector and vector receiver. **(08 Marks)**

8 a. Explain direct sequence spread spectrum technique with block diagram. **(08 Marks)**

b. Differentiate slow frequency hopping and fast frequency hopping. **(05 Marks)**

c. A 3-stage shift register with a linear feedback generates the sequence : 01011100101110

i) Determine the period of the given infinite sequence.

ii) Verify the three properties of the PN sequence for the given sequence. **(07 Marks)**

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10EC/TE61

Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018

Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State and prove sampling theorem of low pass signal. Draw the diagrams of G(f) and sampled signal $G_\delta(f)$. Derive interpolation formula for reconstruction of original signal. **(12 Marks)**

b. A signal $g(t) = 2\cos(400\pi t) + 6\cos(640\pi t)$ is ideally sampled at 500 Hz. If the sampled signal pass through an ideal LPF with a cutoff frequency of 400 Hz, what components will appear in the filter output? **(06 Marks)**

c. What is 'aperture effect'? How is it eliminated? **(02 Marks)**

2 a. Derive an expression for maximum signal to quantization noise ratio for PCM system that employs linear quantization technique. Show that normalized signal quantization noise ratio in dB is given by $(SNR)_{dB} = 4.8 + 6N$. **(08 Marks)**

b. Explain the need for non-uniform quantization. Also explain μ-law and A-law companding. **(08 Marks)**

c. Three independent message sources of bandwidth 1 kHz, 1 kHz, 2 kHz respectively are to be transmitted using TDM scheme. Determine the speed of commutator if each signal is sampled at Nyquist rate. Also find minimum transmission band width. **(04 Marks)**

3 a. With neat diagrams, explain the operation of Delta modulation. Mention the drawbacks of delta modulation. **(08 Marks)**

b. For the binary bit sequence 1001001 draw the waveforms using:
i) Unipolar NRZ ii) Unipolar RZ
iii) Bipolar NRZ iv) Manchester coding waveform. **(04 Marks)**

c. Obtain power spectral density of NRZ unipolar format and draw its normalized PSD. **(08 Marks)**

4 a. Describe Nyquist's criteria for distortionless baseband transmission. **(06 Marks)**

b. Define ISI. Write a brief note on eye pattern. **(08 Marks)**

c. Explain briefly the need for a precoder in a duo binary signaling. For the binary sequence 001101001, obtain precoded sequence, duobinary encoder output and recovered output. **(06 Marks)**

PART – B

5 a. Derive an expression for probability of error 'Pe' of a coherent binary ASK. **(10 Marks)**

b. A binary FSK system transmits data at a rate of 2 Mbps over an AWGN channel. The noise is zero mean with PSD, $\frac{NO}{2} = 10^{-20}$ W/Hz. The amplitude of received signal in the absence of noise is 1 μv. Determine the average probability of error for coherent detection of FSK. Take $\text{erfc}\sqrt{6.25} = 0.00041$. **(06 Marks)**

c. A binary data stream 101101 is to be transmitted using DPSK. Determine the encoded and decoded output. **(04 Marks)**

6 a. With a diagram, explain the model of digital communication system. **(06 Marks)**

b. What do you mean by an optimum receiver with reference to a digital modulation scheme? Write the scheme of a correlation receiver and describe its feature. **(08 Marks)**

c. Find the output of the matched filter and determine the maximum SNR at output if the input S(1) is a rectangular pulse of amplitude A and duration T. **(06 Marks)**

7 a. Write a brief note on maximum-likelihood detector. **(06 Marks)**

b. Explain briefly about adaptive equalization. **(06 Marks)**

c. Three signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ are equiprobable and are given by

$$S_1(t) = \sqrt{\frac{2}{T}} \cos\left(\frac{4\pi t}{T}\right) \quad 0 \le t \le T$$

$$S_2(t) = \sqrt{\frac{2}{T}} \cos\left(\frac{8\pi t}{\pi}\right) \quad 0 \le t \le T$$

$$S_3(t) = \sqrt{\frac{2}{T}} \cos\left(\frac{12\pi t}{\pi}\right) \quad 0 \le t \le T$$

i) Sketch the signal space and decision boundaries for this set of signals.

ii) Show that signal space can be reduced to two dimensions. **(08 Marks)**

8 a. With neat diagram, explain direct sequence spread spectrum system. Write the formula to find processing gain, average probability of error. **(06 Marks)**

b. A PN sequence is generated using 4-stage linear feedback shift register as shown in Fig.Q8(b) with initial condition $C_3C_2C_1C_0 = 1000$. This sequence is used in a slow FH/MFSK system.

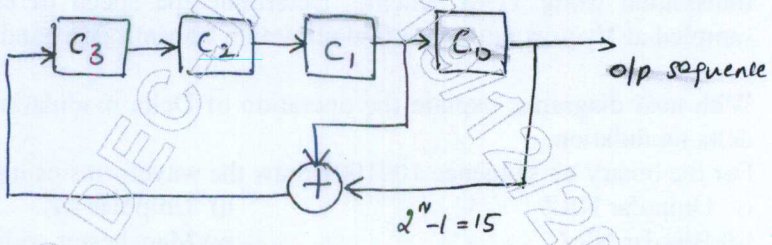

Fig.Q8(b)

Determine the following:

i) Period of PN sequence.

ii) PN sequence for one periodic length.

iii) Verify the three properties of PN sequence. **(08 Marks)**

c. In a fast FH/MFSK system, the signal has following parameters:
Number of bits per MFSK symbol K = 2
Number of MFSK segment per hop = 3
Total number of frequency hops = 8
Number of hops per MFSK symbol = 2
Period of PN sequence L = 15

i) Determine the relation between bit rate and chip rate.

ii) Sketch the variation of frequency of transmitted signal with time. Assume binary data sequence to be 01101100 and one period of PN sequence is 111100010011010. **(06 Marks)**

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