Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Remedial Examination December 2010

Subject code: 722202

Subject Name: Advanced Digital Communication

Date: 20 /12 /2010 **Time: 02.30 pm – 05.00 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 (a) Explain representation of band-pass signals and systems in terms of equivalent low-pass waveforms. Also justify "If s(t) is a real-valued band-pass signal than its equivalent low pass signal $s_l(t)$ is generally a complex-valued signal." **06**

(b) i) Suppose that n(t) is zero mean stationary narrowband process represented by equation $n(t)=x(t)\cos 2\pi f_c t - y(t)\sin 2\pi f_c t$. The autocorrelation function of the equivalent low pass process $z(t)=x(t)+jy(t)$ is defined as $\Phi_{zz}(\tau)=(1/2)E[z^*(t).z(t+\tau)]$. Show that $E[z(t).z(t+\tau)]=0$. **06**

ii) Suppose that a set of M signal waveforms $\{s_{lm}(t)\}$ are complex valued. Derive the equations for the Gram-Schmidt procedure that will result in a set of N≤M orthonormal signal waveforms.

Q.2 (a) i) Compare various Digital modulation methods at 10^{-5} symbol error probability. **06**

ii) A speech signal is sampled at a rate of 8 kHz, logarithmically compressed and encoded into a PCM format using 8 bits per sample. The PCM data is transmitted through an AWGN baseband channel via M-level PAM. Determine the bandwidth required for transmission when M=8 and M=16.

(b) Explain Matched-filter demodulator in brief. Consider the signal: **06**

$$s(t) = (A/T)t\cos 2\pi f_c t \quad (0 \le t \le T)$$
$$= 0 \quad \text{(Otherwise)}$$

i) Determine the impulse response of the matched filter for the signal and find the output of the matched filter at t=T.

ii) Suppose the signal s(t) is passed through a correlator that correlates the input s(t) with s(t). Determine the value of correlator output at t=T.

OR

(b) i) For M-ary phase modulated signal, prove that minimum Euclidian distance for adjacent signal phases is $d_{\min}^{(e)} = \sqrt{\varepsilon_g\left(1-\cos\frac{2\pi}{M}\right)}$ **06**

Where ε_g=energy of gate pulse.

ii) π/4-QPSK may be considered as two QPSK systems offset by π/4 radians.

(1)Sketch the signal space diagram for a π/4-QPSK signal.
(2)Why Gray encoding is generally preferred for assignment of information bits to the possible phases. Using Gray encoding label the signal points with the corresponding data bits.

Q.3 (a) Give any one example of linear modulation with memory and explain the same. **04**

	(b)	How will you determine the spectral content of a digitally modulated signal?	**03**
	(c)	Derive the expression for probability of error of M-ary PAM. Suppose that binary PSK is used for transmitting information over an AWGN with a power spectral density of $(1/2)N_0=10^{-10}$ W/Hz. The transmitted signal energy $\varepsilon_b=(1/2)A^2T$, where T is the bit interval and A is the signal amplitude. Determine the signal amplitude required to achieve an error probability of 10^{-6} when the data rate is 10 kbits/s.	**05**
		OR	
Q.3	**(a)**	Evaluate the probability of error for M-ary Orthogonal signals. Investigate the effect of increasing M on the probability of error for orthogonal signals and justify the statement "The minimum required ε_b/N_0 is 1.42 dB to achieve an arbitrarily small probability of error as $M\rightarrow\infty$ at sufficiently high SNR."	**08**
	(b)	Digital information is to be transmitted by carrier modulation through an additive Gaussian noise channel with a bandwidth of 100 kHz and $N_0=10^{-10}$ W/Hz. Determine the maximum rate that can be transmitted through the channel for four-phase PSK, binary FSK, and four-frequency orthogonal FSK, which is detected noncoherently.	**04**
Q.4	**(a)**	Describe the carrier recovery and symbol synchronization in QAM receiver.	**04**
	(b)	Explain the Costas loop for generating a properly phased carrier for double sideband suppressed carrier signal. Compare it with Squaring loop method and decision-feedback PLL used to establish the carrier phase estimate of carrier signals.	**08**
		OR	
Q.4	**(a)**	Describe carrier recovery technique for M-ary PSK using a decision-feedback PLL.	**04**
	(b)	Explain the effect of intersymbol interference on eye opening and prove Nyquist condition for zero ISI.	**08**
Q.5	**(a)**	Define equalizer and list various types of equalization methods. Discuss the error rate performance of linear MSE equalizer.	**06**
	(b)	Digital communication system employs Gaussian-shaped pulses of the form $x(t)=\exp(-\pi a^2t^2)$. To reduce the level of intersymbol interference to a relatively small amount, we impose the condition that x(T)=0.01, where T is the symbol interval. The bandwidth W of the pulse x(t) is defined as that value of W for which X(W)/X(0)=0.01, where $X(f)$ is the Fourier transform of x(t). Determine the value of W.	**04**
	(c)	Determine the bit rate that can be transmitted through a 4-kHz voice-band telephone (bandpass) channel if 8-point QAM modulation method is used. Assume that the transmitter pulse shape has a raised cosine spectrum with a 50% roll-off.	**02**
		OR	
Q.5	**(a)**	Explain an FFT-based multi-carrier communication system in brief. What is the major problem with multicarrier modulation? Describe the various methods investigated to solve it.	**06**
	(b)	Describe a discrete-time model for a channel with ISI with an example.	**04**
	(c)	List the key features of OFDM system.	**02**

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