EEL306 Communication Engineering Major

May 3, 2009 Time 2 hours Max Marks 40

Please note: Answer all parts of a question at the same place. Scattered parts will not be graded. Write all assumptions and show intermediate steps.

1. Stationarity [10]

Consider a random process

$$z(t) = x(t)\cos(\omega_0 t + \theta) \quad (1)$$

where $x(t)$ is a zero-mean stationary random process with $E\{x^2(t)\} = \sigma_x^2$.

(a) If $\theta = 0$, is $z(t)$ stationary? Explain. [5]

(b) If $\theta \sim$ Uniform($-\pi$, π), is $z(t)$ stationary? Explain. [5]

2. Delta Modulation [10]

Consider delta modulation with step-size = δ_0 and the sampling interval T_s. Let the message signal be $m(t) = A\sin(2\pi f_1 t)$.

(a) Derive the condition for slope overload. [5]

(b) Suppose $m(t)$ is a step input. Clearly *draw* the output of the delta modulator, superimposed on $m(t)$. Label the regions of slope overload and granular noise. [5]

3. PPAM [10]

Suppose we wish to use Pulse Position Amplitude Modulation PPAM, which is a combination of Pulse Position Modulation (PPM) and Pulse Amplitude Modulation (PAM). Consider the bit-stream 110001111. We wish to encode 3 bits per symbol. *Draw* all the possible PPAM waveforms corresponding to the given bit-stream. Explain clearly how you have obtained *each* waveform. Label your axes.

4. Sampling and TDM [10]

Five messages, bandlimited to W, W, $2W$, $4W$, and $4W$ Hz, respectively, are to be time-division multiplexed. Devise a configuration such that each signal is *periodically* sampled at its own minimum rate and the samples are properly *interlaced* for the purpose of TDM.

(a) Let s_{ij} represent the j^{th} sample of the i^{th} message. Write down what the first 12 samples that will be sent over the TDM channel in terms of s_{ij}. Explain. [5]

(b) What is the *minimum* bandwidth required for this TDM signal? Explain. [5]

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Have a wonderful summer vacation !!!