Indian Institute of Technology, Kharagpur

Date: FN/AN **Time:** 3 hours **Full Marks:** 50 **No. of Students** 90

Autumn/Spring Semester, Autumn 2010 **Deptt** E & ECE

Sub. No. EC31001 **3rd Yr. B.Tech.(H)** **Subject Name:** Analog Communications

Answer any six questions. All questions carry equal marks.

1.(a) Considering that a rectangular pulse of amplitude A and duration $-\tau/2 \leq t \leq \tau/2$ is represented by A rect(t/τ), sketch the function $x(t) = \sum_{n=-\infty}^{\infty} g(t - nT)$ on a proportionate scale where g(t) = 0.5 rect((8t-T)/4T) + 0.5 rect ((8t-3T)/2T).

(b) Derive expression for convolution of A_1 rect(t/T_1) and A_2 rect(t/T_2). Also express the Fourier transform of the convolution output.

2. (a) Considering a suitable spectrum for a lowpass real signal m(t), sketch the Fourier transform of its Hilbert transform $\hat{m}(t)$. Also plot on the same frequency scale the Foutier transform of $\hat{m}(t)\ \mathrm{Sin}2\pi f_c t$.

(b) If x(t) has its Fourier transform X(f), prove that x(-at) will have the Fourier transform expressed by [X(f/a)]/|a| for all positive values of a.

3. (a) State the Poisson's Theorem for random variables and mention the constraint for its validity. Prove that for a Poisson distributed random variable the mean equals its variance and is equal to the product np where n is the total number of observations and p is the probability of getting a success.

(b) Describe a procedure to otain spectral width of a stochastic process. Also state and prove the theorem used in the procedure.

4. (a) For a signal $m(t) = A_1 + A_2 \mathrm{Cos}\ 2\pi f_m t$ sampled at a rate $4f_m$, design a PWM system.

(b) Consider a PWM signal $x(t) = A(1 + \cos \pi t/T)$ corrupted by a white Gaussian noise n(t). Describe a procedure how the signal to noise ratio in the demodulated output will be evaluated under first order approximations.

5. (a) Describe with the help of a block diagram generation of Pulse Position Modulated signal. Describe with an example how it differ from that of a Pulse Frequency Modulated signal.

(b) Why synchronization is needed in pulse modulation systems? How can synchronization be achieved in PWM?

6. (a) What do you mean by FDM? Consider an FDM where voice channels of 4 kHz bandwidth are multiplexed to form basic group at carriers $f_{c,n} = 112\text{-}4n$ kHz, $1 \leq n \leq 12$ and such basic groups are multiplexed to form a super group at carriers $f_{c,k} = 372+48k$ kHz, $1 \leq k \leq 5$. Prove that for SSB modulation considered at each stage the minimum transmission bandwidth required for the super group signal will be $2\Delta f$ where Δf consists of frequencies in the band $312\text{kHz} \leq f \leq 552\text{kHz}$.

(b) How many channels if sampled at a rate 1 MHz can be accommodated in a frame of duration 125μsec. What will be the frequency of the Master clock in this case?

7. (a) State and prove the sampling theorem for band pass signals.

(b) Describe a method for generation of wideband FM from available narrowband FM.