IC1513

M.Sc. (Informatics)/I- Sem. - 2015

Paper : IT-13

INTRODUCTION TO COMMUNICATION & SYSTEMS

Time: 3 hours *Maximum Marks: 75*

(Write your Roll No. on the top immediately on receipt of this question paper)

Attempt five *questions in all.* Q.1 *is compulsary*

Q.1(a) Let $g_p(t)$ denote a periodic signal with a period T_0. Then it may expressed , using Fourier series, as:

$$g_p(t) = a_0 + 2\Sigma_{n=1}^{\infty}\left[a_n \cos\left(\frac{2\pi nt}{T_0}\right) + b_n \sin\left(\frac{2\pi nt}{T_0}\right)\right]$$

Find a_n and b_n .? (3)

(b) Show that the complex Fourier series representation is given by (3)

$$g_p(t) = \Sigma_{n=-\infty}^{\infty} c_n \exp\left(j\frac{2\pi nt}{T_0}\right)$$

where $c_n = \frac{1}{T_0}\int_{-T_0/2}^{T_0/2} g_p(t)\exp\left(-j\frac{2\pi nt}{T_0}\right), \quad n = 0, \pm 1, \pm 2, \cdots.$

(c) Expand $F(x) = \sin x, \quad 0 < x < \pi$, in a Fourier cosine series. (3)

(d) Find the Fourier coefficients corresponding to the function (6)

$$F(x) = \begin{cases} 0 & -5 < x < 0 \\ 3 & 0 < x < 5 \end{cases}$$

Q.2(a) Find the Fourier transform of (5)

$$F(x) = \begin{cases} A, & |x| < a \\ 0, & |x| > a \end{cases}$$

(b) Graph $F(x)$ and its Fourier transform for $a = 1$. (3)

(c) Consider a double exponential pulse defined by (4)

$$g(t) = \begin{cases} \exp(-at), & t > 0 \\ 1, & t = 0 \\ \exp(at), & t < 0 \end{cases}$$

Find $G(f)$ the Fourier transform of $g(t)$?

(d) Let $g(t) \rightleftharpoons G(f)$. Show that $g(at) \rightleftharpoons \frac{1}{|a|} G\left(\frac{f}{a}\right)$. (3)

Q.3(a) Consider a linear time-invariant device with a transfer response function defined by (3)

$$H(f) = 7\begin{cases} -j, & f > 0 \\ 0, & f = 0 \\ j, & f < 0 \end{cases}$$

Draw the amplitude response and phase response of the device?

(b) Show that $\exp(j2\pi ft) \rightleftharpoons \delta(f - f_c)$. If $f(t) = \sin(2\pi f_c t)$ then deduce and sketch the spectrum of $f(t)$? (3)

(c) Consider a sinusoidal carrier wave $c(t) = A_c \cos(2\pi f_c t)$ and a messgae signal $m(t)$. Describe with necessary sketches (i) the time domain and (ii) the frequency domain description of AM wave. (6)

(d) Describe a square law modulator for generation of AM wave. (3)

Q.4 (a) How van you obtain a DSBSC signal? What is its bandwidth? Describe synchronous detection method for the demodulation of DSBSC signal. (6)

(b) Explain with the help of a diagram the generation and detection of QAM. (5)

(c) Evaluate the effect of a phase error in the local oscillator on synchronous DSB demodulation. (2)

(d) An AM voltage is represented by the expression

$$V = 5\left[1 + 0.6\cos(6280t)\right]\sin(2\pi \times 10^4 t) volts$$

. What are the minimum and maximum amplitude of the AM wave? What frequency components are contained in the modulated wave and what is the amplitude of each component?

Q5(a) Explain the idea of (i) frequency modulation and (ii) phase modulation. (2)

(b) Write the expressions for the FM and PM waves mentioning the meaning of various symbol used. (2)

(c) Show that the spectrum of a single tone frequency modulated wave is given by (6)

$$S(f) = \frac{A_c}{2} \Sigma_{n=-\infty}^{\infty} J_n(\beta)\left[\delta(f - f_c - nf_m) + \delta(f + f_c + nf_m)\right]$$

where symbols have their usual meaning.

(d) A carrier wave of frequency $1MHz$ and amplitude 3 volts is frequency modulated (FM) by a sinusoidal modulating signal frequency of $500Hz$ and of peak amplitude 1 volt. The frequency deviation of Δf is $1kHz$. The level of the modulating waveform (signal) is changed to 5 volt peak and the modulating frequency is changed to $2kHz$. Obtain the expression for the new modulated waveform (FM). (5)

Q.6(a) Find the Nyquist rate and the Nyquist interval for the signal (3)

$$x(t) = \frac{1}{2\pi}\cos(4000\pi t)\cos(1000\pi t).$$

(b)Describe the generation of PAM and its demodulation. (5)

(c) For a pulse amplitude modulated (PAM) transmission of voice signal having maximum frequency equal to $f_m = 3kHz$, calculate the transmission bandwidth. It is given that the sampling frequency $f_s = 8kHz$ and the pulse duration $\tau = 0.1T_s$. (3)

(d)Derive an expression for signal to quantization noise ratio for a PCM system which employs linear (i.e., uniform) quantization technique. Given that input to the PCM system is a sinusoidal signal. (4)