M.Sc (INFORMATICS)/1st Semester 2017
Paper IT-13- Introduction to Communication Systems

Time: 3hrs

Max.Marks:75

Attempt five questions in all. Question no.1 is compulsory

Q.1(a)Find the Fourier series expansion of the periodic function (5)

$$f(x) = x, \quad -\pi \leq x \leq \pi, \quad f(x+2\pi) = f(x)$$

(b) Define even and odd functions. Draw graph of the functions $(i)\ f(x) = |x|$, $(ii)\ f(x) = x^3$ where x is any real number and explain why the functions are odd or even. (5)

(c) Find the complex Fourier series of the function (5)

$$f(x) = e^{-x}, \quad -\pi < x < \pi.$$

Q.2(a) Find the Fourier transform if the function $f(t) = e^{-a|t|}, \quad -\infty < t < \infty, \quad a > 0$. Write the inverse transform.

(b) Let $g(t) \rightleftharpoons G(f)$. Then (5)

Let $g(t) \rightleftharpoons G(f)$

$$g(at) \rightleftharpoons \frac{1}{|a|}G(\frac{f}{a})$$

where a is a time-scaling factor that may be positive or negative. (5)

(c) Consider an exponentially damped sinusoidal wave defined by (5)

$e^{-t} \sin(2\pi f_c t)$

$$g(t) = \begin{cases} exp(-t)sin(2\pi f_c t), & t > 0 \\ 0, & t \leq 0 \end{cases}$$

Using the expression

$$sin(2\pi f_c t) = \frac{1}{2j}\left[exp(j2\pi f_c t) - exp(-j2\pi f_c t)\right]$$

$= e^{j2\pi f_c t} - e^{-j2\pi f_c t}$

and applying the frequency -shifting property , find the Fourier transform of $g(t)$.

Q.3(a) Write down the properties of Dirac delta function. If $g(t) = sin(2\pi f_c t)$ then show that (5)

$$g(t) \rightleftharpoons \frac{1}{2j}\left[\delta(f - f_c) - \delta(f + f_c)\right].$$

↑ area = unity

5.5

(b) Consider a linear time-invariant system of impulse response $h(t)$ driven by a complex exponential input of unit amplitude i.e., $x(t) = exp(j2\pi f t)$. Deduce an expression for the output $y(t)$ and its Fourier transform. Explain the term (i) amplitude response and (ii) phase response of a linear system. (5

(c) Consider a linear time-invariant device with a transfer function defined by (5)

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

Find the amplitude response and phase response of the device and explain the results along with their schematic diagrams.

Q.4(a) Explain the process of amplitude modulation. Describe the (*i*) time-domain and (*ii*) frequency domain process of amplitude modulation with suitable diagrams. (5)

(b) If a message signal is denoted by $m(t) = A_m cos(2\pi f_m t)$ and the carrier signal by $c(t) = A_c cos(2\pi f_c t)$, then deduce an expression for the Fourier spectrum , $S(f)$, of the amplitude modulated signal $s(t)$. (5)

(c) Explain the process of generating double-sideband suppressed - carrier (DSBSC) modulation. Explain with schematic diagram , the coherent detection of DSBSC modulated waves. D/2 (3)

(d) How Costas loop is used to obtain a synchronous receiving system suitable for use with DSBSC modulated waves? (2)

Q.(5)(a) What do you understand by single-sideband modulation (SSB)? For a message signal $m(t) = A_m cos(2\pi f_m t)$, explain the suppression of lower side-frequency $f_c - f_m$ of the corresponding DSBSC wave. Here f_c corresponds to frequency of the carrier wave. Using a block diagram explain the phase-discrimination method for generating SSB modulated wave. (10)

(b) Draw a block diagram of a two stage SSB modulator. The input signal consists of voice signal occupying the frequency band 0.3 to $3.4kHz$. The two oscillator frequencies have the value $f_1 = 100kHz$ and $f_2 = 10MHz$. Specify (*i*) sidebands of DSBSC modulated wave appearing at the two modulator output, (*ii*) sidebands of SSB modulated wave appearing at the two band-pass filter outputs. (5)

$f'(x) = 4 \cdot 3x^2$

Q.6(a) Describe the (*i*) the angle modulation and (*ii*) frequency modulation of waves. Draw the block diagram for generating frequency modulated (FM) and phase modulated (PM) wave. Show that for a siusoidal modulating wave , $m(t) = A_m cos(2\pi f_m t)$, the spectrum is given by

t)) cos ωt ×

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

B.W 3.40 − 30 = 31

where β is the modulation index, A_c and f_c refers to the carrier wave amplitude and frequency spectively and further $J_n(\beta)$ is the Bessel function of order n.

t + Ac cos 2πkt t

(b) Write short note on (*i*) Pulse amplitude modulation, (*ii*) Pulse code modulation

(c) Determine the Nyquist rate for a continuous -time signal

2πωT 2ωπt

$$x(t) = 6cos50\pi t + 20sin300\pi t - 10cos100\pi t$$

2π 300 T

50π − 1/2π300 T   25   150   50

= 300

a sin 2ωt

2Hωt

2 × 25 × π × t

ω_c

$m(t) = A_m cos(2\pi f_m t)$

$c(t) = A_c cos(2\pi f_c t)$