G 1523 (Pages : 4) Reg. No..............................

Name..................................

B.TECH. DEGREE EXAMINATION, MAY 2015

Fourth Semester

Branch : Applied Electronics and Instrumentation/Electronics and Communication/ Electronics and Instrumentation Engineering

AI 010 403/EC 010 403/EI 010 403—SIGNALS AND SYSTEMS (AI, EC, EI)

(New Scheme—2010 Admission onwards)

[Regular/Improvement/Supplementary]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*
Each question carries 3 *marks.*

1. Calculate the average power of the signal $x(t) = A\sin(w_0 t + \phi)$, $-\infty \le t \le \infty$.

2. Find the Fourier transform of $x(t) = e^{-a|t|}$; $a > 0$.

3. Prove that Discrete-Time-Fourier Transform is periodic with period 2π.

4. Compare Butterworth and Chebyshev filter functions.

5. State any three properties of Region of convergence.

(5 × 3 = 15 marks)

Part B

Answer **all** *questions.*
Each question carries 5 *marks.*

6. If 'E' is the energy of the signal $x(t)$, what is the energy of $x(2t)$ and $x\left(\frac{t}{2}\right)$?

7. Show that the sum of two sinusoids is periodic provided that their frequencies are integral multiples of a fundamental frequency w_0.

8. Using Fourier Transform, find the differential equation description for the system having impulse response $h(t) - \left(2e^{-t} - 3e^{-5t}\right)u(t)$.

Turn over

9. Design a low pass Chebyshev filter whose 3 dB cut off frequency is w_c, and the gain drops to –50 dB at $3w_c$.

10. Find the Laplace Transform of the signal $x(t) = e^{-2t}\,u(t) + e^{3t}\,u(t)$. Also find the ROC.

(5 × 5 = 25 marks)

Part C

Answer **all** *questions.*
Each full question carries 12 *marks.*

11. (a) Prove the following :—

(i) The power of the energy signal is zero over infinite time. (3 marks)

(ii) The energy of the power signal is infinite over infinite time. (3 marks)

(b) Given :

$$x(t) = \begin{cases} 1, & 0 \le t < 1 \\ e^{-t}, & t \ge 1 \\ 0 & \text{otherwise} \end{cases}$$

Plot

(i) $x(2t - 3)$. (2 marks)

(ii) $x(2.5\,t - 0.5)$. (2 marks)

(iii) $x(2 - 1.5\,t)$. (2 marks)

Or

12. (a) State and prove commutative and distributive properties of convolution sum. (6 marks)

(b) Determine the natural response, forced response and output of system described by difference equation,

$$y(n) + 3y(n-1) = x(n) + x(n-1) \text{ if input is } x(n) = \left(\frac{1}{2}\right)^n u(n) \text{ and } y(-1) = 2.$$

(6 marks)

13. (a) For the continuous time periodic signal $s(t) = 2 + \cos 2t + \sin 4t$, determine the fundamental frequency w_0 and the Fourier series coefficients c_n such that $x(t) = \sum_{n=-\infty}^{\infty} c_n e^{-jnw_0 t}$

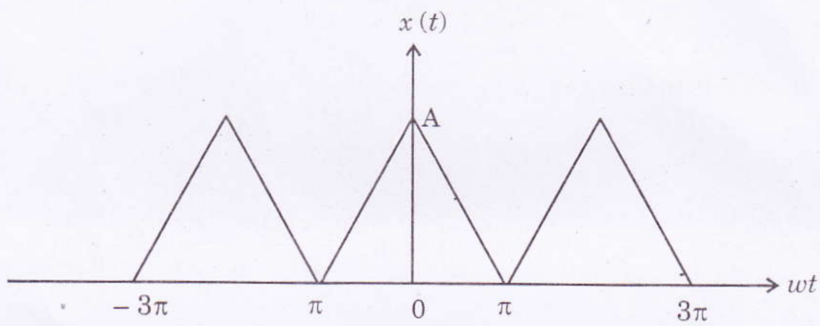
(6 marks)

(b) Show that the magnitude spectrum of every periodic function is symmetrical about the vertical axis passing through the origin, and the phase spectrum is antisymmetrical about the vertical axis passing through the origin.

(6 marks)

Or

14. Find the trigonometric and exponential Fourier series for the waveform shown below :



15. (a) Explain the scaling and time domain convolution properties of DTFT. (4 marks)

(b) Find the DTFT of $x(n) = \left(\frac{1}{2}\right)^n . u(n-4)$. Also, find the magnitude and phase spectra.

(8 marks)

Or

16. Find the frequency response of :

(a) $h(t) = -\delta(t+1) + \delta(n) - \delta(t-1)$. (6 marks)

(b) $h(n) = (-1)^n \left[u(n+2) - u(n-3)\right]$. (6 marks)

Turn over

17. (a) A signal $x(t) = \cos 200\pi t + 2\cos 320\pi t$ is ideally sampled at $f_s = 300$ Hz. If the sampled signal is passed through an ideal low pass filter with a cut-off frequency of 250 Hz, what frequency components will appear in the output ? Draw and label the spectra of (i) $x(t)$,

(i) $x_\delta(t)$, the ideally sampled signal ; and

(ii) Response of the ideal LPF.

(8 marks)

(b) Give the chebyshev filter transfer function and its magnitude response and explain.

(4 marks)

Or

18. Design a second order low pass Butterworth filter with a cut-off frequency of 1 KHz. Choose appropriate data as required, stating them clearly.

19. (a) Find the inverse z-transform of $X(z) = \dfrac{z^4 + z^2}{\left(z - \frac{1}{2}\right)\left(z - \frac{1}{4}\right)}$, ROC $= \frac{1}{2} < |z| < \infty$. (6 marks)

(b) Using Laplace Transform, solve the equation, $\dfrac{d^2x(t)}{dt^2} + 5\dfrac{dx(t)}{dt} + 6x(t) = \delta(t) + 6u(t)$, with

$x(0) = 1$ and $\dfrac{dx(0)}{dt} = 2$.

(6 marks)

Or

20. An LSI system is described by the difference equation

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + x(n-1) \text{ with } y(-1) = 0 \text{ and } y(-2) = -1.$$

Find (a) the natural response of the system (b) the forced response of the system ; and (c) the frequency response of the system for a step input.

(5 × 12 = 60 marks)