(Electronics and Communication Engineering) Course Name: Signals and Systems

Date of Exam: 01/10/2024

Time: 2 Hours, M. Marks: 30 Name of Faculty: Dr. Mrutyunjay Rout

Note: 1. Any missing data may be assumed suitably
2. Symbols/Abbreviations have their usual meaning
3. Right hand side indicate the corresponding mark

Question 1: [5×2]

(a) Sketch the signal $x(t)$ and $x(-t+3)$ if $x(t) = \left(\frac{1}{2}t+1\right)u(t) - \left(\frac{1}{2}t+1\right)u(t-2)$.

(b) Find the fundamental period and fundamental frequency of following signals:

(i) $y_1(n) = \cos\left(\frac{2\pi}{12}n^2\right)$

(ii) $y_2(t) = x(2t)$ if $x(t) = e^{i5\pi t}$

(c) Determine the range of the values of a and b for which the LTI system with impulse response

$$h(n = \begin{cases} a^n, & n \geq 0 \\ b^n, & n < 0 \end{cases}$$

is stable.

(d) Check the following systems for linearity, and time invariance.

(i) $y(t) = \int_{-\infty}^{2t} x(\tau)\,d\tau$.

(ii) $y(n) = 5x(n^2)$.

(e) What is the impulse response $h(t)$ of an LTI system if the system input and output related through the following equation:

$$y(t) = \int_{-\infty}^{t} a^{-(t-\tau)}x(\tau-3)d\tau$$

Question 2: [2.5×2]

(a) Consider the analog signal $x(t) = 2\cos 4\pi t$

(i) Plot $x(t)$ and its spectrum $X(\omega)$ and determine whether $x(t)$ is a band-limited signal.

(ii) Plot the sampled signal of $x(t)$ if the sampling frequency is $\omega_s = 6\pi\ rad/sec$

(b) Check whether the signal $x(t) = \sum_{m=-\infty}^{\infty}\left(\frac{1}{2}\right)^{3t-m}u(3t-m)$ is periodic? If yes, compute its fundamental period and average power.

Question 3: [5]

Find the response of an LTI system with impulse response

$$h(n) = \begin{cases} a^n & 0 \leq n \leq N \\ 0 & otherwise \end{cases} \text{ and input } x(n) = \begin{cases} b^{n-m} & m \leq n \\ 0 & n < m \end{cases}$$

Assume, $a \neq b$.

Question 4: [5]

Given the exponential Fourier series coefficients X_n, determine the signal $x(t)$ if time period $T = 2\pi$.

$$X_n = \frac{1}{8}\delta(n+2) + \frac{1}{2}\delta(n+1) + \frac{1}{2}\delta(n) + \frac{1}{2}\delta(n-1) + \frac{1}{8}\delta(n-2)$$

Also determine the Fourier coefficients for the following signals:

(i) $x(t) * x\left(\frac{t}{2}\right)$

(ii) $x\left(t-\frac{1}{2}\right) + x(2t)$

(iii) $\frac{x(t)+x^*(t)}{3}$

(iv) $\frac{d^3}{dt^3}x(t)$

Question 5: [2.5×2]

(a) Consider two systems described by their impulse responses $h_1(n) = 2\delta(n+2) + A\delta(n+3)$ and $h_2(n) = (0.5)^n u(n)$. Find the response to the input $x(n) = (0.5)^n u(n)$, when two systems are connected in parallel with $A = -0.5$.

(b) Find the CTFT of below signal and plot its magnitude and phase spectrum:

$x(t) = e^{3t}u(-t)$

NATIONAL INSTITUTE OF TECHNOLOGY JAMSHEDPUR

Department of Electronics & Communication Engineering

Autumn END Semester Examination, 2024

B. Tech. (2nd Year): 3rd Semester — Course Code: EC1301

(Electronics and Communication Engineering) — Course Name: Signals and Systems

Date of Exam: 08/12/2024

Time: 3 Hours, M. Marks: 50 — Name of Faculty: Dr. Mrutyunjay Rout

Note: 1. Any missing data may be assumed suitably
2. Symbols/Abbreviations have their usual meaning
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Question 1: [5×2]

(a) Compute the value of energy E and average power P for the signal $x(t) = 3sin\left(6\pi t + \frac{\pi}{2}\right)$.

(b) Find the Fourier series coefficients for the signal $x(t) = 1 + sin6t + cos4t$. CTFS

(c) Compute the N-point DFT of $x(n) = \begin{cases} 1 & for\ 'n'\ even \\ 0 & for\ 'n'\ odd \end{cases}$

(d) Plot the signal $x(t)$ and find its Laplace transform if $x(t+2) = u(t+2) + r(t+1) - 2r(t) + r(t-1) - u(t-2)$.

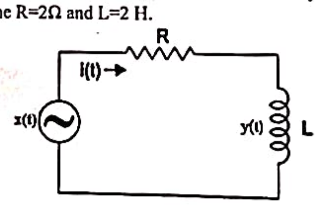
(e) State and prove the multiplication property of DTFS.

Question 2: Contiu

(a) Consider an LTI system with impulse response $h[n] = u[n-2]$. Find the response of this system for the input $x[n] = \left(\frac{1}{2}\right)^{-n} u[-n-2]$. [3]

(b) Find the z-transform and ROC of the signal $x[n] = -\left(\frac{1}{4}\right)^{n} u[-n-1]$. [2]

(c) Find the frequency response and $y(t)$ of the below system if $x(t) = sgn(t)$. Assume R=2Ω and L=2 H. [5]



Question 3: X

(a) When the impulse train $x[n] = \sum_{k=-\infty}^{\infty} \delta(n-4k)$ is the input to a LTI system with frequency response $H(e^{j\omega})$, the output of the system is found to be $y(n) = cos\left(0.5\pi n + \frac{\pi}{4}\right)$. Determine the values of $H\left(e^{\frac{jk\pi}{2}}\right)$ for k=0, 1, 2 and 3. [5]

(b) A DT LTI system is represented by the following difference equation [5]

$$y[n] + 0.5y[n-1] - 0.125y[n-2] = x[n]$$

Determine the response of the system if the input $x[n]$ is $2 - 3cos\left(\frac{n\pi}{6}\right) + 2cos\left(\frac{n\pi}{2}\right) + 5\sin(n\pi)$, $-\infty < n < \infty$

Question 4:

(a) State and verify Parseval's relation for the sequence $x(n) = \left(\frac{1}{3}\right)^{n} u(n)$ in the case of DTFT. [5]

(b) Consider a continuous-time LTI system with step response $a(t) = (1 - e^{-t} - te^{-t})u(t)$. For what input $x(t)$ the output $y(t)$ is $(4 - 2e^{-t} + 3e^{-2t} + 5e^{-3t} + 2e^{-4t})$. u(t) [5]

Question 5:

(a) Determine the frequency response for the system $y(n) = -0.25y(n-1) + x(n) - x(n-1)$ and plot magnitude response and phase response. [5]

(b) State the Duality property of Fourier transform and prove that Fourier transform of $-\frac{1}{jt}x(t) + \pi x(0)\delta(t)$ is $\int_{-\infty}^{\omega} X(\tau)\,d\tau$. [3]

(c) Find Fourier transform of $y(t) = \frac{2}{1+t^2}$ using duality property. [2]