Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
Mid-Semester Examination, Sept 2023

B.Tech. (ECE) Sem-3 Marks: 30

Important Instructions:

- *Plagiarism in any form is highly discouraged and attracts heavy penalty.*
- For any queries, feel free to contact the instructor/ invigilator immediately.
- Appropriate credits would be given for precision, and elaborate explanation.
- Marks are given against every question in {}.

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1. Determine if following signals satisfy the characteristics mentioned against them
    1. $x(t) = \cos^2 2\pi t$, Periodicity? Find period.
    2. $x(t) = e^{\sin t}$, Periodicity? Find period.
    3. $x[n] = \cos[0.2n]$, Periodicity? Find period.
    4. $x(t) = 10\cos(5t)\cos(10t)$, Energy or power?
    5. $x(t) = te^{-|t|}$, Energy or power?
    6. $x(t) = e^{-2t}u(t)$, Even or odd?

    [CO-1,2], $\{2 \times 6 = 12\}$.

2. The input and output of system are related as $y[n] = x[n]x[n-1] + \cos\left(3\pi n - \frac{\pi}{3}\right)$, determine whether the system is linear, time-invariant, bounded-input and bounded-output (BIBO) stability, memoryless, causal? **[CO-2]**, $\{1.5 \times 5 = 7.5\}$.

3. Give an example of system that does not satisfy any of the following: additivity, homogeneity, time-invariance, causality, stability.

    [CO-1,2], {2.5 }

4. Find value of $\int_a^b e^{-t}\delta(5t-10)dt$ when (i) $a = 3, b = 6$, (ii) $a = -3, b = 1$ (iii) $a = -3, b = 3$ and (iv) $a = -\infty, b = \infty$. **[CO-1]**, $\{4 \times 0.5 = 2\}$

5. Find impulse response of a system where output $y[n]$ is related with input $x[n]$ as $y[n] - \frac{1}{2}y[n-1] = x[n]$. **[CO-2, 3]**, {3 }.

6. In an electrical engineering circuit the applied voltage $v(t)$ results into the load current $i(t)$ which are related as $\frac{di(t)}{dt} + 2i(t) = v(t)$. At any instance find $i(t)$ if $v(t) = 5e^{3t}u(t)$. **[CO-2, 3]**, {3 }.

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
Second Sessional Examination, Oct 2022

Time: 60 mins | *B.Tech. (ECE) Sem-3* | Marks: 15

Important Instructions:

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1. If $X(w) = \delta(\omega) + \delta(\omega - \pi) + \delta(\omega - 5)$ is passed through an LTI system given by $h(t) = u(t) - u(t-2)$, determine a closed form expression of $y(t)$. Further, determine if $y(t)$ is periodic or NOT. If periodic, find the period.

   [CO-2,3], $\{3 + 1 + 2 = 6\}$

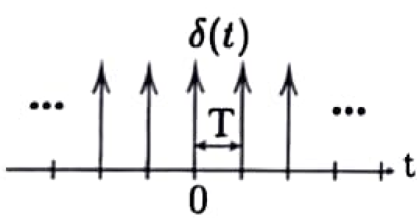
2. A causal and stable LTI system S has the frequency response,

$$H(\omega) = \frac{4 + j\omega}{6 - \omega^2 + 5j\omega}$$

   - Determine a differential equation relating the input $x(t)$ and $y(t)$ of S.
   - Determine the impulse response $h(t)$.
   - What is output of the system if input $x(t) = e^{-4t}u(t) - te^{-4t}u(t)$.

   [CO-3,4], $\{2 + 2 + 2 = 6\}$

3. Calculate and sketch the Fourier transform of the signal shown below. **[CO-4,5]**, $\{3\}$



Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
First Sessional Examination, Sept 2022

Time: 60 mins | *B.Tech. (ECE) Sem-3* | Marks: 15

Important Instructions:

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1. Determine and sketch the Fourier series representation for each of the following signals.

   1. $x(t) = \sin \omega_0 t$
   2. $x(t) = \cos 4t + \cos 6t$

   [CO-2,3], $\{1.5 + 1.5 = 3\}$

2. Let $y(t) = e^{-t}u(t) * \sum_{k=-\infty}^{\infty} \delta(t-3k)$. Show that for $0 \leq t < 3$, the output $y(t) = Ae^{-t}$ and find value of A.

   [CO-1,2], {3}

3. Give an example of system that does not satisfy any of the following: additivity, homogeneity, time-invariance, causality, stability.

   [CO-1,2], {1}

4. Perform step-by-step graphical convolution of the following signals. Here r indicates last digit of your roll number plus 1. [CO-1,2,3,4], {6}

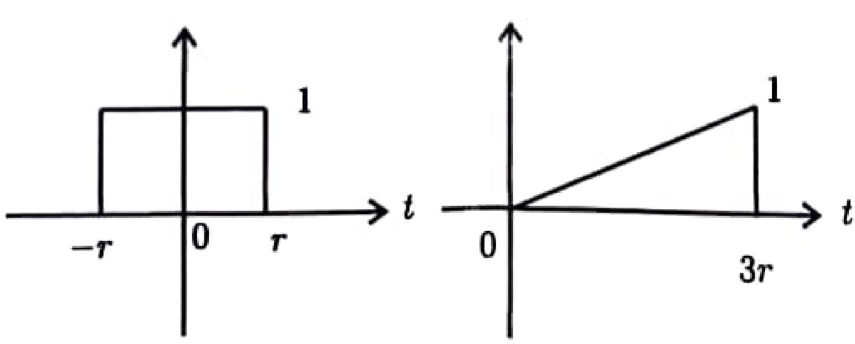

Figure 1: Figure for Q4, Q5

5. With reference to Figure 1Determiner whether the signal $z(t) = \delta(t+r) * x(t) + \delta(t-r) * h(t)$ is energy or power, calculate the respective values. [CO-1,2,3,4], {2 }

Dept. Of Electronics & Communication Engg., VNIT Nagpur, Mid Semester Examination, Odd Semester, 2020 -2021

Subject: Signals & Systems [ECL 211], SLOT: G Maximum marks: 15

Note
i) Answer all questions.
ii) Abbreviations have their usual meanings.
iii) Make suitable assumptions whenever necessary.
iv) Show and explain the steps. Correct answers WITHOUT the intermediate steps will not be given any credits.

Q1. $$x(t) = (1+t)[u(t) - u(t-1)] + 2[u(t-1) - u(t-2)] + (4-t)[u(t-2) - u(t-3)] + t[u(t+1) - u(t)] + (t+2)[u(t+2) - u(t+1)]$$

a) Sketch $x(3-2t)$ b) Sketch $x(-2t)+3$ [CO1, 2.5 +1.5 = 4 Marks]

Q2. Compute Fourier Series coefficients and then Verify Parceval's theorem for the following periodic signal $x(t) = x(t+1)$ [CO2, 2.5+2.5 = 5 Marks]

$$x(t) = \cos[4\pi(t+0.5)] + \sin[8\pi(t+0.5)] + \cos[16\pi(t+0.5)]$$

Q3. Assume S represents a LTI system with the following impulse response $h(t) = 1 \text{ for } |t| \leq 0.5$, $h(t) = 0 \text{ for } |t| > 0.5$. If you apply a pure imaginary complex exponential signal at the input of the LTI system S, find out the value/set of values of the frequency of the pure imaginary exponential input signal for which the energy of the corresponding output signal will be equal to 0. [CO1, 4 Marks]

Q4. Consider the cascade connection of two LTI systems S_1 and S_2 with impulse responses $h_1[n]$ and $h_2[n]$. For the following impulse responses $h_1[n] = \sin[8n]$ and $h_2[n] = a^n u[n], |a| < 1$ and the input sequence $x[n] = \delta[n] - a\delta[n-1]$, determine the corresponding output sequence. [CO4, 2 Marks]

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
Sem-End, Nov 2023

Time: 03 Hours | *B.Tech. (ECE) Sem-3* | Marks: 60

Important Instructions:

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- Assume suitable data wherever necessary.

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1. Consider a signal $x(t) = 1$, for $-1 \leq t \leq 1$. Analytically step-by-step obtain the expression for the output $y(t)$ of an LTI whose input is $x(t)$ and the impulse response $h(t) = \frac{x(t)}{2}$. [10]

2. With respect to Q1.
   (a) Obtain the expressions and neatly sketch the Fourier transforms of the input and the impulse response. [5]
   (b) Verify the convolution property of the Fourier transform specifically with respect to the expressions obtained Q1 (a). [5]

3. With respect to Q1,
   (a) Neatly sketch and label the magnitude of the Fourier transform only between the first zero-crossing on $\pm\Omega$. [5]
   (b) With respect to Q2(a), neatly sketch and label the magnitude of the Fourier transform after sampling exactly at $F_s = F_m$, $F_s = 2F_m$, $F_s = 3F_m$. [5]

4. With respect to Q1,
   (a) Obtain the expressions for the Laplace transforms of the input and the impulse response. [5]
   (b) Verify the convolution property of the Laplace transform specifically with respect to the expressions obtained in the previous part. [5]

5. With respect to Q1.
   (a) Neatly sketch and label the samples of $x(t), h(t)$ and $y(t)$ at every integer of t and obtain respective z-transforms. [5]
   (b) Verify the convolution property of z-transorm specifically with respect to $x[n], h[n]$ and $y[n]$ obtained in Q5(a) [5]
   (c) Ignore the constant (DC) value (if any). Neatly sketch and label the Fourier transform of $y[n]$ from the expression obtained in Q5(a) only between the first zero-crossing on $\pm\omega$. Further, approximately sketch and label the Fourier transform obtained after sampling by 2, upsampling by 3, and upsampling by 3 then downsampling by 2. [10]

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
Signals and Systems Analysis (Code: ECL211)
End Semester Examination, Nov 2022

Time: 03 Hours | *B.Tech. (ECE) Sem-3* | Marks: 50

Important Instructions:

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1. The transfer function of the LTI system is given by $H(s) = \frac{2}{s+3} + \frac{1}{s-2}$. Determine the impulse response if the system is (a) stable and (b) causal. State whether the system will be stable and causal simultaneously. [CO-2,5], {6}
2. A signal $x(t)$ with Fourier transform $X(\omega)$ is real and is positive sided i.e. $x(t) = 0$ for $t \leq 0$. Moreover, we also know $\frac{1}{2\pi}\int_{-\infty}^{\infty} Re\{X(w)\}e^{j\omega t}d\omega = |t|e^{-|t|}$. Based on above information, find $x(t)$. [CO-2,3], {6}
3. Let $x[n] = e^{n/2}u[n]$. Find $2x[5n/3]$, $x[2n]$ and $2x[n^2]$. [CO-1], {3} Also plot*
4. Find the even and odd parts of $x(t) = e^{-2t}\cos(2t)$. [CO-1], {2}
5. Consider a signal $y(t)$ which is related to two signals $x_1(t) = e^{-2t}u(t)$ and $x_2(t) = e^{-3t}u(t)$ as $y(t) = x_1(t-2) * x_2(-t+3)$. Use properties of the Laplace transform to determine the Laplace transform $Y(s)$. [CO-4], {6 }
6. Find $x[\infty]$ for signal $x[n] = 1$ if n is even and $x[n] = 0$ otherwise. [CO-5], {5 }
7. Find $x[n]$ if $X(z) = e^{\frac{1}{z}}$. [CO-5], {4 }
8. Find sampling rate required to sample signals (a)$x(t) = \sin(200\pi t)$ and (b) $x(t) = \cos^3(200\pi t)$. [CO-3], {3 }
9. Find the impulse response $h[n]$ of the LTI system whose transfer function is $H(z) = \frac{3(1-z^{-1})}{1-2.5z^{-1}+z^{-2}}$ assuming that (a) the system is causal and (b) the signal has a discrete time Fourier transform. [CO-4, 5], {6}
10. Determine the z-transform of $x[n] = u[n] - u[n-10]$. [CO-5], {3}
11. (a) Why do in electrical engineering, the signals are considered as sinusoids?. (b) Give an example of useful unstable system. [CO-2], {2}
12. Determine $x(0)$ and $x(\infty)$ if $X(s) = \frac{10(2s+3)}{s(s^2+2s+5)}$. [CO-5], {4}

We hope you enjoyed learning this course. Please share your feedback with the instructor.

End of exam

Dept. Of Electronics & Communication Engg., VNIT Nagpur, End Semester Examination, Odd Semester, 2020 -2021

Subject: Signals & Systems [ECL 211], SLOT: G   Maximum marks: 35

Note
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Q1a. $H(s) = \frac{N(s)}{(s+2)(s+3)}$ represents the system function of a stable and causal LTI system. Find out the one possible expression of the impulse response of its inverse system, where the inverse system is also is stable and causal LTI system. N(s) is a polynomial of s with at least order 2. **CO3 Marks: 4**

Q2a. For a periodic discrete sequence x[n], its Fourier series coefficients are real and even. Show that for the Z transform of that sequence X[z], if there is one zero or pole of X[z] at $z = re^{j\theta}$, then there is also a zero or pole of X[z] at $z = \left(\frac{1}{r}\right)e^{j\theta}$ and at $z = \left(\frac{1}{r}\right)e^{-j\theta}$.

Q2b. Consider an LTI system with input x[n] and output y[n] are related by the following difference Equation

$$y[n] = x[n] + \frac{1}{2}x[n-1] - \frac{7}{11}x[n-2] + \frac{3}{5}y[n-1] - \frac{8}{13}y[n-2] + \frac{1}{3}y[n-3] + \frac{6}{13}y[n-4]$$

Draw the direct form block diagram of the system function H[z] of the above system.
CO3 + CO4 Marks: 4 + 5 = 9

Q3a. Assume that an LTI system S initially at rest with input x(t) and output y(t) are related by the following differential Equation

$$\frac{d^2y(t)}{dt^2} + 8\frac{dy(t)}{dt} + 16y(t) = \frac{d^2x(t)}{dt^2} + 4\frac{dx(t)}{dt} + 3x(t)$$

Find the differential Equation relating the input and output of the system T which is the inverse system of S. The LTI system T is also initially at rest. Find h(t) and g(t) where h(t) and g(t) are the impulse responses of S and T.

Q3b. Assume the impulse response of an LTI system is given by $h(t) = \frac{\sin Wt}{\pi t}$

A continuous time domain periodic signal x(t) is applied at the input of the LTI system. The Fourier series coefficients of x(t) is following

$$x(t) = \sum_{k=-\infty}^{\infty} 0.6^{|k|} e^{j\frac{2\pi}{7}kt}$$

How should you design h(t) so that at the output of the system you will get at least 75% of the average energy per period of x(t).

CO2 Marks: 4 + 4 = 8

Q4. A specific formula for doing an operation between two function f and g is given below

$$S(p,q) = \int_{-\infty}^{\infty} f(t) g_{p,q}^{*}(t) dt \quad \text{where} \quad g_{p,q}(t) = \frac{1}{\sqrt{p}} g\left(\frac{t-q}{p}\right)$$

a) Express S(p, q) as the convolution between f and g.
b) Express S(p, q) as cross correlation between f and g.

[The cross correlation $R(\tau)$ between two functions $x(t)$ and $y(t)$ is given as
$R(\tau) = \int_{-\infty}^{\infty} x(t) y^{*}(t-\tau) dt$, *: complex conjugate]

CO1 Marks 5

Q5a. For the following signals, determine the minimum sampling frequency with which the signals need to be sampled for aliasing free reconstruction.

(i) $sinc(200t) + 3sinc^{3}(120t)$
(ii) $sinc(250t)sinc(500t)$
(iii) $sinc(400t)sin(200t)$

Q5b. Assume the signal $f(t) = sinc(100t) + \cos(150\pi t)$ is sampled using the sampling frequencies f_1 = 200 Hz and f_2 = 120 Hz to obtain $f_1[n]$ and $f_2[n]$. Draw the frequency domain diagram of f(t), $f_1[n]$ and $f_2[n]$. Are you going to observe aliasing problem in any case. If yes, indicate the spectrum/spectra which contain(s) aliasing. What would be the effect of the aliasing during reconstruction?

CO5 Marks 4 + 5 = 9