

TRIBHUVAN UNIVERSITY
 INSTITUTE OF ENGINEERING
Examination Control Division
 2081 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX 651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. a) Define energy signal and power signal. Determine whether the signal $x(t) = e^{-3t}$ is a power signal or energy signal or neither energy nor power signal. [3+3]
- b) Define continuous time unit step signal. Derive the necessary condition for the signal $x(t) = e^{j\omega t}$ to be periodic. [1+3]
2. a) Derive the trigonometric fourier series expansion of a continuous-time periodic signal $x(t)$. [5]
- b) State and prove the time-scaling property for continuous-time fourier series pair. [5]
- c) State and prove frequency shifting property of discrete time fourier series. [3]
3. a) Find the fourier transform of the signal $x(t) = e^{-|at|}$; $a > 0$ and also plot the frequency spectrum. [5]
- b) Show that the convolution in time domain results multiplication in frequency domain using continuous time fourier transform. [5]
4. Determine the discrete time fourier transform of signum function ($\text{sgn}[n]$) and use it to find the DTFT of unit-step signal $u[n]$. [6+6]
5. a) State and prove the linearity and time shifting properties of DTFT [6]
- b) Define sampling theorem and Nyquist criteria for sampling. Find the Nyquist rate for the signal: $x(t) = 20 \sin(500\pi t) + 10 \cos(300\pi t) - 50 \cos(1000\pi t)$ [3+3]
6. a) Derive convolution integral for continuous LTI system. [5]
- b) Find convolution between the signals $x[n] = \{3, 5, 6, 9\}$ and $h[n] = \{-1, 3, 5\}$. Choose your appropriate origin. Show the output signal. [6]
7. a) Derive the expression for impulse response of RC filter and plot the magnitude and phase response. [6]
- b) Find the frequency response ($e^{j\omega}$), plot the magnitude and impulse response $h[n]$ for a system characterized by linear constant coefficient difference equation

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

[6]

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1. a) Briefly explain CT unit impulse, unit step and unit ramp signal. What is the relationship between unit impulse, unit step and unit ramp signal? [4]
 - b) Sketch the signal $x(t) = 5\cos(t)$. State whether the given signal is energy signal or power signal. [4]
 2. Write down the condition of convergence of continuous time Fourier series. Find the Fourier series coefficient a_k for the continuous time period signal. [3+5]
- $$x(t) = \begin{cases} 1.5, & 0 \leq t < 1 \\ -1.5, & 1 \leq t < 2 \end{cases}$$
3. State and prove:
 - a) Parseval's theorem for a DT aperiodic signal. [4]
 - b) Convolution property of the CT Fourier Transform. [4]
 4. a) Derive the expression of Discrete Time Fourier Transform for periodic Sequence. [7]
 - b) Differentiate between energy and power spectral density. [4]
 5. a) How does Nyquist criteria prevent aliasing? Explain with diagram. [4]
 - b) Find the Nyquist rate and interval for the following signal: [4]

$$x(t) = 2\cos(100\pi t) \cos(300\pi t)$$
 6. a) Derive the convolution sum for an LTI system. [6]
 - b) Determine if the following system is linear $y[n] = ax[n] + b$ [4]
 7. a) Derive the expression for impulse response of ideal low pass filter. [5]
 - b) Define LTI system. Explain the properties of discrete time LTI system. [6]
 8. Find the output of an LTI System given by: $x[n] = \delta[n] + 2\delta[n-1] - \delta[n-3]$ and $h[n] = 2\delta[[n+1]] + 2\delta[n-1]$. [8]
 9. Find impulse response for the DT system given by the following Linear Constant Coefficient Difference Equation. $y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = 2x[n]$. [8]

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1. Define Power and Energy Type continuous Time signal with suitable examples. Check whether these signals are Energy or Power Type with required calculation. [2+4]
 - a) $x(t) = u(t)$
 - b) $x(t) = \delta(t)$
2. Derive the expression of Fourier Series Coefficient in exponential form for Continuous time periodic signal. Describe the condition for existence of Fourier series with suitable examples. [5+3]
3. a) Find the Fourier Transform of the signal $x(t) = e^{-at}|t|$; $a > 0$ and also plot the frequency spectrum. [5]
 - b) Show that the convolution in time domain results multiplication in frequency domain using continuous time Fourier Transform. [5]
4. Derive the expression of Fourier Transform of Discrete Time aperiodic Sequence. [8]
5. Define sampling theorem. Determine the Nyquist rate for the continuous time signal, $x(t)$.
 $x(t) = 1 + \cos(2000\pi t) + \sin(4000\pi t)$. [2+4]
6. What are the properties of system? Determine whether the given system is time-variant or not.
 $y(t) = \sin[x(t)]$ [2+5]
 - a) Describe different Properties of Discrete time LTI system with suitable example. [5]
 - b) Convolve the signal $x[n] = \{3, 1, 5\}$ and $h[n] = \{1, 4, -2, 3\}$ [5]
8. a) Describe bode plot with example [4]
 - b) Derive the expression for impulsive response of ideal low pass filter and discuss. [5]
9. a) State and prove the Time-Scaling property for discrete-time Fourier series pair. [4]
 - b) Find the frequency domain representation (both magnitude and phase plot) of a periodic signal defined as $x[n] = \{1, -0.5, 0, 0, 0.5\}$, with period $N = 5$. [6]
10. What is aliasing and how can it be prevented? [6]

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1. Show that any signal can be decomposed into an odd and even component. Is the decomposition unique? Illustrate your argument using the signal.

$$x[n] = \{2, 3, 4, 5, 6\} \quad [3+5]$$

2. a) Derive the Trigonometric Fourier series expansion of a continuous-time periodic signal $x(t)$. [5]

- b) State and prove the Time-Shifting property for discrete-time Fourier series pair. [4]

3. a) State and prove convolution property of discrete time periodic signals. [2+3]

- b) What is Parseval's relation? Prove Parseval's relation for continuous-time periodic signal. [2+3]

4. a) Find the Fourier Transform of the signal $x(t) = e^{-at}|t|$; $a > 0$ and also plot the frequency spectrum. [5]

- b) Obtain the Fourier transform of the continuous-time signal. [6]

5. a) What is convolution? Obtain the expression for convolution sum. [6]

- b) Find and plot the convolution between [8]

$$x[n] = \begin{cases} |n|; & -2 \leq n \leq 2 \\ 0; & \text{otherwise} \end{cases} \quad \text{and} \quad y[n] = \begin{cases} 2n; & 2 \leq n \leq 5 \\ 0; & \text{otherwise} \end{cases}$$

6. a) What do you mean by aliasing? Compute Nyquist rate for [2+4]

$$x(t) = 5\cos(1500\pi t) - 2\sin(2000\pi t) + 3\sin(1850\pi t).$$

- b) Evaluate the Step response of RC filter. [5]

7. a) What is the condition for LTI system to be causal? [5]

- b) Determine if the following system is Linear [3]

$$y[n] = ax[n] + b$$

- c) Check if the system is time invariant [3]

$$y[n] = nx[n] - x[n-1]$$

8. a) Define energy and power signal. [2]

- b) Determine the energy of the signal [4]

$$X(t) = 5\cos\pi t + \sin 5\pi t, -\alpha < t < \alpha$$

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Subject: - Signal Analysis (EX 651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. a) Define energy signal and power signal. Determine whether the signal $x(t) = e^{-5t}u(t+2)$ is energy signal or power signal or neither energy nor power signal. [3+4]

b) $x(t)$ and $y(t)$ are continuous time signals defined as:

$$x(t) = \sin 6\pi t \text{ and } y(t) = \cos 8t$$

Determine whether:

- (i) $x(t)$ is periodic.
- (ii) $y(t)$ is periodic.
- (iii) $x(t) + y(t)$ is periodic

If periodic, find the fundamental time period of $x(t)$, $y(t)$ and $x(t)+y(t)$. [3]

2. a) A continuous time Fourier Series is evaluated over infinite duration while a discrete time Fourier series is evaluated over one time period only. Why? [2]

b) Obtain fourier series coefficients of the signal:

$$x[n] = 1 + 3 \cos\left(\frac{2\pi n}{N} + \frac{\pi}{3}\right)$$

Where,

N is the fundamental time period of $x[n]$.

Also, Plot magnitude and phase spectrum of the coefficients. [2+2+2]

c) Derive exponential form of Fourier series for discrete time signal. [4]

3. a) Derive the Fourier Transform equation for discrete time aperiodic signals. Also prove that the DTFT is periodic with period 2π . [4+2]

b) Given discrete time signal is :

$$x[n] = a^n U[n], |a| < 1$$

Given that Fourier transform of $x[n]$ is continuous in nature, plot magnitude and phase response of the transformed signal. [4]

4. a) State and prove duality property of continuous time Fourier Transform. [5]

b) State and explain Energy density spectrum. [5]

5. a) Derive the convolution integral. [4]

b) Find the convolution between the following sequences.

$$h[n] = \{2, 0, -1, 2\}$$

$$x[n] = \{1, 2, -1, 3\}$$

Choose origin as per your choice. [6]

6. a) What do you mean by causal and non causal systems? Derive the condition for a continuous time LTI system to be causal. [2+3]
- b) Prove, with necessary derivations, that an ideal low pass filter is not physically realizable. Also derive the expression for step response of ideal low pass filter. [3+3]
7. a) Define Nyquist sampling theorem. Explain using frequency domain analysis of impulse train sampling. [6]
- b) Find the frequency response and impulse response for a system characterized by linear constant coefficient difference equation $y[n] = 0.5y[n-1] + x[n]$. [4+2]
8. Consider a continuous time system with input $x(t)$ and output $y(t)$ related by $y(t) = x(t-2) + x(2-t)$. Is the system Linear Time invariant? Explain. [5]

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Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX 651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. a) Define even and odd signal in both continuous time and discrete time with examples. [4]
 b) Explain time shifting, time scaling and time inversion of a continuous time signal with example. [3]
2. a) Derive necessary condition for a discrete time signal to be periodic. Find the energy and power of the discrete time signal $x[n] = e^{jw_0 n} u[n]$, where $u[n]$ is unit step function. [3+4]
 b) Explain the behaviour of discrete time complex exponential $x[n] = c\alpha^n$ where c and α are real. [4]
3. a) What is Parseval's relation? Prove Parseval's relation for continuous-time periodic signal. [2+4]
 b) State and prove time scaling properties of exponential fourier series. [4]
4. a) Derive Fourier series synthesis and analysis equation for discrete time periodic signal. [6]
 b) Explain with necessary derivation that the discrete time Fourier Transform is periodic in frequency with period 2π . [4]
5. a) State and prove frequency derivative property of fourier transform. Use same property to find fourier transform of $x(t) = t^* \exp(-a^*t)u(t)$, $a > 0$ [3+4]
 b) Find Discrete time Fourier transform of the discrete time signal $x[n] = u[n-2] - u[n-6]$. [5]
6. a) What is aliasing in sampling? Determine the Nyquist rate for the continuous time signal $x(t) = 1 + \cos(2,000\pi t) + \sin(4,000\pi t)$ [2+4]
 b) Derive formula to calculate the impulse response of Ideal low pass filter in discrete time. [5]
7. a) Derive convolution sum. [4]
 b) Find the convolution sum of $x[n] = \{1, 3, 4, 3, 1\}$ and $h[n] = \{2, 2, -2\}$ [6]
8. Write short notes: [3x3]
 - a) Frequency shifting DT FT
 - b) LTI system
 - c) Bode plot

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Subject: - Signal Analysis (EX 651)

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1. Derive necessary condition for a discrete time signal $x[n] = e^{j\omega_0 n}$ to be periodic.

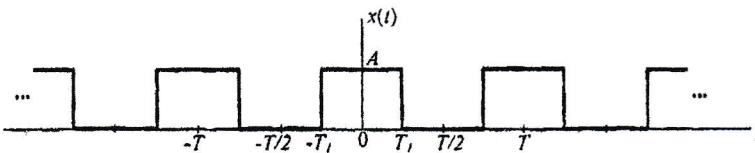
Determine whether the discrete time signal $x[n] = 3e^{j3\pi(n+\frac{1}{2})/5}$ is periodic or not. [4+4]

2. Derive the expression to compute Fourier series coefficients of exponential Fourier series. Explain Gibbs phenomenon. [8]

3. a) State and prove Parseval's relation for Discrete-Time Fourier Series (DTFS). [5]
 b) A periodic square wave as shown in figure below is defined over one period as: [5]

$$x(t) = \begin{cases} A, & |t| < T_1 \\ 0, & T_1 < |t| < T/2 \end{cases}$$

Determine the Fourier series coefficients for $x(t)$.



4. a) State and prove the convolution property of continuous-time Fourier Transform. [5]
 b) Find the Fourier Transform of the signal $x(t) = e^{-at} u(t)$, where a is real constant. Also, draw its amplitude and phase spectra. [6+2]
5. What is aliasing? Determine Nyquist rate for the continuous time signal $x(t) = 1 + \cos(2,000\pi t) + \sin(4,000\pi t)$ [2+4]
6. Derive formula to calculate convolution integral for continuous time LTI system. Find convolution between following continuous time signals $x(t) = e^{-t} u(t)$ and $y(t) = e^{-2t} u(t-3)$ [5+6]

7. a) The impulse response of a LTI system is

$$h[n] = \{1, 2, 1, -1\}$$



Determine the response of the system to the input signal

$$x[n] = \{1, 2, 3, 1\}$$

[6]



- b) Check whether the discrete-time system described by the following input-output relation is linear or non-linear. [4]

$$y[n] = 2 \times x[n] + 5$$

8. Define invertibility of LTI system with suitable example if impulse response $h[n] = U[n]$ and inverse system $h'[n] = \delta[n] - \delta[n-1]$. Prove that their convolution must be $\delta[n]$. [3+4]
9. Find the frequency response $H(e^{j\omega})$ and impulse response $h[n]$ for a system characterized by linear constant coefficient difference equation $y[n] = 0.3y[n-1] + x[n]$. [7]

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Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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1. a) Define 'continuous' and discrete time signals giving suitable examples. [3]
- b) Show that any signal can be decomposed into an odd and even component. [4]
2. a) Derive necessary condition for a discrete time signal to be periodic. Determine whether the following signals are energy or power signal $f(t) = 5 \cos \pi t + \sin 5 \pi t$ [3+3]
- b) Explain the behaviour of continuous time complex exponential signal $x(t) = c e^{at}$. [3]
3. State Parseval's relation for discrete time Fourier series. Find the average power of discrete time periodic signal $X[n] = \sin\left(\frac{\pi n}{3}\right)$ using Fourier series coefficient. [2+5]
4. a) Obtain the expression for analysis equation for DTFS. [6+4]
- b) Show that fourier series coefficient of discrete time signal is periodic in nature. [6]
5. a) State and prove Time shifting property of continuous time Fourier Transform. [2+5]
- b) Find the Fourier transform of continuous time unit step signal. [5]
6. a) What do you mean by sampling, state the requirement of sampling frequency?
 Determine Nyquist rate for $x(t) = \frac{1}{2\pi} \cos(100\pi t) \cos(300\pi t)$ [2+4]
- b) Derive the transfer function for discrete time low pass filter. [4]
7. a) Determine whether the given system is linear or not. [4]
- b) Derive convolution integral of a continuous time signal. [6]
8. Write short notes [3×3]
 - i) Discrete data function
 - ii) Energy and power signal
 - iii) Causal and non causal system

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1. Define even and odd signals. Develop the even/odd decomposition of a general signal $x(t)$. [4+4]
2. a) Derive the Fourier Series Expansion of a continuous – time periodic signal $x(t)$. [5]
 b) Find Fourier series coefficients and associated phase of the signal with fundamental frequency w_0 : $x(t) = 1 + \sin(w_0 t) + 2 \cos(w_0 t) + \cos(2w_0 t + \pi/4)$ [5]
3. a) Explain energy density spectrum of a continuous – time aperiodic signal with necessary derivation. [5]
 b) Find and sketch the Fourier Transform of exponential signal: $x(t) = \exp(-a|t|) u(t)$, $a > 0$. [5]
4. a) State and prove convolution theorem of discrete – time aperiodic signal. [6]
 b) Compute four – point DFT of four – point sequence: $x[n] = \{0, 1, 2, 3\}$. [6]
5. Define sampling theorem and Nyquist criteria for sampling. Find the Nyquist rate for the signal: $x(t) = 20 \sin(500\pi t) + 10 \cos(300\pi t) - 50 \cos(1000\pi t)$ [6]
6. a) Define system. Explain causality and time variance properties of continuous – time LTI system. [2+4]
 b) Find output $y(t)$ of LTI system if input $x(t) = \exp(-at) u(t)$ and impulse response $h(t) = u(t)$. [5]
 c) Derive the conditions for distortionless transmission for continuous – time LTI system. [4]
7. a) Derive the convolution sum for discrete – time LTI system. [5]
 b) Perform convolution between signals: $x_1[n] = \{1, 2, 1, -1\}$ with origin at second position from left and $x_2[n] = \{1, 2, 3, 1\}$ with origin at first position from left. [5]
 c) Find $H(e^{j\omega})$ and $h[n]$ for a discrete – time LTI system with difference equation:

$$y[n] = 0.5 y[n - 1] + x[n]$$
 [5]

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1. Differentiate between energy signal and power signal. Show by giving suitable example that power of the energy signal is zero and energy of the power signal is infinite. [2+5]
2. a) Derive necessary condition for a discrete time signal to be periodic. [3]
b) Determine whether the following discrete time signals are periodic or not [4]
 - (i) $SPn 5n$
 - (ii) $\cos\left(\frac{2\pi n}{5}\right) + \cos\left(\frac{2\pi n}{7}\right)$
3. a) Derive the expression to compute Fourier series coefficients of exponential Fourier series. [5]
b) Explain the Dirichel Conditions for convergence of Fourier series. [3]
4. a) State and prove time shifting and time scaling properties of continuous time Fourier series. [4]
b) Find Fourier series coefficient of discrete time periodic signal

$$x[n] = \sin w_0 n \quad \text{where } w_0 = \frac{2\pi}{N}$$

Plot the signal when $N = 5$. [4]
5. How do you find the Fourier transform of periodic signals? Find the Fourier transform of continuous time rectangular pulse and constant amplitude A and explain the result. [5+5]
6. Show that convolution in time domain results multiplication in frequency domain using continuous time Fourier transform. Determine discrete time Fourier transform of the discrete time signal $x(n) = 2^n U[n]$ and also plot magnitude and phase spectrum. [5+5]
7. State and prove frequency shifting property of Fourier transform. [2+3]
8. What is aliasing? Determine the Nyquist rate for the continuous time signal $x(t) = 1 + \cos(2,000\pi t) + \sin(4,000\pi t)$ [2+4]
9. a) Derive convolution integral for continuous time LTI system. [6]
b) Compute convolution sum of signal $x[n] = \{1, 2, 0, -1\}$ and $h[n] = \{2, 0, 2\}$. [7]
10. For a system characterized by linear constant coefficient difference equation: $y(n) = 0.3y(n-1) + x(n)$, find the transfer function, plot magnitude and find the impulse response of the system. [6]

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1. Define Energy signal and power signal. Determine whether the signal $x(t) = e^{-3t}$ is a power signal or energy signal or neither energy nor power signal. [3+4]
2. Derive the necessary condition for the discrete time signal $x[n] = e^{j\omega_0 n}$ to be periodic. [4]
3. Derive the expression of continuous time exponential Fourier series $x[n] = A \sin \omega_0 n$ [6]
4. Find Fourier series coefficients of signal and plot the coefficients. [5]
5. State and prove the frequency shifting and convolution properties for discrete time Fourier series pair. [3+3]
6. State and prove the Parseval's relation for energy density spectrum. [2+4]
7. Find Fourier transform of signal $x[n] = a^n u[n]$ (where $0 < a < 1$) and plot magnitude and phase spectrum. [3+2]
8. What is aliasing effect and how can we overcome it? Determine Nyquist rate for a continuous time signal $x(t) = 2\sin 40\pi t + 10\cos 200\pi t + 5\cos 100\pi t$. [3+3]
9. What is LTI system? For LTI system, describe the properties: (a) linearity (b) stability (c) time invariance and (d) causality. [2+8]
10. Derive the expression for impulse response of RC filter and plot the magnitude and phase. [4+2]
11. What do you mean by convolution? Derive the expression for convolution of two discrete time signals. [2+6]
12. A discrete time LTI system is defined by the impulse response $h[n] = \begin{cases} n & ; -2 \leq n \leq 2 \\ 0 & ; \text{otherwise} \end{cases}$. If the input to the given system is $x[n] = \{1, -0.25, 0, -1, 0.5, -0.5\}$, find and plot the output of the system. [7]
13. Find the Fourier Transform of the unit step signal. [4]

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1. Differentiate between continuous time and discrete time signals with examples. Show that

$$U[n] = \sum_{k=0}^{\infty} \delta[n-k] \quad [2+4]$$

2. Calculate the fundamental period and fundamental frequency of the periodic signal

$$x[n] = 3 \sin\left(\frac{7\pi}{5}n + \frac{\pi}{2}\right) \quad [4]$$

3. Derive the expression for finding even and odd part of signal $x(t)$. Explain time scaling and time folding. [2+3]

4. Define discrete time complex exponential signal and its different types of behavior. [2+3]

5. a) Derive the expression for Fourier transform equation and inverse Fourier transform equation for continuous time aperiodic signals. [8]

b) State and prove Frequency shift property of the continuous time Fourier Transform. [3]

6. State and prove Parseval's relation for the Discrete time periodic signal. [5]

7. What are the differences between Fourier series and Fourier Transform? Find the Fourier

transform of the discrete time signal $x[n] = a^n \begin{cases} |a| < 1 \\ 0 < a < 1 \end{cases}$ [2+6]

8. Derive the expression for convolution integral for continuous time signal. [6]

9. What is LTI system? In a LTI system show that convolution operation is commutative, find $y[n]$ when $x[n] = \{1, 2, 3, 4\}$ and $n[n] = \{2, 1, 2\}$ [2+3+5]

10. What is sampling? Determine the Nyquist rate for the following signal: [2+3]

$$x(t) = 1 + \cos(200\pi t) + \sin(4000\pi t)$$

11. Derive Formula to calculate the impulse response of continuous time ideal low pass filter. Is this system practically realizable or not. [4+2]

12. Write short notes on: [3×3]

- Energy and power signals
- Invertibility of LTI system
- Nyquist theorem

Exam.	DATE	TIME	MARKS
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define even and odd discrete time signal. Derive the periodicity condition for discrete time signal. [2+3]
- b) Define discrete time delta function or signal. Show the relationship between delta function and unit step function. [2+3]
2. a) Derive Fourier series representation for discrete time signal. [5]
- b) Find the Fourier Series coefficient of the following continuous time periodic signal. [5]

$$x(t) = \begin{cases} 1.5 & 0 \leq t < 1 \\ -1.5 & 1 \leq t < 2 \end{cases} \quad \text{with fundamental frequency } \pi.$$
3. a) Derive the expression for Fourier transform of continuous time periodic signal. [5]
- b) Find the Fourier transform of the signal $x(t) = e^{-2|t-1|}$ [5]
4. a) State and prove the convolution property of continuous-time Fourier series. [2+4]
- b) What is Parseval's relation? Prove parseval's relation for discrete-time periodic signal. [2+4]
5. Find inverse Fourier transform of the rectangular pulse. [6]

$$X(jw) = 1 \quad -w_c < w < w_c \\ = 0 \quad \text{other wise}$$
6. What do you mean by convolution? Derive convolution sum expression. [2+5]
7. a) What do you mean by sampling? Explain. [2]
- b) The signal is sampled at the rate $F_s = 300$ samples/sec. Determine the frequency of the discrete-time signal $x[n] = x_a(nT), T = 1/F_s$ [4]
8. What are the properties of LTI systems? Determine whether the given system is linear or not? $y[n] = e^{x[n]}$ [4+5]
9. Consider a system with impulse response $h[n] = \{1, 2, 2, 5\}$ [8]

Determine the output $y[n]$ for input $x[n] = \{1, 3\}$
10. The signal $x[n] = \cos \frac{\pi}{3} n$ is a periodic signal. What happens if the fundamental frequency of this signal is increased by 2π ? [2]

Exam.	BE	Regular	
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

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Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Define energy signal and power signal. Determine whether the signal is a power signal or energy signal. [3+3]
 $x(t) = e^{-at}$ for $a > 0$
- b) Define discrete time unit step signal. Derive the necessary condition for the signal $x[n] = e^{j\omega n}$ to be periodic. [1+3]
2. a) Derive exponential form of Fourier series for continuous time signal. [5]
- b) State and prove Parseval's relation for the Discrete time periodic signal. [5]
3. Derive the expression for Fourier transform of continuous-time periodic signals. Using this expression obtain the Fourier transform of periodic signal. [4+4]
 $x(t) = 1$ for $0 < t < T, 0$ otherwise
4. a) State and prove the linearity and time shift properties of discrete time Fourier series representation. [6]
- b) State and prove the conjugation property for continuous time Fourier transform. Show that if the signal is real valued in time domain, its spectrum is conjugated symmetric. [4+2]
5. Obtain the DTFT of the signal $x[n] = (n+1)a^n u[n], 0 < a < 1$ [6]
6. What is convolution? Obtain the expression for convolution integral. [2+6]
7. What is impulse train sampling? Explain the aliasing effect that may occur in impulse train sampling. How do you reconstruct original signal from its sample? [1+2+3]
8. What is LTI system? Explain the commutative, associative and distributive properties of discrete time LTI systems. [2+6]
9. The impulse response of a discrete time LTI system is $h[n] = \{1, 1, 2, -1\}$ if input is $x[n] = \{1, 2\}$, find the convolution sum and sketch the output $y[n]$. [6]
10. Find the frequency response $H(e^{j\omega})$ and impulse response $h[n]$ for a system characterized by linear constant coefficient difference equation $y[n] = 0.5y[n-1] + x[n]$. [6]

Exam. Level	New Back (2066 & Inter. Batch)
BE	80
BEN, BPL	32
III / II	Time 3 hrs.

Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Find the energy and power of the signal $x[n] = e^{j\omega n} u[n]$. $u[n]$ is unit step function. What is the period of signal $x[n] = \cos\left(\frac{41\pi}{7}n\right)$? [6]
2. Plot the signal $x(t) = t(u(t+3) - u(t-3))$. [2]
3. Find Fourier series coefficients for periodic rectangular pulses with unity amplitude. Draw the magnitude spectrum. [5+1]
4. Derive the expression for discrete time Fourier series representation of the signal $x[n]$ periodic with period of N. [7]
5. Determine the expression of Fourier Transform for continuous time aperiodic signal. [7]
6. Perform the convolution and draw output $y[n]$ $x[n] = \{1 \ 2 \ 2 \ 3\}$ and $h[n] = \{1 \ 4 \ 3\}$.
 \uparrow \uparrow [7]
7. State and prove Parseval's theorem for continuous time aperiodic signal. [2+4]
8. What is aliasing effect and how can we overcome it? Determine the Nyquist rate for a continuous time signal $x(t) = 6 \cos 50\pi t + 20 \sin 300\pi t - 10 \cos 100\pi t$. [3+3]
9. Find convolution between two signals $x(t) = \begin{cases} e^{0.5t} & \text{for } 0 < t < 5 \\ 0 & \text{otherwise} \end{cases}$ and $h(t) = \begin{cases} 1 & \text{for } 1 < t < 3 \\ 0 & \text{otherwise} \end{cases}$ [7]
10. Derive the expression for impulse response and step response of ideal low pass filter. [4+4]
11. For the LTI system, describe following properties: (a) linearity (b) causality (c) stability (d) time invariance. [6]
12. If the impulse response of continuous time linear time invariant system is $h(t) = e^{-t}u(t-3)$ and input to the system is $x(t) = u(t-2)$, determine the output $y(t)$ of the system. [8]
13. Describe bode plot with example. [4]

Exam. Level Programme Year / Part	Regular / Back		
	BE BEL, BEX III / II	Full Marks Pass Marks	Time
		80 32	3 hrs.

Subject: - Signal Analysis (EX6541)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Define energy and power signal with examples. Describe time shifting, time scaling of a signal. [3+4]
2. Derive convolution integral for continuous time LTI system. [8]
3. State and prove Parseval's Relation for Continuous Time Periodic Signal. [6]
4. Explain aliasing that may occur in any arbitrary band-limited signal $x(t)$ with band-width 'W'. [5]
5. Derive the expression for continuous time Fourier series in exponential form. [7]
6. Explain the convolution properties of continuous time Fourier transform. [6]
7. Discuss the following properties of continuous time Fourier series. (a) Time shifting (b) Time scaling (c) Conjunction. [6]
8. Derive the expression of Fourier transform for continuous time signal. [8]
9. Derive the expression for impulse response of ideal low pass filter and discuss. [5]
10. Find the Fourier Transform of a continuous time unit step signal. [5]
11. Discuss different methods to reconstruct a signal. Determine the Nyquist rate for a continuous time signal $x(t) = \frac{1}{2\pi} \cos(200\pi t) \cos(300\pi t)$. [4+4]
12. Convolve the signals $x[n] = \{1, 2, 1\}$ and $h[n] = \{\uparrow, 2, 3, 1\}$. [6]
13. If the signal is periodic, find the fundamental period of the signal $x[n] = \cos\left(\frac{\pi}{2}n\right) \cdot \cos\left(\frac{\pi}{4}n\right)$. [3]

Exam. Level	BE	New Back (2066 & Later Batch) Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Calculate the total energy and total average power of the signal given below:

$$x(t) = (3+4j)e^{2t}u(-t)$$

[3+1]

Also state whether the signal is energy signal, power signal or neither.

2. Determine whether the signal $x[n] = 5\sin\left(\frac{3\pi}{8}n - \frac{\pi}{2}\right) - 2\cos\left(\frac{7\pi}{12}n\right)$ is periodic or not. If the signal is periodic, calculate its fundamental period and fundamental frequency. [4]

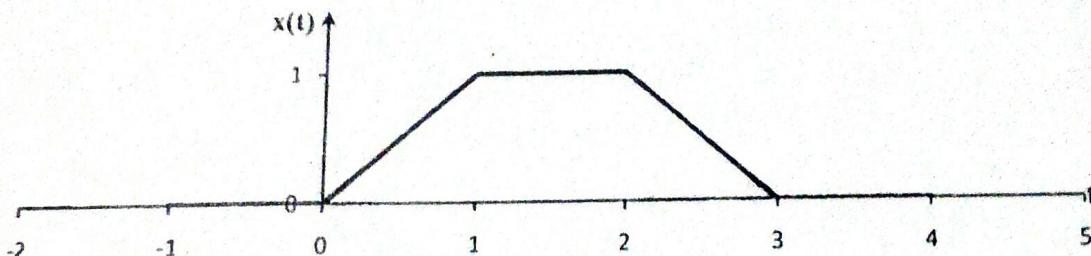
3. How could you represent a signal $x(t)$ with harmonically related exponentials? State and prove conjugation and conjugate symmetry property of CTFS. [4+4]

4. Find the Fourier series coefficients of the signal [6]

$$X[n] = 1 + \sin(2\pi/N)n + 3 \cos(2\pi/N)n + \cos(4\pi/N)n$$

[8]

5. Find the Fourier transform of a trapezoidal signal shown below:



6. How can you generate Fourier transform for discrete time periodic signals? Explain. [3]
7. State and prove Parseval's relation for discrete time Fourier transforms. [5]
8. Compute 4-point DFT of a signal $x[n] = \{2, 1+j, 1-j\}$ and plot its magnitude and phase spectrums. [4+2]
9. State and prove sampling theorem for low pass signals. [6]
10. The impulse responses of two LTI systems are given by $h_1(t) = e^{-\frac{t}{2}}u(t)$ and $h_2(t) = u(t) - u(t-5)$. Determine the equivalent impulse response if these two systems are connected in cascade. Also sketch the graph of equipment impulse response. [8+2]
11. Derive the impulse response for ideal low pass filter with cutoff frequency ω_c . [5]
12. Given a system $Y[n] = 0.5y[n-1] + x[n] + x[n+1]$. Find out its impulse response and frequency response. [7]
13. What are the properties of LTI system? Show that the output of an LTI system is stable if the impulse response is absolutely summable. [8]

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Exam.	Level	Full Marks	80
Programme	BE, BEX	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX651)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

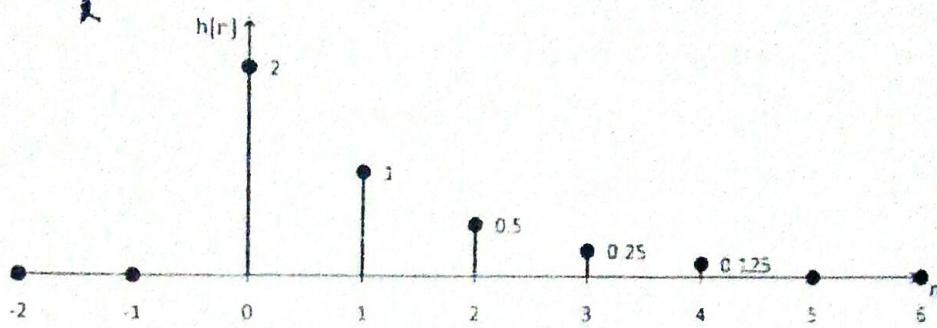
- 3 ✓ 1. What do you understand by periodic and aperiodic signals? Explain with the help of examples. [4]
2. Determine whether the following signals are energy or power signals. [4]
- $f(t) = 3 \cos(2\pi t)$
 - $x[n] = \cos\left(\frac{n}{6}\right)$
- 3 ✓ 2. What is the information provided by Fourier series coefficients of a signal? State and prove time shifting and conjugation properties of continuous time Fourier series representation. [1+6]
- 4 ✓ 3. Find out Fourier series coefficients of a periodic discrete time signal described over a period as [5+2]
- $$x[n] = \begin{cases} 2; & |n| \leq 1 \\ 0; & 1 < |n| \leq 1 \times 3 \end{cases}$$
- Using the Fourier series coefficients calculated above; find the Fourier series coefficients of the signal $e^{j\frac{4\pi}{7}n} x[n]$.
5. Given the relationship $y(t) = x(t)*h(t)$ and $g(t) = x(3t)*h(3t)$ and given that $x(t)$ has the Fourier transform of $X(j\omega)$ and $h(t)$ has Fourier transform $H(j\omega)$, use Fourier transform properties to show that $g(t)$ has the form $g(t) = Ay(Bt)$. Determine the values of A and B. [8]
- 3 ✓ 4. Explain the linearity and time shifting properties of continuous time Fourier transform. [4]
- 5 ✓ 5. Find the Fourier transform of continuous time unit impulse and rectangular pulse. Discuss the result. [6]
- 4 ✓ 6. Find the Fourier transform of everlasting sinusoid $X(t) = \cos\omega_0 t$. [4]
- 6 ✓ 6. What do you mean by aliasing? Explain with the help of frequency domain analysis for impulse-train sampling. [1+5]
- 5 ✓ 7. What are the properties of systems? Determine whether the given system is time-variant or not: $y(t) = \sin[x(t)]$. [2+3]
- 5 ✓ 8. Let $x(t)$ be the input to an LTI system with unit impulse response $h(t)$, where, $x(t) = e^{-at} u(t)$, $a > 0$ and $h(t) = u(t)$. Verify commutative law of LTI system. [5]

Q12. What is distortionless transmission? Derive the expression for unit step response of ideal low pass filter. **85**

[5]

Q13. A discrete time LTI system has an impulse response as shown below:

[6+2]



If the input to the given system is $x[n] = \{-0.25, 0.5, 1, -0.5, 0, 0.25\}$, calculate and plot the output of the system.

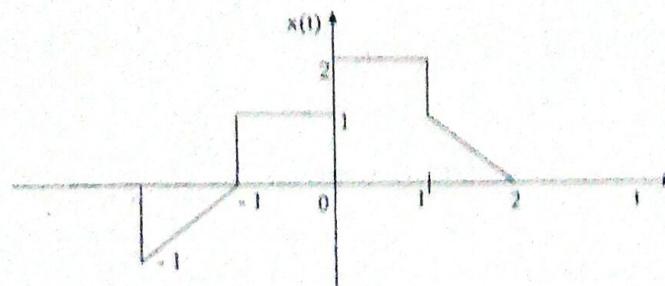
Q14. Define systems with memory and memory-less systems with examples. Explain the causality property of discrete time LTI systems. **176** [3+4]

Exam Level	B.E.	Full Marks	80
Programme	B.E., BE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Signal Analysis (EX631)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Define energy and power type signal with suitable examples. Sketch and label the signal $y(t) = \{x(t) + x(-t)\}u(t)$ for given signal $x(t)$ depicted below. [3+5]



2. Derive the expression for Fourier series representation of a signal $x(t)$ periodic with period T . [8]

3. Find the Fourier series representation of the signal $x[n] = \sum_{\ell=-\infty}^{\infty} \delta[n - \ell N]$. [6]

4. State and prove Parseval's theorem for continuous time aperiodic signal. [4]

5. ALTI system has input $x(t) = e^{-t}u(t)$ and impulse response $h(t) = e^t u(-t)$. Find output $y(t)$ of the system using Fourier transform of $x(t)$ and $h(t)$. [8]

6. Compute discrete time Fourier transform of the discrete time signal $x[n] = \left(\frac{1}{2}\right)^n u[-n-1]$ [5]

7. Find circular convolution of the signal $x[n] = \{1, 0, 0, 1\}$ and $y[n] = \{2, 0, 2\}$. [5]

8. What is sampling. How are spectrum of continuous time signal and its sampled version related? Illustrate with diagram. [6]

9. Write about the following properties of continuous time system: (a) Linearity (b) Causality (c) Memory (d) Stability (e) Time invariance. [5]

10. Derive the expression for impulse response and step response of first order continuous time system described by the differential equation $\tau \frac{dy(t)}{dt} + y(t) = x(t)$. [5]

11. If the impulse response of continuous time linear time invariant system is $h(t) = u(t) - u(t-3)$ and input to the system is $x(t) = u(t+4) - u(t)$, determine the output $y(t)$ of the system. [5]

12. Find output of a LTI system using convolution sum, if the input signal is $x[n] = \delta[n] + 2\delta[n-1] - \delta[n-3]$ and impulse response of the system is $h[n] = 2\delta[n+1] + 2\delta[n-1]$. [7]

13. For a system characterized by Linear constant coefficient difference equation $y[n] = 0.5y[n-1] + x[n]$, find the frequency response $H(e^{j\omega})$ and impulse response $h[n]$. Also plot the frequency response magnitude $|H(e^{j\omega})|$. [8]