TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2078 Chaitra**

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|---|---|---|---|
| **Exam.** | **Regular** | | |
| **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. Show that any signal can be decomposed into an odd and even component. Is the decomposition unique? Illustrate your argument using the signal.

   $x[n] = \{2, 3, 4, 5, 6\}$ [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 $x(t) = e^{-a|t|}$ ; $a > 0$ 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]

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

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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| 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 $x(t) = e^{-5t}u(t+2)$ 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:
   $x(t) = \sin 6\pi t$ 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 $2\pi$. [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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INSTITUTE OF ENGINEERING
**Examination Control Division**
**2076 Baisakh**

| Exam. | Back | | |
|---|---|---|---|
| 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.*
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- ✓ *Assume suitable data if necessary.*

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 $x[n] = e^{jw_o n}u[n]$, 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 $\alpha$ 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 $2\pi$. [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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TRIBHUVAN UNIVERSITY
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**Examination Control Division**
**2076 Bhadra**

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## *Subject:* - Signal Analysis *(EX 651)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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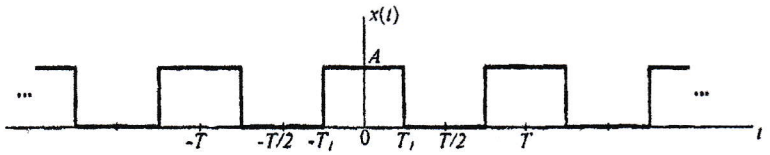
1. Derive necessary condition for a discrete time signal $x[n]=e^{jw_0 n}$ to be periodic. Determine whether the discrete time signal $x[n]=3e^{j3\pi(n+\frac{1}{2})/5}$ is periodic or not. [4+4]
2. Derive the expression to compute Fourier series coefficients of exponential Fourier series. Explain Gibbs 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
   $h[n] = \{1, \underset{\uparrow}{2}, 1, -1\}$
   Determine the response of the system to the input signal
   $x[n] = \{1, \underset{\uparrow}{2}, 3, 1\}$ [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] = δ[n] - δ[n-1]. Prove that their convolution must be δ[n]. [3+4]
9. Find the frequency response $H(e^{jw})$ 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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**2075 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
| 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 '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]
   $Y(t) = A\,x(t) + B$
   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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21 TRIBHUVAN UNIVERSITY
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**Examination Control Division**
**2075 Baisakh**

| Exam. | Back | | |
|---|---|---|---|
| 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.
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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]
   c) State and prove the time shifting property of Discrete – time Fourier series. [4]
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 $H(e^{jw})$ and h[n] for a discrete – time LTI system with difference equation: [5]
   $y[n] = 0.5\, y[n-1] + x[n]$

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21 TRIBHUVAN UNIVERSITY
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**2074 Bhadra**

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

***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**.*
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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
   $x[n] = \sin w_o n$ 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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**2073 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| 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.*
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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 $x[n]=e^{jwn}$ 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 $h[n]=\begin{cases} n & ; -2\le n\le 2 \\ 0 & ; \text{otherwise} \end{cases}$. 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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21 TRIBHUVAN UNIVERSITY
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**Examination Control Division**
**2073 Bhadra**

| Exam. | Regular | | |
|---|---|---|---|
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| 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.*
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1. Differentiate between continuous time and discrete time signals with examples. Show that
$U[n] = \sum_{k=0}^{\infty} \delta[n-k]$ [2+4]

2. Calculate the fundamental period and fundamental frequency of the periodic signal
$x[n] = 3\sin\left(\frac{7\pi}{5}n + \frac{\pi}{2}\right)$ [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 $x[n] = \{\underset{\uparrow}{1},2,3,4\}$ and $n[n] = \{\underset{\uparrow}{2},1,2\}$ [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]

   i) Energy and power signals
   ii) Invertibility of LTI system
   iii) Nyquist theorem

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21 TRIBHUVAN UNIVERSITY
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**Examination Control Division**
**2072 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| 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.*
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- ✓ *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 slep 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]

$$x(t)=\begin{cases}1.5 & 0\le t<1\\ -1.5 & 1\le t<2\end{cases}$$ 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]

$X(jw)=1 \quad -w_c<w<w_c$
$=0 \quad$ 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 Fs = 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 impluse response [8]

$h[n]=\{1, 2, 2, 5\}$

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 $2\pi$? [2]

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21 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2072 Ashwin**

| Exam. | 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.*
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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 $x[n] = e^{jwn}$ 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 $h[n] = \{\underset{\uparrow}{1}, 1, 2, -1\}$ if input is $x[n] = \{\underset{\uparrow}{1}, 2\}$, find the convolution sum and sketch the output $y[n]$. [6]
10. Find the frequency response $H(e^{jw})$ 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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**Examination Control Division**
**2071 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEX, BEL | 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. 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 $y[n]$ $x[n] = \{1\ \underset{\uparrow}{2}\ 2\ 3\}$ and $h[n] = \{1\ \underset{\uparrow}{4}\ 3\}$. [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]

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INSTITUTE OF ENGINEERING
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**2071 Bhadra**

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|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BEL, BEX | Pass Marks | 32 |
| Year / Part | III / II | Time | 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 $h[n] = \{\underset{\uparrow}{1}, 2, 3, 1\}$. [6]
13. If the signal is periodic, find the fundamental period of the signal $x[n]=\cos\left(\frac{\pi}{2}n\right).\cos\left(\frac{\pi}{4}n\right)$. [3]

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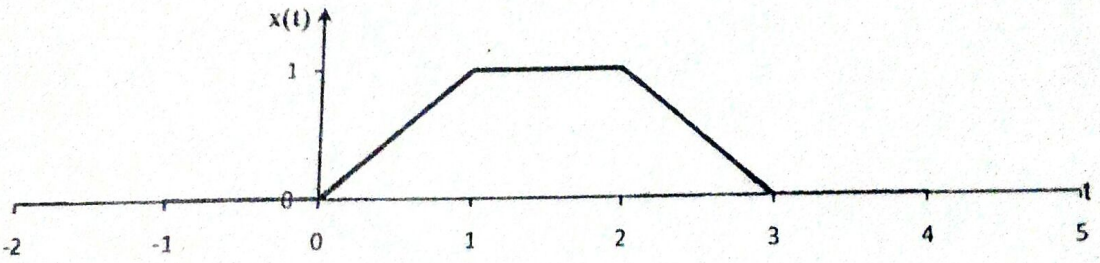
**2070 Magh**

| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| 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. Calculate the total energy and total average power of the signal given below:
   $x(t) = (3+4j)\, e^{2t}\, u(-t)$
   Also state whether the signal is energy signal, power signal or neither. [3+1]
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]
   $X[n] = 1 + \sin(2\prod/N)n + 3\cos(2\prod/N)n + \cos(4\prod/N)n$
5. Find the Fourier transform of a trapezoidal signal shown below: [8]




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 $\omega_c$. [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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## *Subject*: - Signal Analysis *(EX651)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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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]
   a) $f(t) = 3\cos(2\pi t)$
   b) $x[n] = \cos\left(\frac{n}{6}\right)$
3. 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. Find out Fourier series coefficients of a periodic discrete time signal described over a period as [5+2]

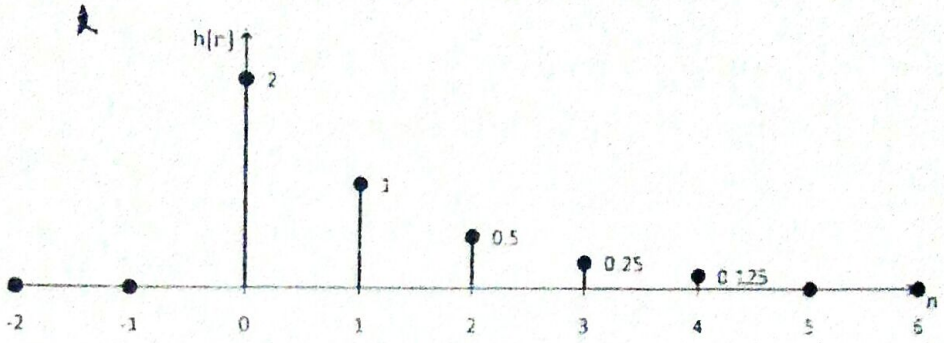
$$x[n] = \begin{cases} 2; & |n| \le 1 \\ 0; & 1 < |n| \le 1 \times 3 \end{cases}$$

Using the Fourier series coefficients calculated above; find the Fourier series coefficients of the signal $e^{j\frac{4\pi}{7}n} x[n]$.

9. 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]
8. Explain the linearity and time shifting properties of continuous time Fourier transform. [4]
7. Find the Fourier transform of continuous time unit impulse and rectangular pulse. Discuss the result. [6]
8. Find the Fourier transform of everlasting sinusoid $X(t) = \cos\omega_0 t$. [4]
6. What do you mean by aliasing? Explain with the help of frequency domain analysis for impulse-train sampling. [1+5]
10. What are the properties of systems? Determine whether the given system is time-variant or not: $y(t) = \sin[x(t)]$. [2+3]
11. 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]

12. What is distortionless transmission? Derive the expression for unit step response of ideal low pass filer. [5]

13. 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.

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

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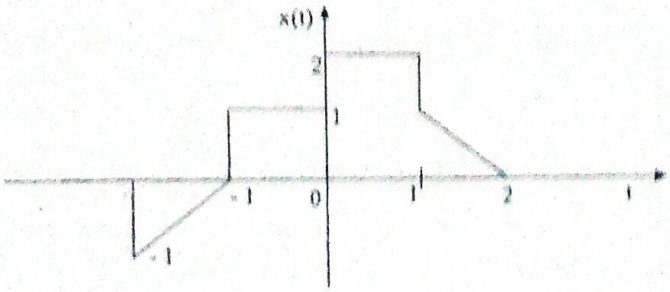
1. Define energy and power type signal with suitable examples. Sketch and label the signal $y(t) = \{x(t) + x(-t)\}u(t)$ for given signal $x(t)$ depicted below. [3+5]




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 $x[n] = \{\underset{\uparrow}{1}, 0, 0, 1\}$ and $y\{\underset{\uparrow}{2}, 0, 2\}$. [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 $H(e^{jw})$ and impulse response $h[n]$. Also plot the frequency response magnitude $|H(e^{jw})|$ [8]

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