**VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI**



|| Jai Sri Gurudev ||

**Sri AdhichunchanagiriShikshana Trust ®**

**BGS INSTITUTE OF TECHNOLOGY**

**BG Nagara -571448, Mandya District**



**Department of Electronics and Communication Engineering**

 **Question Bank of**

 **Signals and Systems (18EC44)**

Prepared By:

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| **Programme** | Electronics and CommunicationEngineering | **Degree** | Bachelor of Engineering |
| **Course** | Signals and Systems | **Semester** | IV |
| **Course Code** | 18EC44 | **Course Type** | Theory |
| **Total Planned****Hours** | 50 | **Credits** | 04 |
| **CIE** | 40 | **SEE** | 60 |
| **Faculty Name** | ANUSHA M N | **Semester/Section** | 4th ‘A’& ‘B’ Sec |

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| **Course Outcomes** |
| **CO1** | **Outline** the basics of Continuous time, Discrete time signals and Classifications of signals and system.. |
| **CO2** | **Analyze** thetime domain representations for LTI systems using Convolution**.** |
| **CO3** | **Explain** the concepts of Frequency domain representation of signals and its advantages**.** |
| **CO4** | **Apply** the properties of Fourier representations to signals**.** |
| **CO5** | **Show the** conversion of time domain signals to Z-domain**.** |

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| **Course Syllabus** |
| **Module** | **Contents** | **No. of Hours** |
| 1 | **Introduction and Classification of signals:** Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power.**Elementary signals/Functions:** Exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sync functions.**Operations on signals:** Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding.**Systems:** Definition, Classification: linear and non-linear, time variant and invariant, causal and non- causal, static and dynamic, stable and unstable, invertible. **L1, L2, L3.** | 10 |
| 2. | **Time domain representation of LTI System:** System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral and convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.**L1, L2, L3** | 10 |

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| 3 | System interconnection, system properties in terms of impulse response, step response in terms of impulse response (4 Hours).**Fourier Representation of Periodic Signals**: Introduction to CTFS and DTFS, definition, properties (No derivation) and basic problems (inverse Fourier series is excluded) (06 Hours). **L1, L2, L3** | 10 |
| 4 | **Fourier Representation of aperiodic Signals**:**FT representation of aperiodic CT signals - FT,** definition, FT of standard CT signals, Properties and their significance (4 Hours).**FT representation of aperiodic discrete signals-DTFT**, definition, DTFT of standard discrete signals, Properties and their significance (4 Hours).**Impulse sampling and reconstruction:** Sampling theorem (only statement) and reconstruction of signals (2 Hours). **L1, L2, L3** | 10 |
| 5 | **Z-Transforms:** Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems. **L1, L2, L3** | 10 |

**MODULE 1:**

**Introduction and Classification of signals, Elementary Signals, Operations on signals, Systems**

**1.** Distinguish between: **i)** Continuous and discrete-time signals **[4M]**

 **ii)** Deterministic and random signals **[4M]**

 **iii)** Even and odd signals **[4M]**

 **iv)** Energy and power signals **[4M]**

 **v)** Periodic and aperiodic signals **[4M]**

**2.** Find the even and odd components for the following signals:

**i)** x (t) = 1 + t cos(t) + t2 sin(t) + t3 sin(t) cos(t) **[4M]**

**ii)** x(t)=cos t +sin t+ sin t cos t **[4M]**

**iii)** x (n) = e**n** –e**-n [4M]**

**iv)** x (t) = (1+ )t) **[4M]**

**v)** x(t) = [sin **2 [4M]**

**3.** Detemine and sketch the even and odd part for the following signals:

**i)** x (t) = u (t)  **[5M]**

**ii)** x (t) = **[5M]**

**iii)** x (n) = u (n) **[5M]**

**iv)**

  **[5M]**

**v)**

 **[5M]**

 **vi)**

** [5M]**

 **vii)**

** [5M]**

**viii)**

** [5M]**

 **ix)**

 ** [5M]**

**x)**

 ** [5M]**

**xi)**

 ** [5M]**

**4.** Determine whether the given signal is periodic or aperiodic. If periodic, find the fundamental time period:

**i)** x(t)=sin2 (4t) **[4M]**

**ii)** x (t) = sin ( **[6M]**

**iii)** x (n) = **[6M]**

**iv)** x (n) =  **[6M]**

**v)** x(n) = (-1 )**n [4M]**

**vi)** x(n) = cos (2n) **[3M]**

**vii)** x(t) = cos (20πt) + sin (50πt) **[4M]**

**viii)** x(t) = cos sin **[6M]**

**5.** Determine whether the continuous-time signal is periodic or not. If periodic, find the

fundamental period:

**i)** x (t) =x1(t) + x2(t) + x3(t) with fundamental periods of 3.2, 9.6 and 12.8

secs for x1(t), x2(t) and x3(t) respectively **[5M]**

**ii)** x (t) =x1(t) + x2(t) + x3(t) with fundamental periods of 1.08, 3.6 and 2.025 secs for x1(t),

x2(t) and x3(t) respectively. **[5M]**

**6.** Determine whether the signals given are energy or power signals. Justify your

answer and further determine its energy or power signal:

**i)** x (n) **=** u (n) **[4M]**

**ii)** x (t) **=**   **[5M]**

**iii)** x (n)=8 (0.5)n u(n-1) **[4M]**

**iv)** x (n) = **A[4M]**

**v)** x(t)=e-at u(t) **[4M]**

**vi)** x (t) = **[5M]**

**7.** Determine whether the signals shown given are energy or power signals. Justify your

answer and further determine its energy or power signal:

**i)**

 **[6M]**

**ii)**

 **[5M]**

**iii)**

** [6M]**

**iv)**

** [5M]**

**7.** Sketch: **i)** z(t)=r(t+2) - r(t+1) - r(t-1) + r(t-2) **[4M]** **ii)** x(t) = u(t+1) – 2u(t) + u(t-1)**[3M]**

**iii)** y(t)=r(t+1) - r(t) + r(t-2) **[3M]** **iv)** z(t) = -u(t+3) + 2u(t+1) -2 u(t-1) + u(t-3) **[4M]**

**v)** x(t)=u(t+1)-2u(t)+u(t-1) **[3M]**

**8.** Find and sketch the following signals and their first derivatives:

 **i)** x(t)=u(t)-u(t-a) **[4M]** **ii)** y(t)=t[u(t)-u(t-a)] **[5M]**

**9.** Consider the signals x(t) & y(t) shown in fig (a)& (b) respectively. Sketch & label the

following signals: **i)** x(t) y(-t-1) **ii)** x(2t) y(2t+1) **iii)** x(t)[ δ(t-1) + δ(t-2)] +y(t) δ(t+2)

**iv)** x(2t) \* y(t+1)

** [8M]**

**10.** Given the signal x(t) as shown in fig, sketch the following:

**i)**x(2t+2) and **ii)** x(t/2-1)

 **[6M]**

**11.** Consider the signals x(t) and h(t) shown in fig (a) and (b) respectively. Sketch and label

the following signals i) x(t)h(t+1) ii) x(t-1)h(-t+1)

**[8M]**

**12.** If x(n) = (8-n){u (n) -u(n-8)}, Sketch: **i)** x(n) **ii)** y1 (n) = x (-2n-1) **iii)**y2(n) = x (-n-3)

**iv)** y3(n) = x(- + 3) **[8M]**

**13.** For the following system, check whether the given system is

 **i)** linear **ii)** Time-invariant **iii)** memory less **iv)** causal **v)** stable: **[5M]**

 **i)** y (t)=

**ii)** y(t)=x(t/2)

**iii)** y(t)=dr

**iv)** y(t)=x(t2)

**v)** y(t)=t x(t)

**vi)** y (n) =x(n)

**vii)** y(n)=ex(n)

**viii)** y(n)= log10 (|x(n)|)

**ix)** y (n) = x (n) + 3 u(n+1)

**x)** x(n)=g(n) x(n)

**14.** Construct the given signal x(t) in terms of g(t) shown in the fig below:

**i)**

** [5M]**

**ii)**

** [5M]**

**iii)**

**[5M]**

**MODULE-2: Time domain representation of LTI Systems**

**1.** Derive the expression for

**i)** Convolution sum **[4M] ii)** Convolution integral **[4M]**

**2.** P.T **i)** x (n) \* u (n-n0) = **[3M]**

**ii)** x(n)\*(n)=x(n) **[3M]**

**iii)** x(n)\*(n-n0)=x(n-n0) **[3M]**

**iv)** x (n) \* u (n) = **[3M]**

**3.** P.T **i)** x (t) \* u (t-t0) = **[3M]**

**ii)** x(t)\*(t)=x(t) **[3M]**

**iii)** x(t)\*(t-t0)=x(t-t0) **[3M]**

**iv)** x (t) \* u (t) = **[3M]**

**4.** State and prove the following properties of convolution sum :

**i)** Commutative property **[4M]**

**ii)** Associative property **[6M]**

**iii)** Distributive property **[4M]**

**6.** State and prove the following properties of convolution integral:

 **i)** Commutative property **[4M]**

 **ii)** Associative property **[6M]**

 **iii)** Distributive property **[4M]**

**7.** Compute the convolution of the two sequences:

**i)** x(n)={1,-2,3,-3} & h(n)={-2,2,-2} **[5M]**

**ii)** x1(n)={1,2,3} & x2(n)={1,2,3,4} **[5M]**

**iii)** x(n)={1,2,3,4} and h(n)={1,5,1} **[5M]**

**iv)** x(n)={1,3,2,2} and h(n)={1,4,2,1} **[6M]**

**8.** The impulse response of discrete time LTI system is given by, h(n)=u(n+1)-u(n-4). The

system is excited by the input sigal x(n)=u(n)-2u(n-2)+u(n-4). Obtain the response of the

system y(n)=x(n)\*h(n) and plot the same. **[7M]**

**9.** Evaluate the discrete time convolution sum for x1(n) = (1/2)n u(n-2) & x2(n)=u(n). **[6M]**

**10.** An LTI system is characterized by an impulse response, h(n)=(1/2)n u(n). Find the response of the system for the input x(n)=(1/4)n u(n). **[6M]**

**11.** An LTI system is characterized by an impulse response h(n)=(3/4)n u(n). Find the response of the system when the input x(n)=u(n). Also evaluate the output of the system at n=+5 and

n=-5. **[6M]**

**12.** An LTI system is characterized by an impulse response, Find the convolution of two finite duration sequences,

h(n)=an u(n) for all n and x(n) = bn u(n) for all n

i) when ab ii) when a=b. **[7M]**

**13.** An LTI system characterized by the impulse response h(n) = βn u(n) and input sequence x(n) = αn u(n) , find y(n) for **i)** α **ii)** α = β **iii)** α. **[10M]**

**14.**Evaluate y(n)=x(n)\*h(n) for the signal defined by: x(n)= βn u(n);| β|<1 and h(n)=u(n-3). **[6M]**

**15.** Evaluate y(t)=x(t)\*h(t) for the signal defined by x(t)=e-3t u(t) and h(t)=u(t+3) **[6M]**

**14.** If h(t)=u(t)-u(t-3) and x(t)=u(t)-u(t-1), determine the output y(t). **[8M]**

**16.** Determine the output of an LTI system for an input x(t)=u(t)-u(t-2) and impulse response h(t)=u(t)-u(t-2). **[8M]**

**17.** Given x(t)=t;0t1 and 0 elsewhere and h(t)=u(t)-u(t-2), evaluate and sketch y(t)=x(t)\*h(t). **[7M]**

**18.** An LTI system characterized by the impulse response, h(t) = u(t-2) and input sequence, x(t) = u(t). Find y(t). **[6M]**

**19.** Find the response y(t)=x(t)\*h(t) for the signal x(t)=eat u(t);a>0 and impulse response

h(t)=u(t). **[6M]**

**20.** Find the continuous time convolution integral given below:

y(t) = cos(πt) {u(t+1) – u(t-3)} \* u(t). **[6M]**

**21.** Perform the convolution for the following signals: x1(t) = e-at; 0 &

x2(t) = 1 ; 0**. [10M]**

**MODULE 3:**

**System interconnection and properties of impulse response**

**1.** Check whether the impulse response is Memoryless, Causal & Stable for:

**i)** h(n) = (0.99) n u(n+6) **[3M]**

**ii)** h(n) **=** 2u(n)-2u(n-2) **[3M]**

**iii)** h(n)=(1/2)n u(n) **[3M]**

**iv)** h(n)=(0.99)n u(n+3) **[3M]**

**v)** h(t)=e2tu(t-1) **[3M]**

**vi)** h(t)=e-2|t|  **[3M]**

**vii)** h(t)=e-3tu(t-1) **[3M]**

**viii)** h(t) **=** u(-1-t) **[3M]**

**2.** Evaluate the step response for the LTI system represented by the following impulse responses:

**i)** h(n)=(1/2)n u(n) **[4M]**

**ii)** h(n)=u(n) **[4M]**

**iii)** h(n) = (n) – (n-1) **[4M]**

**iii)** h(t) = t u (t) **[4M]**

**iv)** h(t)=u(t+1)-u(t-1) **[4M]**

**v)** h(t) = **[6M]**

**vi)** h(t)=e-2|t| **[6M]**

**3.** For the given difference equation: y (n) = x(n-1) + 2 x(n) – x(n-1), determine the impulse response and also check whether the impulse responses are memoryless, causal and stable. **[5M]**

**4.** Find an expression for impulse response of interconnection of LTI systems shown in fig

**i)**

****

**ii)**



**iii)**

****

**5.** Evaluate the DTFS representation for the signal:

x(n)= + 1. Sketch magnitude and phase spectra. **[10M]**

**6.** Determine the DTFS coefficients of the signal x(n)=.

Draw: i) Magnitude spectrum ii) phase spectrum **[10M]**

**7.** Find the Fourier series coefficients of the signal x(t) shown in fig and draw its spectra.

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**[10M]**

**8.** Find DTFS of the signal x(n) as shown in the fig and also draw the amplitude and phase spectra.

 **[10M]**

**9. Compute the fourier series of the signal x(t) shown in fig**

** [10M]**

**MODULE 4:**

**Fourier Transform**

**1.**State and prove the following properties of DTFT **i)** Frequency differentiation **[4M]** **ii)** Time shifting **[4M]** **iii)** Frequency shift [4M] **iv)** Convolution **[5M]**

**2.** State and prove the following properties of FT **i)** Differentiation in time-domain property **[5M] ii)** Time scaling **[4M]**

**3.** Obtain the DTFT for:

**i)** x (n) = cos (w0n) u(n) **[4M]**

**ii)** x(n)=-an u(-n-1) **[4M]**

**iii)** x(n)=u(n) **[6M]**

**iv)** x(n)=a|n| ; |a|<1 **[4M]**

**v)** x(n) =2n u(-n) **[4M]**

**4.** Compute the Fourier transform for the following signals:

**i)**x(t)= e-a|t| **[4M]** **ii)** x(t)= eat u(-t) **[4M]** **iii)** x(t)=sin w0t u(t) **[7M]**

**iv)** x (t) = **[8M]**

**5.** Obtain the Fourier transform of the signal x (t) =**u(t)** ; a>0 and plot its magnitude and phase spectrum. **[6M]**

**6.** Obtain the fourier transform representation for the periodic signal x(t)=sin w0t and draw the magnitude and phase. **[7M]**

**7.** Using convolution theorem find the inverse DTFT of X(given X(, |a| < 1. **[6M]**

**8.** Find inverse fourier transform of X (jw) = using appropriate properties.

**9.** Compute inverse FT of X(jw)= **[6M]**

**10.** Find the inverse fourier transform of X(jw)= **[6M]**

**11.** State sampling theorem and briefly explain the reconstruction of continuous time signals

from the samples. **[6M]**

**12.** Determine the Nyquist rate for each of the following signals:

**i)** x1(t)=sinc(200t) ii) x2(t)=sinc2(200t) **[6M]**

**13.** Find the nyquist rate and nyquist interval for the following:

**i)** x(t)=1+cos(2000t)+sin(4000t)

**ii)** x(t)=cos t+3sin 2t+sin 4t **[8M]**

**Module 5:**

**Z-Transform**

**1.** What is region of convergence (ROC)? Mention its properties. **[6M]**

**OR**

 Explain the properties of ROC along with example. **[10M]**

**2.** State and prove:

 **i)** Time shifting **[5M]**

**ii)** Time reversal property **[5M]**

**iii)** differentiation in Z-domain property **[5M]**

**iv)** initial value theorem **[5M]**

**v)** Convolution properties of z-transform **[6M]**

**vi)** final value theorem of Z-transform **[5M]**

**3.** Determine X (z) and indicate the ROC and locations of poles and zeros of X(z) in the z-plane:

**i)** x (n)= an u(n) **[4M]**

**ii)** x (n)= sinΩ0n u(n) **[6M]**

**iii)** x (n) = (1/2) |n| **[5M]**

**iv)** x (n)=a |n| for |a|<1 **[5M]**

**v)** x (n)=(1/3)n sin() u(n) **[6M]**

**4.** Find the z-transform of the following signals using appropriate properties along with ROC’s**:**

**i)** x(n)= n2 u(n) **[5M]**

**ii)** x(n) = (n+1) cos Ω0(n+1) u(n+1) **[6M]**

i**ii)** x(n) = (n-2) u(n-2) **[6M]**

**iv)** x(n)=n(1/2)n u(n) **[6M]**

**v)** x(n) = n sin u(n) **[6M]**

**vi)** x(n) = n2 u(n-2) **[6M]**

**vii)** x(n) = (n+1) cos Ω0(n+1) u(n+1) **[6M]**

**5.** Find the inverse Z-transform of the following X(z) by using partial fraction expansion

 Method: x(z) = . if ROC’s are:

 **i)** |z| > 3 **ii)** |z| < **iii)** < |z| <3 **[8M]**

**6.** Find the inverse Z-transform of the following X (z) = for

**i)** ROC |Z|>1/2 **ii)** ¼<|z|<1/2.

 **[10M]**

**7.** Determine the inverse z-transform of the function, X(z)= using partial fraction expansion. **[7M]**

**8.** Find the inverse Z-transform of the following X (z) = for

**i)** ROC |Z|>1 **ii)** ROC |z| <1 using long division method. **[8M]**

**9**. A LTI discrete time system is given by the difference equation,

y(n) = y(n-1) + y(n-2) + x(n-1). Determine **i)** H(z) and h(n) **ii)** Is the system stable **iii)** Is the system causal. **[8M]**

**10.** Determine the transfer function and impulse response of the system described by y(n)-1/2y(n-1)=2x(n-1). **[7M]**

**11.** A system is described by the difference equation: y(n)-y(n-1)+1/4y(n-2)=x(n)+1/4x(n-1)-

1/8x(n-2). Find the transfer function of the system. **[5M]**

**12.** The system function of an LTI is given as H (z) =. Specify the ROC of

H(z) and determine the unit sample response h(n) for the following conditions:

i) Stable system

ii) Causal system **[8M]**

**13.** A discrete LTI system is characterized by the difference equation,

y(n)=y(n-1)+y(n-2)+x(n-1). Find the system function H(z) and indicate the ROC if the system

is stable. Also determine the unit sample response of the stable system. **[10M]**

**15.** An LTI system is described by the equation y(n)=x(n)+0.8x(n-1)+0.8x(n-2)-0.49y(n-2).

Determine the transfer function H (z) of the system and also sketch the poles and zeros. **[6M]**

**16.** A causal system has input x(n) and output y(n). Find the impulse response of the system

if, x(n)=(n)+(n-1)-(n-2) and y(n)=(n)-(n-1). **[8M]**