**Code No.**

**METHODIST COLLEGE OF ENGINEERING & TECHNOLOGY (An Autonomous Institution)**

**B.E. (ECE) III-Semester (AICTE) (Regular) Examination, Feb/March -2023**

**Subject: SIGNALS AND SYSTEMS**

**Time: 3 hoursMax.Marks:60**

**Note: Missing data, if any, maybe suitably assumed.**

**PART-A**

**Answer All the questions.**

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| **Q.No.** | **Questions** | **Marks** | **CO** | **BTL** |
| **1. a** | **Sketch the addition of two signals x(t) and y(t) shown below.**    **Solution:** | **2** | **1** | **L2** |
| **b** | **Find the even and odd components of the signal x(t)=cost+sint+cost.sint**  **Solution:**  Any signal can be represented as the sum of even and odd components. i.e. x(t)= xe(t)+ xo(t)  x(t)=cost+sint+cost.sint  x(-t)=cos(-t)+sin(-t)+cos(-t).sin(-t)  x(-t)=cost-sint-cost.sint  Even component xe(t)=1/2[x(t)+x(-t)]  xe(t)=1/2[cost+sint+cost.sint+ cost-sint-cost.sint]  xe(t)=cost  Odd component xo(t)=1/2[x(t)-x(-t)]  xo(t)=1/2[cost+sint+cost.sint- cost+sint+cost.sint]  xo(t)=sint+cost.sint | **2** | **1** | **L1** |
| **c** | **Define Trigonometric Fourier series.**  The **trigonometric Fourier series** representation of a periodic signal x (t) with fundamental period T, is given by  Where ak and bk are Fourier coefficients given by  a0 is the dc component of the signal and is given by | **2** | **2** | **L1** |
| **d** | **State Dirichlet conditions for the existence of Fourier series?**  1. x (t) is absolutely integrable over any period, that is,  2. x (t) has a finite number of maxima and minima within any finite interval of t.   1. x (t) has a finite number of discontinuities within any finite interval of t, and each of these discontinuities are finite.   Note that the Dirichlet’s conditions are sufficient but not necessary conditions for the Fourier series representation. | **2** | **2** | **L1** |
| **e** | **Find the Fourier transform of impulse function**  **Solution:**  X(w)=F{x(t)}= dt  X(w)= dt  By using sampling property of impulse function  X(w)=  X(w)= | **2** | **3** | **L1** |
| **f** | **Define Correlation and what are its types?**  **Sol:** In general, correlation describes the mutual relationship which exists between two or more things. The same definition holds good even in the case of signals. That is, correlation between signals indicates the measure up to which the given signal resembles another signal.  Correlation is used to compare signals. Correlation is of two types.  1. Auto Correlation 2. Cross Correlation  Auto correlation is used to compare a signal with itself and cross correlation is used to compare two different signals. | **2** | **3** | **L1** |
| **g** |  | **2** | **4** | **L2** |
| **h** | **Determine whether the system y(n)= is causal or non-causal system?**  **Solution:**  y(n)=  here, the present ouput y(n) depends only on past input x(n-2).  So the given system is causal system. | **2** | **4** | **L1** |
| **i** | **Find the Z-transform and ROC of the unit step function?**  **Solution:**  Z{x(n)}=X(Z)=  Z{x(n)}=X(Z)=  Z{x(n)}=X(Z)=  Z{x(n)}=X(Z)=  Z{x(n)}=X(Z)= ++  Z{x(n)}=X(Z)=  ROC: | **2** | **5** | **L2** |
| **j** | What are the properties of ROC of Z-Transform?  1. ROC of z-transform is indicated with circle in z-plane. 2. ROC does not contain any poles. 3. If x(n) is a finite duration causal sequence or right sided sequence, then the ROC is entire z-plane except at z = 0. 4. If x(n) is a finite duration anti-causal sequence or left sided sequence, then the ROC is entire z-plane except at z = ∞. 5. If x(n) is a infinite duration causal sequence, ROC is exterior of the circle with radius a. i.e. |z| > a. 6. If x(n) is a infinite duration anti-causal sequence, ROC is interior of the circle with radius a. i.e. |z| < a. 7. If x(n) is a finite duration two sided sequence, then the ROC is entire z-plane except at z = 0 & z = ∞. | **2** | **5** | **L1** |

**PART-B**

**Answer Any Five questions**.

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| **Q.No.** |  | **Questions** | **Marks** | **CO** | **BTL** |
| **2.** | **a** | Identify for the systems described by the following equations, with the input *x(t)* and output *y(t)*, determine which of the systems are linear and which are nonlinear & the systems are time-invariant parameter systems and which are time-varying-parameter systems.      Ans:   1. y(t) = t2x(t)   Ans:    y(t) = t2x(t)  y(t, T) = t2x(t-T)  y(t-T) = (t-T)2x(t-T)  ∴y(t, T) ≠ y(t-T). Hence, the system is time variant. | **4** | **1** | **L2** |
| **b** | **Explain about the classification of continuous time systems with examples?**  **Solution:**  Static and dynamic systems  Causal and non causal systems  Linear and non linear systems  Time invariant and time variant systems  Stable and unstable systems | **4** | **1** | **L1** |
| **3.** | **a** | **Show that the signal (t)=2 and (t)=(1-2t) are orthogonal over an interval [0,1]?**  **Solution:**  We know that two signals (t) and (t) are orthogonal over an interval (), if they satisfy the condition (t)dt=0.  In this case, (t)dt= (1-2t) dt  (t)dt=  (t)dt=  (t)dt=  (t)dt=  (t) and (t) are orthogonal to each other over an interval [0,1]. | **3** | **2** | **L2** |
| **b** | **Find the Exponential Fourier series of the periodic function shown in below figure?**    **Solution:**  Exponential Fourier series is f(t)=  Where exponential Fourier series coefficients  c0=  C0=a0=  cn =  sa(n) | **5** | **2** | **L3** |
| **4.** | **a** | **Find the Laplace transform and ROC of the signal x(t)=.u(t)+.u(t)**  **Solution:**  L{x(t)}=X(s)=  L{x(t)}=X(s)=  L{x(t)}=X(s)=+  L{x(t)}=X(s)=+  L{x(t)}=X(s)= +  L{x(t)}=X(s)= +  L{x(t)}=X(s)= +  ROC: Re(s) and Re(s)  Common ROC: Re(s) | **4** | **3** | **L3** |
| **b** | **Find the inverse Laplace transform of the signal X(s)=**  **Solution:**  X(s)=  x(t)=  x(t)=  x(t)=  x(t)= {  x(t)= }  x(t)= | **4** | **3** | **L3** |
| **5.** | **a** | **Find linear convolution of x(n) = {1, 2, 3, 1} and h(n) = {1, 1, 1} using graphical method.**      The linear convolution output is y(n) = {1, 3, 6, 6, 4, 1} | **6** | **4** | **L2** |
| **b** | **Define sampling theorem.**  A continuous time signal can be represented in its samples and can be recovered back when sampling frequency fs is greater than or equal to the twice the highest frequency component of message signal. i. e.  fs≥2fm. | **2** | **4** | **L1** |
| **6.** | **a** | **State & prove the Z-Transform properties.**  **a) Time Reversal property b) Differentiation in Z-domain property**  **a) Time Reversal property**  **Statement:**  If Z{x(n)}=Z{x(-n)}=  **Proof:**  From the definition of Z-Transform, Z{x(n)} =X(z)=  Z{x(-n)} =  Let - =p  Z{x(-n)} =  Z{x(-n)} =  Z{x(-n)}=  **b) Differentiation in Z-domain property**  **Statement:**  If Z{x(n)}= X(z) then Z{n.x(n)}=-z.  **Proof:**  From the definition of Z-Transform, Z{x(n)} =X(z)=  Differentiate above equation w.r.to z on both sides  =}  =  =  =.  =.  =  Z{n.x(n)}=-z. | **4** | **5** | **L2** |
| **b** | **Find the inverse Z-Transform of the signal X(z)= by using partial fractions method, if**   1. **ROC:** 2. **ROC:** 3. **ROC:**   **Solution:**  X(z)=  X(z)= =  The above equation can be expressed in partial fractions form as:  == +  A= (z -)  A= =-3  B= (z -)  B= =3  == +  X(z)=-3. +  Apply inverse Z-Transform on both sides, we get   1. If ROC:   x(n)=u(n)+.u(n)   1. If ROC:   x(n)=u(-n-1)-.u(-n-1)   1. If ROC:   x(n)=u(n)-.u(-n-1) | **4** | **5** | **L3** |
| **7.** | **a** | **Find the Energy and Power of the signal x(t)=e-j2πt**  **Solution:**  Energy E=  E==  E=  E=  E=  Power P=  P= =  P=  P=1  E=P=1. So the given signal is power signal. | **3** | **1** | **L2** |
| **b** | **What is the relationship between exponential and trigonometric Fourier series representation?**  The **trigonometric Fourier series** representation of a periodic signal x (t) with fundamental period T, is given by  Where ak and bk are Fourier coefficients given by  a0 is the dc component of the signal and is given by  The complex **Exponential Fourier Series** representation of a periodic signal x(t) with fundamental period To is given by Where, Ck is known as the **Complex Fourier Coefficient** and is given by, Relationship between coefficients of exponential form and coefficients of trigonometric form a0 = C0, ak = Ck+ C-k, bk = j(Ck – C-k),  ,  When x (t) is real, then a, and b, are real, we have  ak = 2Re[ck] and bk = -2Im[ck] | **5** | **2** | **L1** |
| **8.** | **a** | **Find the inverse Fourier transform of the function X(w)=**  **Solution:**  X(w)=  we know that F{.u(t)}=  F{.u(t)}=  By using time differentiation property of fourier transform,  F{}= jw. X(w)  So = | **4** | **3** | **L3** |
| **b** | **Find the DFT of a sequence x[n]=[1,0,-1,0]**  N = 4  Therefore X[k]= [0, 2, 0, 2] | **4** | **4** | **L2** |
| **9.** | **a** | **Find the Z-transform and ROC of the signal x(n)={2,1,-3,0,4}**  **Solution:**  Z{x(n)}=X(Z)=  Z{x(n)}=X(Z)=++........  Z{x(n)}=X(Z)=-3+4.  Z{x(n)}=X(Z)=-3+4.  ROC is entire Z-Plane except z=0 | **4** | **5** | **L2** |
| **b** | **Write short notes on operations on signals.**  **Ans: There are two variable parameters in general:**   1. Amplitude 2. Time   **The following operation can be performed with amplitude:**  **Amplitude Scaling**  C x(t) is a amplitude scaled version of x(t) whose amplitude is scaled by a factor C.  Amplitude scaling Addition Addition of two signals is nothing but addition of their corresponding amplitudes. This can be best explained by using the following example:  Amplitude addition  As seen from the diagram above,  -10 < t < -3 amplitude of z(t) = x1(t) + x2(t) = 0 + 2 = 2  -3 < t < 3 amplitude of z(t) = x1(t) + x2(t) = 1 + 2 = 3  3 < t < 10 amplitude of z(t) = x1(t) + x2(t) = 0 + 2 = 2  **Subtraction**  Subtraction of two signals is nothing but subtraction of their corresponding amplitudes. This can be best explained by the following example:  Amplitude subtraction  As seen from the diagram above,  -10 < t < -3 amplitude of z (t) = x1(t) ×x2(t) = 0 ×2 = 0  -3 < t < 3 amplitude of z (t) = x1(t) ×x2(t) = 1 ×2 = 2  3 < t < 10 amplitude of z (t) = x1(t) × x2(t) = 0 × 2 = 0  **The following operations can be performed with time:**  **Time Shifting**  x(t ± t0) is time shifted version of the signal x(t).  x (t + t0) →→ negative shift  x (t - t0) →→ positive shift  Time shifting  Example:      **Time Scaling**  x(At) is time scaled version of the signal x(t).  where A is always positive.  |A| > 1 →→ Compression of the signal  |A| < 1 →→ Expansion of the signal  Time scaling  Note: u(at) = u(t) time scaling is not applicable for unit step function.  Examples    **Time Reversal**  x(-t) is the time reversal of the signal x(t).  Time reversal  Example | **4** | **1** | **L2** |

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