MUTHAYAMMAL ENGINEERING COLLEGE
(An Autonomous Institution)
(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

MKC

2021-22

ECE

Must Know Concepts (MKC)

Course Code & Course Name: 19ECC02 & SIGNALS AND SYSTEMS
Year/Sem/Sec : II /III/ECE

S.No	Term	Notation (Symbol)	Concept/Definition/Meaning/Units/Equation/Expression	Units
UNIT-I Signals and Systems				
1	Signal	-	A signal is a function of one or more independent variables which contain some information. Eg: Radio signal, TV signal, Telephone signal etc.	-
2	System	-	A system is a set of elements or functional blocks that are connected together and produces an output in response to an input signal. Eg: Audio Amplifier, attenuator, TV set etc.	-
3	CT signals	x(t)	Continuous time signals are defined for all values of time. It is also called as an analog signal and is represented by x(t). Eg: AC waveform, ECG etc.	-
4	DT signal	x(n)	Discrete time signals are defined at discrete instances of time. It is represented by x(n). Eg: Amount deposited in a bank per month.	-
5	Examples of CT signals	-	AC waveform, ECG, Temperature recorded over an interval of time etc.	-
6	Examples of DT signals	-	Amount deposited in a bank per month/Year.	-
7	Unit Step Signal	u(t)	$u(t) = 1$ for $t \geq 0$ 0 otherwise	-
8	Unit Ramp Signal	r(t)	$r(t) = 1$ for $t \geq 0$ 0 otherwise	-
9	Unit Impulse Signal	δ(t)	$\delta(t) = 1$ for $t = 0$ 0 for $t \neq 0$	-
10	Classification of Signals	-	Continuous time and Discrete time signals Deterministic and random signals. Periodic and non periodic signals	-

			Even and odd signals Energy and power signals Causal and Non Causal Signals	
11	Basic Operation of Signals	-	• Time Shifting • Time Reversal • Time Scaling • Amplitude Scaling • Signal Addition • Signal Multiplication	-
12	Deterministic Signals	-	A deterministic signal is one which can be completely represented by mathematical equation at any time. In a deterministic signal there is no uncertainty with respect to its value at any time	-
13	Random Signals	-	A random signal is one which cannot be represented by any mathematical equation.	-
14	Power Signals	-	The signal x(t) is said to be power signal, if and only if the normalized average power p is finite and non-zero.	-
15	Energy Signals	-	A signal x(t) is said to be energy signal if and only if the total normalized energy is finite and non-zero.	-
16	Odd & Even Signals	-	A DT signal x(n) is said to be an even signal if x(-n) = x(n) and an odd signal if x(-n) = -x(n). A CT signal is x(t) is said to be an even signal if x(t) = x(-t) and an odd signal if x(-t) = -x(t).	-
17	Periodic and Aperiodic signals	-	A signal is said to be periodic signal if it repeats at equal intervals. Aperiodic signals do not repeat at regular intervals.	-
18	Causal and Non Causal Signals	-	If a signal said to be Causal x(t) = 0 for t < 0. Otherwise the signal is Non Causal	-
19	Classification of CT and DT systems.	-	• Linear and Non-Linear systems • Time invariant and Time varying systems. • Causal and Non causal systems. • Stable and unstable systems. • Static and dynamic systems.	-
20	linear and non-linear systems	-	A system is said to be linear if superposition theorem applies to that system. If it does not satisfy the superposition theorem, then it is said to be a nonlinear system.	-

21	Time invariant and Time variant systems	-	A system is time invariant if the time shift in the input signal results in corresponding time shift in the output. A system which does not satisfy the above condition is time variant system.	-
22	Stable and Unstable systems	-	When the system produces bounded output for bounded input, then the system is called bounded input, bounded output stable. A system which does not satisfy the above condition is called a unstable system.	-
23	Static and Dynamic system	-	A system is said to be static or memory less if its output depends upon the present input only. The system is said to be dynamic with memory if its output depends upon the present and past input values.	-
24	Causal and Non Causal Systems	-	A Causal system is one for which the output at any time t depends on the present and past inputs. But not Future inputs. Otherwise it is Noncausal Systems	-
25	Representation of DT Signals	-	• Graphical Representation • Functional Representation • Tabular Representation • Sequence Representation	-
UNIT-II Analysis of Continuous Time Signals				
26	Fourier series	-	Fourier series is calculated for periodic signals. Expands the signal in time domain.	-
27	Fourier transform	-	Fourier transform is calculated for nonperiodic as well as periodic signals. Represents the signal in frequency domain.	-
28	Types of Fourier series	-	Three types of Fourier series such as trigonometric, polar and complex exponential.	-

29	Dirichlet conditions for Fourier series.	-	• The function x(t) should be within the interval T_o. • The function x(t) should have finitie number of maxima and minima in the interval T_o. • The function x(t) should have finite number of discontinuities in the interval T_0. • The function should be absolutely integrable. $\int_{<T0>} \lvert x(t)dt < \infty$	-
30	Relationship between Fourier transform and Laplace transform	-	X(s)=X(jω) when s=jω This means Fourier transform is same as Laplace transform when s=jω.	-
31	Properties of Fourier series	-	• Linearity • Time Shifting • Frequency Shifting • Conjugation • Time Reversal • Time scaling • Multiplication • Differentiation • Real and Even Signals • Real and Odd Signals	-
32	Relationship between Fourier series and fourier transform	-	Fourier series is for periodic signals and Fourier transform is for aperiodic signals. Fourier series is used to decompose signals into basis elements (complex exponentials) while fourier transforms are used to analyze signal in another domain (e.g. from time to frequency, or vice versa).	-
33	Fourier transforms pair for continuous time signal.	-	Fourier transform : X(ω) $=\int_{-\infty}^{\infty} x(t)$ e^{-jwt} dt Inverse Fourier transform : X(f) = 1/2π $\int_{-\infty}^{\infty} X(\omega)$ e^{jwt} d**ω**	

35	properties of continuous-time Fourier transform	-	• Linearity • Time reversal • Time scaling • Conjugation. • Parseval's relation • Differentiation • Integration • Convolution • Multiplication.	-
36	Unilateral Laplace transforms	-	Unilateral Laplace Transform : It is a convenient tool for solving differential equations with initial conditions. $X(s) = \int_0^{\infty} x(t)e^{-at}$ dt.	-
37	Bilateral Laplace transforms	-	It is used to analyze the system characteristics like stability, causality and Frequency response.	-
38	Fourier transform	-	$X(\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-jwt}\, dt$	-
39	Inverse Fourier transform	-	$X(f) = 1/2\pi \int_{-\infty}^{\infty} X(\omega)\, e^{jwt}\, d\boldsymbol{\omega}$	-
40	properties of Laplace transform	-	• Linearity • Transform of Derivatives • Transform of Integrals • Scaling Property • Time Shifting • Frequency Shifting • Differentiation Time Domain • Time Convolution • Frequency Convolution • Initial Value Theorem • Final Value Theorem	-
41	Laplace Transform	-	$X(s) = \int_{-\infty}^{\infty} X(\omega)\, e^{-st}\, dt$	-
42	ROC	-	Region of Convergence	-
43	Region of Convergence	-	ROC of Laplace Transform ROC contains strip lines parallel to jω axis in s-plane. If x(t) is absolutely integral and it is of finite duration, then ROC is entire s-plane. If x(t) is a right sided sequence then ROC : Re{s} > σ_o. If x(t) is a left sided sequence then ROC : Re{s} < σ_o.	-

44	Initial value theorem	-	$x(0) = \lim_{s \to \infty} sX(s)$	-
45	Final value theorem		$x(\infty) = \lim_{s \to 0} sX(s)$	-
46	Dirichlet conditions for Fourier Transform	-	x(t) must absolutely integrable over a period. x(t) must have a finite number of exterma in any given interval, i.e. there must be a finite number of maxima and minima in the interval. x(t) must have a finite number of discontinues in any given interval, however the discontinuity cannot be infinite. x(t) must be bounded. $\int_{<T0>} \lvert x(t) dt < \infty$	-
47	Applications of Fourier Transform	-	Such as Image Analysis, Image Filtering, Image Reconstruction and Image Compression, Etc..	-
48	Applications of Laplace Transform	-	Analog Signal Processing Circuit Analysis for Electric and Electronic Fields	-
49	Give the necessary condition for convergence of the Laplace transform is the absolute integrability.	-	The necessary condition for convergence of the Laplace transform is the absolutely integral of $f(t)e^{-\sigma t}$. Mathematically, this can be stated as $\int_{-\infty}^{\infty} \lvert f(t)e^{-\sigma t} \rvert dt < \infty$ Laplace transform exists only for signals which satisfy the above equation in the given region.	-
50	Laplace transform of δ(t).	-	1	-
UNIT III Linear Timeinvarient Continuous Time Systems				
51	Convolution Integral	-	$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau) h(t-\tau) d\tau$	-
52	Commutative property	-	x(t)*h(t) = h(t)*x(t)	-
53	Associative Property	-	[x(t)*h1(t)]*h2(t) = x(t)*{h1(t)+h2(t)}	-

54	Distributive property	-	x(t)*h1(t)+h2(t) = x(t)*{h1(t)+h2(t)}	-
55	Impulse Response of Continuous System	-	The impulse response is the output produced by the system when unit impulse is applied at the input. The impulse response is denoted by h(t).	-
56	Unit Step Response of the System	-	The Unit Step response is the output produced by the system when unit Step is applied at the input. The Unit Step response is denoted by u(t).	-
57	Basic steps of Convolution Integrals	-	Folding Shifting Multiplication Integration	-
58	State the properties needed for interconnecting LTI systems.	-	For parallel connection, h(t)= h1(t) + h2(t) For series connection, h(t) = h1(t) * h2(t)	-
59	linear time invariant system	-	The output response of linear time invariant system is linear and time invariant	
60	Condition for LTI System to be Causal	-	LTI continuous system is Causal if and only if its impulse Response is Zero for negative values of t	-
60	Stability Condition for impulse response	-	$\int_{-\infty}^{\infty} \lvert h(t) \rvert \, dt < \infty,$	-
61	Transfer Function	-	it's the ratio of the Laplace transform of the output signal to the Laplace Transform of the input signal with all initial condition are Zero.	-
62	Natural Response	-	It is the part of total Response which is due to initial conditions of the system alone.	
63	Forced Response	-	It is the part of total Response which is due to input alone.	-
64	Total Response	-	Total Response of the System is Sum of Natural Response and Forced Response	-
65	Zeros	-	The roots of the numerator polynomial are called the zeros of the transfer function.	-
66	Poles	-	The roots of the denominator polynomial are called the zeros of the transfer function.	-
67	Transient Response	-	It is the part of Forced Response which is due to poles of the system. The Transient Response vanishes after a sufficiently Long Time.	-
68	Steady State Response	-	It is the part of Forced Response which is due to poles of input signals X(s) is known	-

			as Steady State Response. The Response exists after the transients dies out.	
69	Transfer function of Ideal Integrator	-	Transfer function of Ideal Integrator is 1/s	-
70	Condition for Stability of the System	-	For a system to be stable, the plots of transfer Function must be in a Half of s-plane	-
71	Types of Realizations	-	Direct Form I, Direct Form II, Cascade Form, Parallel Form	-
72	Why Differentiators are not used in Realizing practical systems?	-	The Differentiators are not used in Realizing practical systems because Differentiators amplifies high Frequency noise.	-
73	Drawbacks of transfer function analysis.	-	Transfer function is defined under zero initial conditions. Transfer function approach can be applied only to linear time invariant systems. It does not give any idea about the internal state of the system. It cannot be applied to multiple input multiple output systems.	-
74	Block Diagram	-	It is interconnection of subsystems representing certain basic mathematical operation in such a way that the overall diagram represents the system mathematical model	-
75	Signal flow graph	-	It is the graphical representation of the relationship between the variables of a set of linear algebraic equations.	-
UNIT-IV Analysis of Discrete Time Signals				
76	Sampling Theorem	-	A continuous time signal can be represented in its samples and can be recovered back when **sampling** frequency f_s is greater than or equal to the twice the highest frequency component of message signal.	-
77	Sampler	-	Its converts the Continuous time signal to discrete time signal.	-
78	Filter	-	Blends multiple samples together.	-

79	Nyquist frequency	f_N	The frequency equal to one-half of the sampling rate is therefore a bound on the highest frequency that can be unambiguously represented by the sampled signal.	-
80	Sampling frequency	f_s	It is defined as the number of samples obtained in one second, or $f_s = 1/T$. The sampling rate is measured in hertz or in samples per second.	Hz
81	Aliasing	-	It is a phenomenon where the high frequency components of the sampled signal interfere with each other because of inadequate sampling $f_s < 2f_m$.	-
82	Anti-aliasing Filter	-	An anti-aliasing filter is a filter used before a signal sampler to restrict the bandwidth of a signal to satisfy the Nyquist – Shannon sampling theorem over the band of interest.	-
83	Discrete-Time Fourier Transform (DTFT)	-	$X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n}$	-
84	Inverse transform of DTFT	-	$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\omega)\cdot e^{i\omega n}\,d\omega = T\int_{-\frac{1}{2T}}^{\frac{1}{2T}} X_T(f)\cdot e^{i2\pi fnT}\,df.$	-
86	Condition for existence of DTFT	-	If x(n)is absolutely summable then $\lvert x(n)\rvert < \infty$ If x(n) is not absolutely summable then it should have finite energy for DTFT to exit.	-
87	Z-transforms	-	$X(z) = \sum_{k=-\infty}^{\infty} x(n)z^{-k}$ $X(z) = Z[x(n)]$	-
88	Advantage of FFT over DFT	-	FFT algorithm reduces number of computations.	
89	Region of convergence with respect to Z transform	-	Region of convergence (ROC) is the area in Z plane where Z transforms convergence. In other word, it is possible to calculate the X(z) in ROC.	-
90	Initial value theorem of Z transforms.	-	The initial value of the sequence is given as, **X(0)=**$\lim_{z\to 1}$ X(z).	-
91	Nyquist rate	-	When the sampling rate becomes exactly equal to '2W' samples/sec for a give bandwidth of W hertz, then it is called Nyquist rate. Nyquist rate =2W Hz	Hz
92	Nyquist interval	-	Nyquist interval is the time interval between any two adjacent samples.	-

			Nyquist interval=1/2Wseconds.	
93	Final value theorem for z-transform	-	The final value of a sequence is given as, $x(\infty) = \lim_{z\to 1}(1 - Z^{-1})X(z)$	-
94	Two sided z-transform	-	$X(z) = \sum_{k=-\infty}^{\infty} x(n)z^{-k}$	-
95	Convolution property of z -transform.	-	The convolution of two sequences in time domain is equivalent to multiplication of their z-transforms. $x_1(n)^* x_2(n)=X_1(z)X_2(z)$.	-
96	Parseval's theorem	-	Consider the complex valued sequences x(n) and y(n), $x(n)y^*(n)=1/N\ X(k)Y^*(k)$	-
97	Applications of FFT	-	Filtering Spectrum analysis Calculation of energy spectral density	-
98	Relation between Z transform and Fourier transform of discrete time signal.	-	$X(e^{j\omega m})=X(Z)\|z=e^{j\omega m}$ This means Z transform is same as fourier transform when evaluated on unit circle.	-
99	Properties of DTFT.	-	Periodicity, Linearity, Time shifting, Frequency shifting, Scaling, Differentiation in frequency domain, Time reversal, Convolution , Multiplication in time domain & Parseval"s theorem	-
100	Types of z transform	-	Long division Method Partial Fraction Method Residue Method Convolution Method	-
Unit V Linear Timeinvariant Discrete Time Systems				
101	Types of Realizations		Direct Form I, Direct Form II, Cascade Form, Parallel Form	-
102	Commutative property of convolution	-	$x(n)*h(n)=h(n)*x(n)=y(n)$	-
103	Associative property of convolution	-	$[x(n)*M_1(n)]*M_2(n) =x(n)*[M_1(n)*M_2(n)]$	-

104	Distributive property of convolution	-	$x(n)*[M_1(n)+M_2(n)]=x(n)*M_1(n)+x(n)*M_2(n)$	-
105	Non-recursive system	-	When the output y(n) of the system depends upon present and past inputs	-
106	Recursive system	-	When the output y(n) of the system depends upon present and past inputs as well as past outputs	-
107	Convolution sum	-	If x(n) and h(n) are discrete variable functions, then its convolution sum y(n) is given by, $y(n) = \sum x(k)\, h(n-k)$	-
108	System function of the discrete time system	-	$Y(n) = 0.5y(n-1) + x(n)$ Taking z-transform of both sides, $Y(z) = 0.5z^{-1}Y(z)+X(z)$ $H(z) = Y(z)/X(z) = 1/(1 – 0.5z^{-1})$	-
109	Steps involved in finding convolution sum	-	Folding Shifting Multiplication Summation	-
110	System function	-	H(z)= Y(z) is called system function. It is the z transform of the unit sample X(Z) response h(n) of the system.	-
111	LTI causal system	-	A LTI system is causal if and only if ,h(n) = 0 for n	-
112	LTI stable system	-	The bounded input x(n) produces bounded output y(n) in the LTI system only if, _ | h(k)|	-
113	FIR system	-	The systems for which unit step response h(n) has finite number of terms, they are called Finite Impulse Response (FIR) systems.	-
114	IIR system	-	The systems for which unit step response h(n) has infinite number of terms, they are called Infinite Impulse Response (IIR) systems.	-
115	Relation between Fourier transform and z transform	-	The Fourier transform is basically the z-transform of the sequence evaluated on unit circle. i.e., $X(z)\|_{z=e^{jw}} = X(w)$ at $\|z\|=1$ i.e., unit circle.	-

116	Advantage of direct form 2 over direct form 1 structure	-	The direct form 2 structure has reduced memory requirement compared to direct form 1 structure.	-
117	Uunit sample response of discrete time system	-	The unit step response of the discrete time system is output of the system to unit sample sequence.	-
118	Methods of obtaining inverse Z transform	-	• Long Division Method • Partial fraction expansion. • Contour integration • Residue Method Convolution.	-
119	Circular convolution	-	This property states that multiplication of two DFT is equal to circular convolution of their sequence in time domain.	-
120	Transfer function of the DT system	-	The Transfer function of DT system is defined as the ratio of Z transform of the system output to the input. That is ,H(z)=Y(z)/X(z),	-
121	Impulse response of a DT system.	-	The impulse response is the output produced by DT system when unit impulse is applied at the input. The impulse response is denoted by h(n). The impulse response h(n) is obtained by taking inverse Z transform from the transfer function H(z).	-
122	What are the blocks used for block diagram representation.	-	The block diagrams are implemented with the help of scalar multipliers, adders and multipliers	-
123	properties of convolution.	-	i.Commutative ii.Assosiative. iii.Distributive	-
124	natural response & forced response	-	This is output produced by the system only due to initial conditions .Input is zero for natural response. Hence it is also called zero input Response. This is the output produced by the system only due to input .Initial conditions are considered zero for forced response.	-
125	zero input Response & complete response	-	This is output produced by the system only due to initial conditions .Input is zero for zero input response. The complete response of the system is equal	-

			to the sum of natural response and forced response .Thus initial conditions as well as input both are considered for complete response.	
Placement Questions				
126	Zero padding	-	The method of appending zero in the given sequence.	-
127	Tools used for analysis of LTI-CT systems	-	✓ Fourier transform ✓ Laplace transform	-
128	Examples for CT signals	-	AC waveform, ECG, Temperature recorded over an interval of time etc	-
129	Examples of DT signals	-	Amount deposited in a bank per month	-
130	Rayleigh's energy theorem.	-	It states that the energy of the signal may be written in frequency domain as superposition of energies due to individual spectral frequencies of the signal.	-
131	Types of interconnection	-	parallel connection, h(t)= $h_1(t)+h_2(t)$ series connection, h(t)= $h_1(t)*h_2(t)$.	-
132	Poisson summation formula	-	An equation that relates the Fourier series coefficients of the periodic summation of a function to values of the function's continuous Fourier transform.	-
133	Continuous time real exponential signal	-	Continuous time real exponential signal is defined by x(t)=Ce^at where c and a are complex numbers. If c and a are real	-
134	Continuous time growing exponential signal	-	It is defined as $x(t)=Ce^{at}$ where c and a are complex numbers. If a is positive, as t increases , then x(t) is a growing exponential.	-
135	Continuous time decaying exponential	-	It is defined as $x(t)=Ce^{at}$ where c and a are complex numbers. If a is negative, as t increases, then x(t) is a decaying exponential.	-
136	Basic operations on Signals	-	i. Time Shifting ii. Time scaling iii. Time Reversal iv. Amplitude Scaling v. Signal Addition vi. Signal Multiplication	-
137	How the aliasing process is eliminated	-	Sampling rate $f_s \leq 2W$.	-

			Strictly band limit the signal to ‘W’. This can be obtained by using the Low pass filer before the sampling process.	
138	Methods to find inverse z-transform	-	• Partial fraction expansion • Contour integration • Power series expansion • Convolution method.	-
139	Classification of the system based on unit sample response	-	➢ FIR (Finite impulse Response) system. ➢ IIR (Infinite Impulse Response) system.	-
140	If u(n) is the impulse response of the system, what is its step response?	-	Here h(n) = u(n) and the input is x(n) = u(n) Hence output y(n) = h(n) *x(n) = u(n)* u(n)	-
141	A causal discrete time system is BIBO stable only if its transfer function has…	-	A causal discrete time system is stable if poles of its transfer function lie within the unit circle.	-
142	What about the stability of system in $H(z) = \frac{z(3z-4)}{(z-0.4)(z-2)}$	-	system is stable	-
143	F.T. of continuous non-periodic signal is	-	aperiodic	-
144	The inverse Fourier transform of the function F(ω) = 2/jω is	-	*sgnt*	-
145	An impulse train is	-	a number of pulses spaced from each other	-
146	The function which relates output of a system to the	-	Transfer function	-

	input(signal) of a system is			
147	Give Some Examples Of Causal Signal	-	Unit Step Signal, Exponential Signal.	-
148	Consider a continuous-time system with input x(t) and output y(t) given by y(t) = x(t) cos(t) This system is	-	linear and time-varying	-
149	A system is defined by its impulse response $h(n) = 2^n u(n-2)$. The system is	-	causal but not stable	-
150	Two systems with impulse responses h1(t) and h2(t) are connected in cascade. Then the overall impulse response of the cascaded system is given by	-	Convolution of $h_1(t)$ and $h_2(t)$	-

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