SIGNALS AND SYSTEMS (EC304PC)
COURSE PLANNER

I. COURSE OVERVIEW:

Signals and Systems encounter extensively in our day-to-day lives, from making a phone call, listening to a song, editing photos, manipulating audio files, using speech recognition software's like Siri and Google now, to taking EEGs, ECGs and X-Ray images. Each of these involves gathering, storing, transmitting and processing information from the physical world.

This course will equip to deal with these tasks efficiently by learning the basic mathematical framework of signals and systems. Here we will explore the various properties of signals and systems, characterization of Linear Time Invariant Systems/ Time variant systems, convolution and Fourier Series and Transform, and also deal with the Sampling theorem, Z-Transform, Correlation and Laplace transform. Ideas introduced in this course will be useful in understanding further Electronic/ Electrical Engineering courses which deal with control systems, communication systems, digital signal processing, statistical signal analysis and digital message transmission. Further concepts such as signal sampling and aliasing are introduced. The theory is exemplified with processing of signals in MATLAB.

II. PREREQUISITS:

1. Engineering Mathematics
2. Basics of Vector Theory

III. COURSE OBJECTIVES:

1.	This gives the basics of Signals and Systems required for all Electrical Engineering related courses.
2.	To understand the behavior of signal in time and frequency domain
3.	To understand the characteristics of LTI systems
4.	This gives concepts of Signals and Systems and its analysis using different transform techniques.

IV. COURSE OUTCOMES:

S.No.	Description	Bloom's Taxonomy Level
1.	Differentiate various signal functions.	Remember, Understand (Level1, Level2)
2.	Represent any arbitrary signal in time and frequency domain.	Apply, (Level 3)
3.	Understand the characteristics of linear time invariant systems.	Remember, Understand (Level1, Level2)
4.	Analyze the signals with different transform technique.	Analyze (Level 4)

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

	Program Outcomes (PO)	Level	Proficiency assessed by
PO1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments, Exercises
PO2	**Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Assignments
PO3	**Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1	Assignments
PO4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	-	-
PO5	**Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	Assignments
PO6	**The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	-	-
PO7	**Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	-
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	**Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Oral Discussions
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	-	-

Program Outcomes (PO)		Level	Proficiency assessed by
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	-
PO12	**Life-Long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	Assignments

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	1	Lectures, Assignments
PSO2	**Problem-Solving Skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	3	Tutorials
PSO3	**Successful Career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VII. SYLLABUS:

UNIT - I Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality in Complex functions, Classification of Signals and systems, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.

UNIT – II Fourier series: Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum.
Fourier Transforms: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals,

Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Introduction to Hilbert Transform.

UNIT - III Signal Transmission through Linear Systems: Linear System, Impulse response, Response of a Linear System, Linear Time Invariant(LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI System, Filter characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics, Causality and Paley-Wiener criterion for physical realization, Relationship between Bandwidth and rise time, Convolution and Correlation of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution.

UNIT – IV Laplace Transforms: Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.
Z–Transforms: Concept of Z- Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.

UNIT - V Sampling Theorem: Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing, Introduction to Band Pass Sampling.

Correlation: Cross Correlation and Auto Correlation of Functions, Properties of Correlation Functions, Energy Density Spectrum, Parsevals Theorem, Power Density Spectrum, Relation between Autocorrelation Function and Energy/Power Spectral Density Function, Relation between Convolution and Correlation, Detection of Periodic Signals in the presence of Noise by Correlation, Extraction of Signal from Noise by Filtering.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, 2013, BSP.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2 Ed.

REFERENCE BOOKS:

1. Signals and Systems – Simon Haykin and Van Veen, Wiley 2 Ed.,
2. Signals and Systems – A. Rama Krishna Rao, 2008, TMH
3. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.
4. Signals, Systems and Transforms -C.L.Philips, J.M.Parr and Eve A.Riskin,3Ed.,2004, PE.
5. Signals and Systems – K. Deergha Rao, Birkhauser, 2018.

NPTEL Web Course: https://nptel.ac.in/courses/108104100
NPTEL Video Course: https://nptel.ac.in/courses/108104100

GATE SYLLABUS:
Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform.

Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

IES SYLLABUS:

Classification of signals and systems: System modeling in terms of differential and difference equations; State variable representation; Fourier series; Fourier transforms and their application to system analysis; Laplace transforms and their application to system analysis; Convolution and superposition integrals and their applications; Z-transforms and their applications to the analysis and characterization of discrete time systems; Random signals and probability, Correlation functions; Spectral density; Response of linear system to random inputs.

VIII. COURSE PLAN (Lesson Plan):

Lecture No.	Unit	Topics to be covered	Subtopics	Link for PPT	Link for PDF	Link for Small Projects/ Numericals	Course Learning Outcomes	Teaching Methodology	References
1	1	Introduction of S&S and Detail Introduction about the syllabus	Prerequisite Vector Prerequisite Function	https://docs.google.com/presentation/d/1eD3Xya4L-rShzUjStFHxpSDTGRj1WKY4/edit?usp=sharing&ouid=107982842699867915530&rtpof=true&sd=true	https://drive.google.com/file/d/1nb11Q1WgfBTDNiRrpcJQIGGoW12_cKKq/view?usp=sharing	**NA**	Understand	Chalk and talk, PPT	T1
2	1	Signal	Introduction classification Properties			**NA**	Understand	Chalk and talk, PPT	T1
3	1	system	Introduction classification Properties			**NA**	Understand	Chalk and talk, PPT	T1
4	1	Tutorial 1	vector and function	**NA**	**NA**	**NA**	Self assessment	Chalk and talk,PPT	T1

5	1	Basic Signals	Concepts of Impulse function, Unit Step function, ramp function.	https://docs.google.com/presentation/d/1eD3Xya4L-rShzUjStFHxpSDTGRj1WKY4/edit?usp=sharing&ouid=107982842699867915530&rtpof=true&sd=true	https://drive.google.com/file/d/1nb11Q1WgfBTDNiRrpcJQIGGoW12_cKKq/view?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
6	1	Basic Signals	Exponential and Sinusoidal signals signum function			NA	Understand	Chalk and talk,PPT	T1
7	1	Tutorial 2	Signals and properties	**NA**	**NA**	**NA**	Understand	Chalk and talk,PPT	T1
8	1	Tutorial 3	System and properties	**NA**	**NA**	**NA**	Understand	Chalk and talk,PPT	T1
9	1	Vectors and Signals,	Analogy with examples	https://docs.google.com/presentation/d/1eD3Xya4L-rShzUjStFHxpSDTGRj1WKY4/edit?usp=sharing&ouid=107982842699867915530&rtpof=true&sd=true	https://drive.google.com/file/d/1nb11Q1WgfBTDNiRrpcJQIGGoW12_cKKq/view?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
10	1	Orthogonal functions	Space approximation			**NA**	Understand	Chalk and talk,PPT	T1
11	1	Orthogonal functions	Orthogonality in Complex functions			**NA**	Understand	Chalk and talk,PPT	T1
12	1	Orthogonal functions	Mean Square Error Closed or complete set of Orthogonal functions			**NA**	Understand	Chalk and talk,PPT	T1
13	1	REVISION	**NA**	**NA**	**NA**	**NA**	Self assessment		
14	1	Student presentation	**NA**	**NA**	**NA**	**NA**	Self assessment		
15	1	Mock Test	**NA**	**NA**	**NA**	**NA**	Evaluation		

16	2	Fourier series	**Introduction**	https://drive.google.com/drive/folders/1e62Xccb9BeZFlQxTMCbQrm-z__adPAHo?usp=sharing	https://drive.google.com/drive/folders/1uBvIxYiPvlusuG81z065xhJTHEU30zEO?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
17	2	Fourier series	Continuous time periodic signals,			**NA**	Understand	Chalk and talk,PPT	T1
18	2	Fourier series	Properties of Fourier Series,			**NA**	Understand	Chalk and talk,PPT	T1
19	2	Fourier series	Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum.			**NA**	Understand	Chalk and talk,PPT	T1
20	2	Tutorial 4	Fourier Series and Properties	_**NA**	_**NA**	**NA**	Self assessment	Chalk and talk,PPT	T1
21	2	Fourier Transforms	: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal	https://drive.google.com/drive/folders/1e62Xccb9BeZFlQxTMCbQrm-z__adPAHo?usp=sharing	https://drive.google.com/drive/folders/1uBvIxYiPvlusuG81z065xhJTHEU30zEO?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
22	2	Fourier Transforms	Fourier Transform of standard signals, Fourier Transform of Periodic Signals,			**NA**	Understand	Chalk and talk,PPT	T1
23	2	Fourier Transforms	Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Introduction to Hilbert			**NA**	Understand	Chalk and talk,PPT	T1

			Transform						
24	2	Tutorial 5	Fourier Transform	**NA**	**NA**	**NA**	Self assessment		
25	2	Revision	**NA**	**NA**	**NA**	**NA**	Self assessment		
26	2	Student presentation	**NA**	**NA**	**NA**	**NA**	Self assessment		
Mid Term 1									
27	3	system	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant(LTI) System,	https://drive.google.com/drive/folders/1wbfiYl3-MtZKh0u4tTH26ARlgQoIIGck?usp=sharing	https://drive.google.com/drive/folders/1g4Ge7kWY50xel0YLlZpmoBF2uo-cDUho?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
28	3	LTI and LTV systems	Signal Transmission through Linear Systems: Linear Time Variant (LTV) System, Transfer function of a LTI System,			**NA**	Understand	Chalk and talk,PPT	T1
29	3	Tutorial 6	System(LTI and LTV systems)	**NA**	**NA**	**NA**	Self assessment		
30	3	Filter and Bandwidth	Filter characteristic of Linear System, Distortion less	https://drive.google.com/drive/folders/1wbfiYl3-MtZKh0u4tTH26ARlgQoIIGck?usp=sharing	https://drive.google.com/drive/folders/1g4Ge7kWY50xel0YLlZpmoBF2uo-cDUho?usp=shar	**NA**	Apply	Chalk and talk,PPT	T1

			transmission through a system, Signal bandwidth, System Bandwidth,		ing				
31	3	Filter and Design	Ideal LPF, HPF, and BPF characteristics, Causality and Paley-Wiener criterion for physical realization,			**NA**	Apply	Chalk and talk,PPT	T1
32	3	Working of Filter	Relationship between Bandwidth and rise time, Convolution and Correlation of Signals			**NA**	Apply	Chalk and talk,PPT	T1
33	3	Exercise on convolution, Tutorial 7	Concept of convolution in Time domain and Frequency domain Graphical representation of Convolution	**NA**	**NA**	**NA**	Self assessment		
34	3	Revision	**NA**	**NA**	**NA**	**NA**	Self assessment		
35	3	Student presentation	**NA**	**NA**	**NA**	**NA**	Self assessment		
36	4	Laplace Transforms	Introduction	https://drive.google.com/folders/14jfno14Zp8r-rLJwBdzj9qpR2-tjvMzn?usp=sharing	https://drive.google.com/folders/14IwB0sr06Z9DDfewjKEBMMHd8petMUT?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
37	4	Laplace Transforms	Concept of Region of Convergence (ROC) for Laplace Transforms,			**NA**	Understand	Chalk and talk,PPT	T1

			Properties of L.T,						
38	4	Laplace Transforms	Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.			**NA**	Understand	Chalk and talk,PPT	T1
39	4	Tutorial 8	Laplace Transforms	**NA**	**NA**	**NA**	Self assessment		
40	4	Z Transforms	Z– Transforms: Concept of Z-Transform of a Discrete Sequence,	https://drive.google.com/drive/folders/14jfno14Zp8r-rLJwBdzj9qpR2-tjvMzn?usp=sharing	https://drive.google.com/drive/folders/14IwB0sr06Z9DDfewjKEBMMMHd8petMUT?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T1
41	4	Z Transforms	fourier and Z Transforms, Region of Convergence in Z-Transform,			**NA**	Understand	Chalk and talk,PPT	T1
42	4	Z Transforms	Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.			**NA**	Understand	Chalk and talk,PPT	T1
43	4	Tutorial 9	Z-Transform	**NA**	**NA**	**NA**	Self assessment		
44	4	MOCK TEST-2	MOCK TEST-2	**NA**	**NA**	**NA**	Evaluation		
45	4	Revision	**NA**	**NA**	**NA**	**NA**	Self assessment		

46	4	Student presentation	**NA**	**NA**	**NA**	**NA**	Self assessment		
47	5	Sampling theorem:	Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling,	https://drive.google.com/drive/folders/1Dy9047IpxjFuc744DL9yzjzh-MXv867n?usp=sharing	https://drive.google.com/drive/folders/148W8vucg0WLmafKCgWbxqCJad1zXeRau?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T2
48	5	Reconstruction on Band Pass	of signal from its samples, Effect of under sampling – Aliasing,				Understand	Chalk and talk,PPT	T2
49	5	Tutorial 10	Sampling	**NA**	**NA**	**NA**	Self assessment		
50	5	Correlation:	Cross Correlation and Auto Correlation of Functions,	https://drive.google.com/drive/folders/1Dy9047IpxjFuc744DL9yzjzh-MXv867n?usp=sharing	https://drive.google.com/drive/folders/148W8vucg0WLmafKCgWbxqCJad1zXeRau?usp=sharing	**NA**	Understand	Chalk and talk,PPT	T2
51	5	Properties	Energy Density Spectrum, Parsevals Theorem,			**NA**	Understand	Chalk and talk,PPT	T2
52	5	Properties	Power Density Spectrum, Relation between Autocorrelation Function and Energy/Power Spectral Density Function,			**NA**	Understand	Chalk and talk,PPT	T2
53	5	Convolution and Correlation	Relation , Detection of Periodic Signals in the presence of Noise by			**NA**	Understand	Chalk and talk,PPT	T2

			Correlation,						
54	5	Extraction	Signal from Noise by Filtering			**NA**	Understand	Chalk and talk,PPT	T2
55	5	Tutorial 11	Fourier Transform	**NA**	**NA**	**NA**	Self assessment		
56	5	Revision	**NA**	**NA**	**NA**	**NA**	Self assessment		
57	5	Student presentation	**NA**	**NA**	**NA**	**NA**	Self assessment		
MID-II EXAMINATION									
Text Book									
1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2 Ed.									
2. Signals, Systems & Communications - B.P. Lathi, 2013, BSP.									
Reference Books									
1. Signals and Systems – Simon Haykin and Van Veen, Wiley 2 Ed.,									
2.Signals and Systems – A. Rama Krishna Rao, 2008, TMH									
3. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.									
4.Signals, Systems and Transforms - C. L. Philips, J.M.Parr and Eve A.Riskin, 3 Ed., 2004, PE.									
5. Signals and Systems – K. Deergha Rao, Birkhauser, 2018									

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	-	1	-	-	-	1	-	-	1	1	3	-
CO2	3	3	1	-	1	-	-	-	1	-	-	1	1	3	-
CO3	3	3	1	-	1	-	-	-	2	-	-	1	1	3	-
CO4	3	3	2	-	1	-	-	-	2	-	-	1	1	3	-
Average	3	3	1.25	-	1	-	-	-	1.5	-	-	1	1	3	-
Average (Rounded)	3	3	1	-	1	-	-	-	2	-	-	1	1	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

X. JUSTIFICATIONS FOR CO-PO MAPPING:

Mapping	Low (1), Medium (2), High(3)	Justification
CO1-PO1	3	Students will be able to discuss the analogy between vectors and signals.
CO1-PO2	3	Students will be able to describe the signal approximation using orthogonal functions.
CO1-PO3	1	Students will be able to discuss about Exponential and sinusoidal signals, Concepts of Impulse function, Unit step function, Signum function.
CO1-PO5	1	Students will be able to illustrate Fourier series, Continuous time periodic signals, properties of Fourier series.
CO1-PO9	1	Students will be able to illustrate Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum.
CO1-PO12	1	Students will be able to compute Fourier transform from Fourier series.
CO1-PSO1	1	Students will be able to compute Fourier transform of arbitrary signal.
CO1-PSO2	3	Students will be able to compute Fourier transform of standard signals.
CO2-PO1	3	Students will be able to compute Fourier transform of periodic signals.
CO2-PO2	3	Students will be able to demonstrate the Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, and Linear time variant (LTV) system.
CO2-PO3	1	Students will be able to discuss Filter characteristics of linear systems.
CO2-PO5	1	Students will be able to demonstrate the Causality and Paley-Wiener criterion for physical realization.
CO2-PO9	1	Students will be able to describe Laplace transforms, Partial fraction expansion, Inverse Laplace transform.
CO2-PO12	1	Students will be able to demonstrate the concept of region of convergence (ROC) for Laplace transforms.
CO2-PSO1	1	Students will be able to examine the constraints on ROC for various classes of signals.
CO2-PSO2	3	Students will be able to examine the fundamental difference between continuous and discrete time signals.
CO3-PO1	3	Students will be able to describe concept of Z- Transform of a discrete sequence.
CO3-PO2	3	Students will be able to describe concept and methods to determine the inverse Z- Transform of a discrete sequence.

CO3-PO3	1	Students will be able to describe concept of Z- Transform of a discrete sequence.
CO3-PO5	1	Students will be able to explain the distinction between Laplace, Fourier and Z transforms, Region of convergence in Z-Transform,.
CO3-PO9	2	Students will be able to explain the constraints on ROC for various classes of signals
CO3-PO12	1	Students will be able to illustrate Sampling theorem.
CO3-PSO1	1	Students will be able to illustrate the types of sampling.
CO3-PSO2	3	Students will be able to illustrate Reconstruction of signal from its samples.
CO4-PO1	3	Students will be able to illustrate the effect s of undersampling.
CO4-PO2	3	Students will be able to demonstrate cross correlation.
CO4-PO3	2	Students will be able to demonstrate properties of correlation function.
CO4-PO5	1	Students will be able to demonstrate Energy density pectrum, Parseval's theorem.
CO4-PO9	2	Students will be able to demonstrate Power density spectrum.
CO4-PO12	1	Students will be able to discuss relation between autocorrelation function and energy spectral density
CO4-PSO1	1	Students will be able to discuss relation between autocorrelation function and power spectral density
CO4-PSO2	3	Students will be able to express Relation between convolution and correlation.

XI. QUESTION BANK (JNTUH):

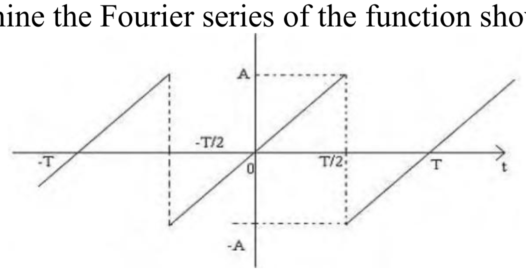
UNIT - I

Long Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Write the classification of all the standard signals	Remember	1
2.	Prove that sin nwt and cos mwt are orthogonal to each other for all integers m,n	Apply	1
3.	Prove that the complex exponential signals are orthogonal functions $x(t)=e^{jnwt}$ and $y(t)=e^{jmwt}$ let the interval be(t_0, t_0+T)	Apply	1
4.	Discuss how an unknown function f(t) can be expressed using infinite Mutually orthogonal functions. Hence show the representation of a waveform f(t) using trigonometric Fourier series.	Apply	1
5.	Explain the analogy of vectors and signals in terms of	Understand	1

	orthogonality and evaluation of constant.		

Short Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Define the following basic signals with graphical representation i) Unit Sample Signal ii) Unit Step Signal iii) Ramp Signal iv) Sinusoidal signal.	Remember	1
2.	Write short notes on "orthogonal vector space"	Understand	1
3.	List out all the properties of Fourier Series.	Understand	1
4.	Determine the Fourier series of the function shown in  figure	Remember	1
5.	Give relationship between Trigonometric and Exponential Fourier series.	Understand	1

UNIT - II

Long Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Find the Fourier transform of the function i) $f(t) = e-a|t| \sin (t)$ ii) $f(t) = \cos at2$ iii) $f(t) = \sin at2$	Apply	2
2.	Find the even and odd components of the signal $x(t) = \cos(\omega ot+\pi/3)$.	Understand	2
3.	A rectangular function f(t) is defined by $f(t) = 1; 0 < t < \pi$ $= -1; \pi < t < 2\pi$ Approximate this function by a waveform sint over the interval $(0, 2\pi)$ such that the mean square error is inimum.	Understand	2
4.	Show that autocorrelation and power spectral density form a Fourier Transform Pair.	Understand	2
5.	State and prove Parseval's Theorem.	Remember	2

Short Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome

1.	State and prove any Four Properties of Fourier Transform.	Remember	2
2.	Briefly explain Dirichlet's conditions for Fourier series	Understand	2
3.	State Time Shifting property in relation to Fourier series.	Understand	2
4.	Find the fourier transform of x(t)=sin(wt)	Understand	2
5.	Write the standard forms three classes of Fourier series	Evaluate	2

UNIT - III

Long Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	A system represented by y(t) = 2x(t-2) + 2x(t+2). i) Is the system time invariant? Justify your answer. ii) Is the system causal? Justify your answer.	Remember	3
2.	Define Linearity and Time-Invariant properties of a system.	Understand	3
3.	Show that the output of an LTI system is given by the linear convolution of input signal and impulse response of the system.	Understand	3
4.	What are the requirements to be satisfied by an LTI system to provide distortion less transmission of a signal?	Understand	3
5.	Bring out the relation between bandwidth and rise time	Understand	3

Short Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Define the terms: i) Signal Bandwidth ii) System bandwidth	Remember	3
2.	Define the terms: Linear time Variant system Paley-wiener criteria for physical reliability.	Remember	3
3.	Discuss the effect of aliasing due to under sampling.	Understand	3
4.	Briefly explain BIBO stability concept.	Remember	3
5.	State Convolution property of Fourier Transform.	Analyze	3

UNIT - IV

Long Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Find the inverse Z transform of X(z) = ln(1+az-1) ; ROC	Understand	4

	|z|>a		
2.	State and Prove Initial value and Final value theorem w.r.t Laplace transform	Remember	4
3.	State any four properties of Laplace transform.	Understand	4
4.	Find the inverse Laplace transform of (S-1) / (S) (S+1).	Understand	4
5.	Bring out the relationship between Laplace and Fourier Transform.	Analyze	4

Short Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Define Laplace Transform and Its inverse.	Remember	4
2.	Define Region of convergence and state its properties.	Remember	4
3.	Find the Laplace transform of f(t) = *sin* at *cos* bt & f(t) = t *sin* at	Understand	4
4.	State the properties of the ROC of Laplace transform	Remember	4
5.	Define Region of Convergence and state its properties w.r.t Z- Transform.	Remember	4

UNIT - V

Long Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	State and prove sampling theorem for band limited signals	Understand	4
2.	Derive the relationship between autocorrelation function and energy spectral density of an energy signal.	Understand	4
3.	Discuss the process of reconstructing the signal from its samples.	Understand	4
4.	Bring out the relation between Correlation and Convolution.	Remember	4
5.	Define Nyquist rate. Compare the merits and demerits of performing sampling using impulse, Natural and Flat-top sampling techniques.	Remember	4

Short Answer Questions:

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1.	Find the convolution of two signals x(n) = { 1, 1, 0, 1, 1} and h(n) = { 1, -2, -3, 4}	Remember	4
2.	Define autocorrelation and state its properties.	Remember	4

3.	What is the condition for avoid the aliasing effect?	Understand	4
4.	What is the significance of antialiasing filter	Analyze	4
5.	Define sampling of band pass signals.	Analyze	4

OBJECTIVE QUESTIONS:
UNIT I

1. The type of systems which are characterized by input and the output quantized at certain levels are called as _________________. [ ]
   a) analog b) discrete c) continuous d) digital
2. The type of systems which are characterized by input and the output capable of taking any value in a particular set of values are called as ____________. [ ]
   a) analog b) discrete c) digital d) continuous
3. An example of a discrete set of information/system is ______________. [ ]
   a) the trajectory of the Sun b) data on a CD
   c) universe time scale d) movement of water through a pipe
4. A system which is linear is said to obey the rules of ___________. [ ]
   a) scaling b) additivity c) both scaling and additivity d) homogeneity
5. A time invariant system is a system whose output __________________. [ ]
   a) increases with a delay in input b) decreases with a delay in input
   c) remains same with a delay in input d) vanishes with a delay in input
6. Basically signals can be broadly classified as .... & ....
7. The condition for Orthogonality between two time domain signals is.............
8. The condition for periodicity of a continuous time signal is..............
9. The equation for finding the power of DT signal is................
10. The Fourier Series of a continuous time signal is defined as............

UNIT II

1. ______________ discovered Fourier series. [ ]
   a) Jean Baptiste de Fourier b) Jean Baptiste Joseph Fourier
   c) Fourier Joseph d) Jean Fourier
2. ____ are the conditions which are required for a signal to fulfil to be represented as Fourier series. [ ]
   a) Dirichlet's conditions b) Gibbs phenomenon
   c) Fourier conditions d) Fourier phenomenon
3. ____________ are the two types of Fourier series. [ ]
   a) Trigonometric and exponential b) Trigonometric and logarithmic
   c) Exponential and logarithmic d) Trigonometric only
4. _________ are the Fourier coefficients in the following. [ ]
   a) a_0, a_n and b_n b) a_n c) b_n d) a_n and b_n
5. ____ is the disadvantage of exponential Fourier series. [ ]
   a) It is tough to calculate b) It is not easily visualized
   c) It cannot be easily visualized as sinusoids d) It is hard for manipulation
6. The Fourier transform of x(t) is given by……..
7. Fourier transform is used to analyze a ………..signal in frequency domain.

8. The inverse Fourier transform of X(w) is given by…….
9. ………………… is the Fourier transform of a delta function.
10. According to sampling theorem the frequency of sampling f_s should be …………

UNIT III

1. The rule h*x = x*h is called _______________. [ ]
a) Commutativity rule b) Associativity rule c) Distributive rule d) Transitive rule
2. For an LTI discrete system to be stable, the square sum of the impulse response should be ____. [ ]
a) Integral multiple of 2pi b) Infinity c) Finite d) Zero
3. The rule (h*x)*c = h*(x*c) is called ______________. [ ]
a) Commutativity rule b) Associativity rule c) Distributive rule d) Transitive rule
4. The system h(t) = exp(-7t) correspond to a _____________ system. [ ]
a) Yes b) No c) Marginally Stable d) None
5. ________________ expression equal to: h*(d+bd), d(t) is the delta function. [ ]
a) h + d b) b + d c) d d) h + b
6. A continuous time system is time ………if the time shift is reflected in the output signal also.
7. The equation for transfer function of a system is given by the ratio of ……& …….
8. _____________ defines impulse response of a continuous time system.
9. The range of frequencies of an ideal low pass filter will br from…….Hz to…..Hz
10. If a system is causal then the condition in terms of the impulse response h(t) is….

UNIT IV

1. Transfer function may be defined as ______. [ ]
a) Ratio of out to input b) Ratio of Laplace transform of output to input
c) Ratio of Laplace transform of output to input with zero initial conditions d) None
2. _______ are the poles of transfer function which is defined by input x(t)=5Sin(t)-u(t) and output y(t)=Cos(t)-u(t). [ ]
a) 4.79, 0.208 b) 5.73, 0.31 c) 5.89, 0.208 d) 5.49, 0.308
3. Any system is said to be stable if and only if _________. [ ]
a) It poles lies at the left of imaginary axis b) It zeros lies at the left of imaginary axis
c) It poles lies at the right of imaginary axis d) It zeros lies at the right of imaginary axis
4. _____________ justifies the linearity property of z-transform [x(n)↔X(z)].[ ]
a) x(n)+y(n) ↔X(z)Y(z) b) x(n)+y(n) ↔X(z)+Y(z)
c) x(n)y(n) ↔X(z)+Y(z) d) x(n)y(n) ↔X(z)Y(z)
5. _______ is the set of all values of z for which X(z) attains a finite value. [ ]
a) Radius of convergence b) Radius of divergence
c) Feasible solution d) None of the mentioned
6. The mathematical computation called…… is used to represent continuous time signals in terms of complex exponentials.
7. The Laplace transform of $x(t)=e^{-at}u(t)$ is……...
8. The time delay property of Laplace transform is given by ………………….
9. ______________ are two advantages of Laplace transforms.
10. The inverse Laplace transform of X(s) is given by ………………..

UNIT V

1. The value of h[n]*d[n-1], d[n] being the delta function is ____________. [ ]
   a) h[n-2] b) h[n] c) h[n-1] d) h[n+1]
2. The convolution of x(t) = exp(2t)u(-t), and h(t) = u(t-3) is ____________. [ ]
   a) 0.5exp(2t-6) u(-t+3) + 0.5u(t-3) b) 0.5exp(2t-3) u(-t+3) + 0.8u(t-3)
   c) 0.5exp(2t-6) u(-t+3) + 0.5u(t-6) d) 0.5exp(2t-6) u(-t+3) + 0.8u(t-3)
3. The convolution of x(t) = exp(3t)u(-t), and h(t) = u(t-3) is ________. [ ]
   a) 0.33exp(2t-6) u(-t+3) + 0.5u(t-3) b) 0.5exp(4t-3) u(-t+3) + 0.8u(t-3)
   c) 0.33exp(2t-6) u(-t+3) + 0.5u(t-6) d) 0.33exp(3t-6) u(-t+3) + 0.33u(t-3)
4. The value of d(t-34)*x(t+56), d(t) being the delta function is ______. [ ]
   a) x(t + 56) b) x(t + 32) c) x(t + 22) d) x(t – 22)
5. If h_1, h_2 and h_3 are cascaded, the overall impulse response is ________. [ ]
   a) h_1 * h2 * h_3 b) $h_1 + h_2 + h_3$ c) h_3 d) all of the above

6. The equation for convolution in time domain is ……….
7. Convolution sum is the mathematical computation that can be performed only on ……. signals.
8. $x(n).\delta(n-n_0)$ = …………………………
9. The spectral density functions of the periodic or non-periodic signal x(t) represents the distribution of power or energy in the ………. domain.
10. If X(f) is the frequency domain function of a signal x(t) then its ESD is given as ………………

XII. WEBSITES:

1. https://www.edx.org/counse/signals-systems-part-1-iitbombay-ee210-1x-1
2. nptel.ac.in/courses/117104074
3. dsp.rice.edu/courses/elec301

XIII. EXPERT DETAILS:

1. Mr. S. Srinivasan, Professor, Indian Institute of Technology, Madras
2. Dr. V. Sumalatha (JNTUA)
3. Dr. P. V. D. Somasekhar Rao (JNTUH)
4. Dr. T.Satya Savithri (JNTUH)

XIV. JOURNALS:

INTERNATIONAL

1. IEEE Journal on Selected Areas in Communications
2. IEEE Transactions on Signal Processing
3. IEEE Transactions on Circuits and Systems
4. IEEE Transactions on Audio, Speech, and Language Processing

NATIONAL

1. The Journal of the Acoustical Society of America
2. EURASIP Journal on Advances in Signal Processing
3. Journal of Signal Processing Systems

XV. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Signal approximation using orthogonal functions.
2. Fourier series representation of periodic signals.
3. Fourier series properties.
4. Fourier transforms properties.
5. Signal transmission through linear systems.

XVII. CASE STUDIES / SMALL PROJECTS:

1. Estimation of Improved DFT Characteristics.
2. Calculation Fourier Transform using Mat Lab.
3. Designing of an LTI System.