INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**SIGNALS AND SYSTEMS**			
Course Code	**A30406**			
Regulation	**R15– JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	1	-	4
Course Coordinator	Mrs. L Shruthi, Assistant Professor, ECE			
Team of Instructors	Mr. N Nagaraju, Assistant Professor, ECE			

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. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	5	Engineering Mathematics, Basics of Vector Theory

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam Marks	Total Marks
Midterm Test There shall be two midterm examinations.Each midterm examination consists of essay paper, objective paper and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of20minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark.	75	100

Sessional Marks	University End Exam Marks	Total Marks
First midterm examination shall be conducted for the first two and halfunits of syllabus and second midterm examination shallbe conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with critical thinking.Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

I. To provide background and fundamentals vectors for the analysis and processing of signals.
II. Evaluate the Fourier series of periodic signals and its properties.
III. Determine the Fourier Transform of signals and its properties.
IV. Convert a continuous time signal to the discrete time domain and reconstruct using the sampling theorem.
V. Analyze a discrete time LTI/LT systems using linear convolution.
VI. Apply the convolution theorem and correlation for continuous time signals.
VII. Use Laplace and Z-transform for analyzing Continuous/ Discrete time signals and systems.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. **Understand**the principles of vector spaces, including how to relate the concepts of basis, dimension, inner product, and norm to signals. Know how to analyze, design, approximate, and manipulate signals using vector-space concepts.
2. **Understand**and classify signals (e.g. periodic, even) and systems (e.g. causal, linear) and an understanding of the difference between discrete and continuous time signals and systems, understand the principles of impulse functions, step function and signum function.
3. **Analyze**the implications of linearity, time-invariance, causality, memory, and bounded-input, bounded-out (BIBO) stability.
4. **Determine** the response of linear systems to any input signal by convolution in the time domain, and by transformation to the frequency domain, filter characteristics of a system and its bandwidth, theconcepts of auto correlation and cross correlation and power density spectrum.
5. **Understand**the definitions and basic properties (e.g. time-shift, modulation, Parseval's Theorem) of Fourier series, Fourier transforms, Laplace transforms, Z transforms, and an ability to compute the transforms and inverse transforms of basic examples using methods such as partial fraction expansions, ROC of Z Transform/ Laplace Transform.
6. **Analyze** the Sampling theorem, reconstruction, aliasing, and Nyquist's theorem to represent continuous-time signals in discrete time so that they can be processed by digital computers.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: An ability to apply knowledge of basic sciences, mathematical skills, engineering and technology to solve complex electronics and communication engineering problems (**Fundamental Engineering Analysis Skills**).	H	Assignments, Tutorials
PO2	**Problem analysis**: An ability to identify, formulate and analyze engineering problems using knowledge of Basic Mathematics and Engineering Sciences (**Engineering Problem Solving Skills**).	S	Assignments
PO3	**Design/development of solutions**: An ability to provide solution and to design Electronics and Communication Systems as per social needs **(Social Awareness).**	H	Mini Projects
PO4	**Conduct investigations of complex problems**: An ability to investigate the problems in Electronics and Communication field and develop suitable solutions (**Creative Skills**).	H	Projects
PO5	**Modern tool usage** An ability to use latest hardware and software tools to solve complex engineering problems (**Software and Hardware Interface**).	S	Projects
PO6	**The engineer and society**: An ability to apply knowledge of contemporary issues like health, Safety and legal which influences engineering design **(Social Awareness).**	N	--
PO7	**Environment and sustainability**: An ability to have awareness on society and environment for sustainable solutions to Electronics and Communication Engineering problems **(Social Awareness).**	N	--
PO8	**Ethics**: An ability to demonstrate understanding of professional and ethical responsibilities **(Professional Integrity).**	S	Oral Discussions
PO9	**Individual and team work**: An ability to work efficiently as an individual and in multidisciplinary teams **(Team work).**	N	--
PO10	**Communication**:An ability to communicate effectively and efficiently both in verbal and written form **(Communication Skills).**	S	Presentations
PO11	**Life-long learning**: An ability to develop confidence to pursue higher education and for life-long learning **(Continuing Education Awareness).**	S	Seminars, Discussions
PO12	**Project management and finance**: An ability to design, implement and manage the electronic projects for real world applications with optimum financial resources **(Practical Engineering Analysis Skills**).	H	Development of Prototype, Projects

N - None **S - Supportive** **H - Highly Related**

VIII. 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.	H	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.	S	Tutorials

Program Specific Outcomes		Level	Proficiency assessed by
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.	S	Seminars and Projects

N - None **S - Supportive** **H- Highly Related**

IX. SYLLABUS:

UNIT -I:

Signal Analysis and Fourier series

Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation usingOrthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality inComplex functions, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signumfunction.

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.

UNIT-II:

Fourier Transforms and Sampling

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.

Sampling: Sampling theorem – Graphical and analytical proof for Band Limited Signals, Types of Sampling Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of undersampling – Aliasing, Introduction to Band Pass sampling.

UNIT-III:

Signal Transmission Through Linear Systems: Linear System, Impulse response, Response of a LinearSystem, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTIsystem, Filter characteristics of Linear Systems, Distortion less transmission through a system, Signal bandwidth,System bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Paley-Wiener criterion for physicalrealization, Relationship between Bandwidth and Rise time.

UNIT-IV:

Convolution and Correlation of Signals: Concept of convolution in Time domain and Frequency domain,Graphical representation of Convolution, Convolution property of Fourier Transforms, Cross Correlation andAuto Correlation of functions, Properties of Correlation function, Energy density spectrum, Parseval's Theorem,Power density spectrum, Relation between Auto Correlation function and Energy/Power spectral density function,Relation between Convolution and Correlation, Detection of periodic signals in the presence of Noise byCorrelation, Extraction of signal from noise by filtering.

UNIT-V:

Laplace Transforms and Z-Transforms

Laplace Transforms: Review of Laplace Transforms (L.T), Partial fraction expansion, Inverse LaplaceTransform, Concept of Region of Convergence (ROC) for Laplace Transforms, Constraints on ROC for variousclasses of signals, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certainsignals using waveform synthesis.

Z–Transforms: Fundamental difference between Continuous and Discrete time signals, Discrete time signalrepresentation using Complex exponential and Sinusoidal components, Periodicity of Discrete time signal usingcomplex exponential signal, 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 ofsignals, Inverse Z-transform, Properties of Z-transforms.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, 2013, BSP. (T1)
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, 2 Ed., PHI. (T2)

REFERENCE BOOKS:

1. Signals & Systems - Simon Haykin and Van Veen,Wiley, 2 Ed. (R1)
2. Signals and Signals – Iyer and K. Satya Prasad, Cengage Learning. (R2)
3. Signals and Systems – A.Rama Krishna Rao – 2008, TMH. (R3)
4. Introduction to Signal and System Analysis – K.Gopalan 2009, Cengage Learning. (R4)
5. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition. (R5)
6. Signals, Systems and Transforms - C. L. Philips, J.M.Parr and Eve A.Riskin, 3 Ed., 2004, PE. (R6)

IX. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
1-4	I	**Discuss** the analogy between vectors and signals. **Describe** the signal approximation using orthogonal functions	Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions	T1-3.1, 3.2
5-8		**Discuss** aboutExponential and sinusoidal signals, Concepts of Impulse function, Unit step function, Signum function.	Orthogonality in complex functions Exponential and sinusoidal signals, Concepts of Impulse function, Unit step function, Signum function.	T1-3.2
9-12		**Illustrate** Fourier series, Continuous time periodic signals,properties of Fourier series	Representation of Fourier series, Continuous time periodic signals,properties of Fourier series,	T1-3.3
13-17		**Illustrate**Dirichlet's conditions,Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum	Dirichlet's conditions,Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum	T1-3.3,3.4,3.5 ,3.6
18-20	II	**Compute**Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodicsignals	Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals	T1-4.1,4.5,4.6 ,4.7
21-24		**Illustrate** the Properties of Fourier transforms, Fourier transforms involving impulse function and Signum function and Introduction to Hilbert Transform.	Properties of Fourier transforms, Fourier transforms involvingimpulse function and Signum function, Introduction to Hilbert Transform.	T1-4.8,6.5,
25-28		**Illustrate**Sampling theorem and , Types of sampling	Sampling theorem – Graphical and analytical proof for Band Limited Signals, Types of sampling-impulse sampling, Natural and Flat top Sampling	R1-3.5
29-31		**Illustrate**Reconstruction of	Reconstruction of signal from its	R1-3.6

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
		signal from its samples, effect of under sampling	samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling.	
32-33	III	**Demonstration** of Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system. **compute** Transfer function of a LTI system.	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.	T1-6.1,6.8,
34-35		**Discuss** Filter characteristics of linear systems, . Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics,	Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics,	T1-6.11,6.1,6.14
36-37		**Demonstrate** the Causality and Paley-Wiener criterion for physical realization,, **Analyze**Relationship between bandwidth and rise time	Causality and Paley-Wiener criterion for physical realization, Relationship between bandwidth and rise time.	T1-6.15
38-40	IV	**Express**concept of convolution in time domain and frequency domain, Graphical representation of convolution **Explain**Convolution property of Fourier transforms	Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Convolution property of Fourier transforms.	T1-11.1, 11.2, 11.3
41-45		**Demonstrate**cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum	Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum	T1-12.2,12.3, 4.9
46-48		**Discuss**relation between autocorrelation function and energy/power spectral density function **Express**Relation between convolution and correlation	Relation between autocorrelation function and energy/power spectral density function, Relation between convolution and correlation	T1-12.1,12.2
49-51		**Discuss**thedetection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.	Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.	T1-12.5,12.7
52-55		**Describe**Laplace transforms, Partial fraction expansion, Inverse Laplace transform,	Review of Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of	R1-6.1,6.2,6.3,6.5,6.9

Lecture No.	Unit No	Course Learning Outcome	Topics Covered	Text Book/ Reference
	V	Concept of region of convergence (ROC) for Laplace transforms.	convergence (ROC) for Laplace transforms.	
56-59		**Examine** theconstraints on ROC for various classes of signals **Describe**Properties of L.T's relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.	Constraints on ROC for various classes of signals, Properties of L.T's relation between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.	T1-6.4,6.8
60-61		**Examine**thefundamental difference between continuous and discrete time signals **Analyze**discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal	Fundamental difference between continuous and discrete time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal	R1-7.1
62-64		**Describe**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	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	R1-7.2,7.3,7.4 ,7.5

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H							S				H		S	S
II		S								S			H	S	
III				H				S			S		H	S	
IV			H		S							H	H	S	
V	H			H										S	
VI		S			S					S			H	S	
VII				H							S	H	H	S	S

S – Supportive **H - Highly Related**

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

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H		H					S			S	H		S	S
2	H				S						S		H	S	
3		S			S			S				H	H	S	
4	H			H				S		S	S			S	
5	H	S	H		S								H	S	
6	H		H	H						S			H	S	

S – Supportive **H - Highly Related**

Prepared by **:** Mrs. L Shruthi, Assistant Professor, ECE

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