INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**SIGNALS AND SYSTEMS**				
Course Code	AECB14				
Programme	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	0	3	2	1
Chief Coordinator	Dr. V Padmanabha Reddy, Professor, ECE				
Course Faculty	Ms. V Bindu Sree, Assistant Professor, ECE Mr. P Sandeep Kumar, Assistant Professor, ECE				

I. COURSE OVERVIEW:

The course introduces the relation between signals and vectors. This presents description, representation, and classification of continuous and discrete time signals. This course focuses on giving exposure on mathematical tools like Fourier series, Fourier transform, Laplace transforms, and Z-transforms by analyzing signals and systems for their properties. It covers properties of linear time invariant (LTI) systems and ideal filter characteristics by interpreting distortion less transmission. The course also provides concepts of sampling and reconstruction of signal from samples, effects of under sampling, convolution, correlation autocorrelation, power density spectrum, energy density spectrum, detection and extraction of signals in presence of noise.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHSB05	III	Complex Analysis and Special functions	3
UG	AHSB11	II	Mathematical Transform Technique	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Signals and Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✔	Open Ended Experiments						

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exam.

Quiz-Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE(Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Quiz
PO 2	**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
PO 3	**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.	2	Term paper/ Assignments
PO 4	**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.	2	Seminars /Mini Project
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	Seminars / Mini Project

3 = High; 2 = Medium; 1 = Low

II. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**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.	3	Seminars and assignments
PSO 2	**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.	2	Assignments
PSO 3	**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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Classify signals and systems and their analysis in time and frequency domains.
II	Study the concept of distortion less transmission through LTI systems, convolution and correlation properties.
III	Understand Laplace and Z-Transforms their properties for analysis of signals and systems.
IV	Identify the need for sampling of CT signals, types and merits and demerits of each type.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Apply the knowledge of linear algebra to represent any arbitrary signals in terms of complete sets of orthogonal functions and classify the signals and systems based on their properties.	CLO 1	Apply the knowledge of vectors to find an analogy with signals.
		CLO 2	Understand Orthogonal signal space and orthogonal functions.
		CLO 3	Introduce the basic classification of signals in both continuous and discrete domain, exponential and sinusoidal signals, standard test signals
		CLO 4	Introduce the basic classification of systems in both continuous and discrete domain
CO 2	Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.	CLO 5	Representation of Fourier series for a periodic signal.
		CLO 6	Deduce Fourier Transform from Fourier series
		CLO 7	Compute Fourier Transform of Periodic Signal
		CLO 8	Introduce the special transform-Hilbert transform
CO 3	Understand the properties of linear time invariant	CLO 9	Analyze time variance for linear systems.

COs	Course Outcome	CLOs	Course Learning Outcome
	system, ideal filter characteristics through distortion less transmission and its bandwidth, causality with convolution and correlation.	CLO 10	Understand the concept of distortion less transmission through a system
		CLO 11	Analyze Causality and Paley-Wiener criterion for physical realization.
		CLO 12	Understand the concept of convolution through graphical representation
CO 4	Apply the Laplace transform and Z-transform and their Region of convergence (ROC) properties for analysis of continuous-time and discrete-time signals and systems respectively.	CLO 13	Introduce the concepts of Laplace transform for conversion to S-domain.
		CLO 14	Represent Region of Convergence for Laplace transforms and properties of Laplace Transforms.
		CLO 15	Understand the Z-Transform for discrete signals with issues of Region of Convergence
		CLO 16	Analyze the properties of Z-Transforms.
CO 5	Understand the process of sampling to convert an analog signal into discrete signal and the effects of under sampling and study correlation, spectral densities.	CLO 17	Categorical analysis of sampling into different types.
		CLO 18	Understand how to reconstruct signals after sampling
		CLO 19	Understand cross correlation and auto correlation concepts.
		CLO 20	Analyze Power Spectral and Energy Spectral Characteristics

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AECB14.01	CLO 1	Apply the knowledge of vectors to find an analogy with signals.	PO1	2
AECB14.02	CLO 2	Understand Orthogonal signal space and orthogonal functions.	PO1	3
AECB14.03	CLO 3	Introduce the basic classification of signals in both continuous and discrete domain, exponential and sinusoidal signals, standard test signals	PO2,PO5	3
AECB14.04	CLO 4	Introduce the basic classification of systems in both continuous and discrete domain	PO2,PO5	3
AECB14.05	CLO 5	Representation of Fourier series for a periodic signal.	PO1,PO2	2
AECB14.06	CLO 6	Deduce Fourier Transform from Fourier series	PO3,PO5	3
AECB14.07	CLO 7	Compute Fourier Transform of Periodic Signal	PO4, PO5	3
AECB14.08	CLO 8	Introduce the special transform-Hilbert transform	PO3	2
AECB14.09	CLO 9	Analyze time variance for linear systems.	PO4, PO5	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AECB14.10	CLO 10	Understand the concept of distortion less transmission through a system	PO2, PO5	2
AECB14.11	CLO 11	Analyze Causality and Paley-Wiener criterion for physical realization.	PO4	2
AECB14.12	CLO 12	Understand the concept of convolution through graphical representation	PO1,PO4, PO5	3
AECB14.13	CLO 13	Introduce the concepts of Laplace transform for conversion to S-domain.	PO2, PO5	3
AECB14.14	CLO 14	Represent Region of Convergence for Laplace transforms and properties of Laplace Transforms.	PO4	2
AECB14.15	CLO 15	Understand the Z-Transform for discrete signals with issues of Region of Convergence	PO2	2
AECB14.16	CLO 16	Analyze the properties of Z-Transforms.	PO4, PO5	2
AECB14.17	CLO 17	Categorical analysis of sampling into different types.	PO1,PO4	3
AECB14.18	CLO 18	Understand how to reconstruct signals after sampling	PO4, PO5	2
AECB14.19	CLO 19	Understand cross correlation and auto correlation concepts.	PO1,PO4, PO5	2
AECB14.20	CLO 20	Analyze Power Spectral and Energy Spectral Characteristics	PO1,PO4, PO5	2

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

Course Outcome(COs)	Program Outcomes (POs)					Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2
CO 1	3	3			1	2	
CO 2	2		3	3	3	1	3
CO 3	3	2	2	3	1	3	
CO 4		3		2	3	1	2
CO 5	2			2	1	3	

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2												2		
CLO 2	3												2		
CLO 3		3			1								3		
CLO 4		3			1								2		
CLO 5	2												1	3	
CLO 6			3		3								2	3	
CLO 7				3	3								1	2	
CLO 8			2											3	
CLO 9				3	1								3		
CLO 10		2	2		1								3		
CLO 11				2									3		
CLO 12	3			3	3								3		
CLO 13		3			3								1	2	
CLO 14				2									1	2	
CLO 15		2											1	2	
CLO 16				2	1								1	1	
CLO 17	3			2									3		
CLO 18				2	1								3		
CLO 19	2	2			1								3		
CLO 20	2			2	1								2		

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XIII. ASSESSMENT METHODOLOGIES - DIRECT

CIE Exams	PO1, PO2,PO3 PO4,PO5,PSO1, PSO2	SEE Exams	PO1, PO2,PO3 PO4,PO5,PSO1, PSO2	Assignments	-	Seminars	PO1, PO2,PO3 PO4,PSO1,PSO2
Laboratory Practices	PO5	Student Viva	-	Mini Project	-	Certification	-
Guest Lectures	PO4						

XIV. ASSESSMENT METHODOLOGIES – INDIRECT:

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS:

MODULE – I	SIGNAL ANALYSIS	Classes: 08

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.

MODULE - II	FOURIER SERIES	Classes: 10

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 Transforms.

MODULE - III	SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS	Classes: 10

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.

MODULE - IV	LAPLACE TRANSFORM AND Z-TRANSFORM	Classes: 08

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.

MODULE - V	SAMPLING THEOREM	Classes: 09

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, Parseval's 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. B.P. Lathi, "Signals, Systems & Communications", BSP, 2013.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2nd Edition 2010.

Reference Books:
1. Simon Haykin and Van Veen, "Signals and Systems" , Wiley Publications, 2nd Edition, 2010. 2. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.
Web References:
1. https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1 2. https://www.mooc-list.com/course/digital-signal-processing-coursera
E-Text Books:
1. http://onlinevideolecture.com/ebooks 2. http://www.freebookcentre.net/SpecialCat/Free-Signal-Processing-Book

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Apply the knowledge of vectors to find an analogy with signals.	CLO 1	T1:44
3-5	Understand Orthogonal signal space and orthogonal functions.	CLO 2	T1:61
6-8	Introduce the basic classification of signals in both continuous and discrete domain, exponential and sinusoidal signals, standard test signals	CLO 3	T2:1-37
9-10	Introduce the basic classification of systems in both continuous and discrete domain	CLO 4	T2:38-53
11-13	Representation of Fourier series for a periodic signal.	CLO 5	T2:186-205
14-16	Deduce Fourier Transform from Fourier series	CLO 6	T2:285-295
17	Compute Fourier Transform of Periodic Signal	CLO 7	T2:296
18-19	Introduce the special transform-Hilbert transform	CLO 8	R1
20-22	Analyze time invariance for linear systems.	CLO 9	T1:221-229
23-25	Understand the concept of distortion less transmission through a system	CLO 10	T1:248
26-27	Analyze Causality and Paley-Wiener criterion for physical realization.	CLO 11	T1:252
28-30	Understand the concept of convolution through graphical representation	CLO 12	T1:400
31-32	Introduce the concepts of Laplace transform for conversion to S-domain.	CLO 13	T2:655-661
33-34	Represent Region of Convergence for Laplace transforms and properties of Laplace Transforms.	CLO 14	T2:662-670
35-36	Understand the Z-Transform for discrete signals with issues of Region of Convergence	CLO 15	T2:741-757
37-39	Analyze the properties of Z-Transforms.	CLO 16	T2:767-774
40-42	Categorical analysis of sampling into different types.	CLO 17	T2:515
43-46	Understand how to reconstruct signals after sampling	CLO 18	T2: 522
47-50	Understand cross correlation and auto correlation concepts.	CLO 19	T1:518-527
51-56	Analyze Power Spectral and Energy Spectral Characteristics	CLO 20	T1:528

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Discrete Time Fourier Series and Discrete Time Fourier Transforms	MOOCS	PO1, PO3	PSO1

Prepared by:
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