INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**PROBABILTY THOERY AND STOCHASTIC PROCESS**				
Course Code	**AEC003**				
Programme	B.Tech				
Semester	III	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mrs. G Ajitha, Assistant Professor, ECE				
Course Faculty	Dr. M V Krishna Rao, Professor, ECE Mr. N Nagaraju, Assistant Professor, ECE Mrs. G Ajitha, Assistant Professor, ECE Mr. G Anil Kumar Reddy, Assistant Professor, ECE				

I. COURSE OVERVIEW:

The course addresses the concepts, principles and techniques of sets and probability and random variable and random process. The course teaches the fundamentals of probability applying the concepts of mean,variance and development techniques. This course forms the basis for the study of advanced subjects like signals and systems. Students will learn probability concepts and difference between random variable and random process and estimation of power spectral density.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS004	II	Complex Analysis and Probability Distributions	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Probability Theory and Stochastic Process	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATION METHODOLOGY:

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 units and each unit 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 unit. 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

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	Lectures, Assignments
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	Lab related exercises
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	Laboratory Practice

3 = High; 2 = Medium; 1 = Low

VII. 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	Seminar
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	Lab related exercises
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 (COs):

The course should enable the students to:	
I	Know the theoretical formulation of probability, random variables and stochastic processes.
II	Be Familiar with the basic concepts of the theory of random variables in continuous and discrete time domain and analyze various analytical properties such as statistical averages.
III	Understand the concept of stationary in random processes and study various properties such as autocorrelation, cross correlation and apply them for signal analysis.
IV	Relate time domain and frequency domain representations of random processes and model different scenarios of random environment in signal processing applications.

IX. 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
AEC003.01	CLO 1	Understand probabilities and be able to solve	PO 1, PO 2	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		using an appropriate sample space		
AEC003.02	CLO 2	Remember different random variables and their properties	PO 1, PO 2	3
AEC003.03	CLO 3	Discuss various operations like expectations from probability density functions (pdfs) and probability distribution functions	PO 1, PO 2, PO 4	3
AEC003.04	CLO 4	Remember Transformations of random variables	PO 1, PO 2	2
AEC003.05	CLO 5	Perform Likelihood ratio tests from pdfs for statistical engineering problems.	PO 1, PO 2	3
AEC003.06	CLO 6	Understand Operations on multiple random variables like moments	PO 1, PO 2	3
AEC003.07	CLO 7	Calculate Mean and covariance functions for simple random variables.	PO 1, PO 2	3
AEC003.08	CLO 8	Understand the Ergodic processes	PO 1	2
AEC003.09	CLO 9	Understand Auto-correlation and cross correlation properties between two random variables	PO 1, PO 2	3
AEC003.10	CLO 10	Explain the concept of random process; differentiate between stochastic, stationary and ergodic processes.	PO 1	3
AEC003.11	CLO 11	Explain the concept of power spectral density and power density spectrum of a random process.	PO 1, PO 4	3
AEC003.12	CLO 12	Apply the power density spectrum of a random process in system concepts	PO 1, PO 4	3
AEC003.13	CLO 13	Remember the Autocorrelation to stochastic process	PO 1	3
AEC003.14	CLO 14	Remember the Autocorrelation to stochastic process	PO 1,PO 2	3
AEC003.15	CLO 15	Apply the Gaussian Noise to stochastic process	PO 2, PO 4	3
AEC003.16	CLO 16	Apply the concept of probability theory and random process to understand and analyze real time applications	PO 4	1
AEC003.17	CLO 17	Acquire the knowledge and develop capability to succeed national and international level competitive examinations.	PO 4	1

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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	3	3											3	2	
CLO 2	3	3											3	2	
CLO 3	3	3		3									3	2	
CLO 4	2	2													

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

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 4	SEE Exams	PO 1, PO 2, PO 4	Assignments	PO 1	Seminars	PSO 1
Laboratory Practices	PO 2, PO 4	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Unit-I	PROBABILITY AND RANDOM VARIABLE
Introduction to probability through sets and probability: Relative frequency; Experiments and sample spaces, discrete and continuous sample spaces; Events; Probability definitions and axioms; Mathematical model of experiments; Probability as a relative frequency; Joint probability; Conditional probability, total probability; Baye's theorem and independent events. Random variable: Definition of random variable, conditions for a function to be a random variable, discrete, continuous and mixed random variable.	

Unit-II	DISTRIBUTION AND DENSITY FUNCTIONS
Distribution and density functions: Distribution and density functions definitions and properties; Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional distribution, methods of defining conditioning on an event, conditional density, properties. Operation on one random variable expectations: Introduction, expected value of a random variable, function of a random variable, moments about the origin, central moments, variance and skew; Chebyche's inequality; Characteristic function; Moment generating function; Transformations of a random variable: Monotonic transformations for a continuous random variable; Non monotonic transformations of continuous random variable; Transformation of a discrete random variable.	
Unit-III	**MULTIPLE RANDOM VARIABLES AND OPERATIONS**
Multiple random variables: Vector random variables, joint distribution function, properties of joint distribution; Marginal distribution functions, conditional distribution and density: Point conditioning, conditional distribution and density: Interval conditioning, statistical independence, sum of two random variables, sum of several random variables; Central limit theorem. Operations on multiple random variables: Expected value of functions of random variables: Joint moments about the origin, joint central moments, joint characteristic functions and jointly Gaussian random variables: Two random variables case and N random variable case, properties; Transformations of multiple random variables; Linear transformations of Gaussian random variables	
Unit-IV	**STOCHASTIC PROCESSES: TEMPORAL CHARACTERISTICS**
The random process concept, classification of processes, deterministic and non deterministic processes, distribution and density functions, concept of stationary and statistical independence; First order stationary processes; Second order and wide sense stationary, N Order and strict sense stationary, time averages and periodicity, mean Ergodic processes, correlation Ergodic processes; Autocorrelation function and its properties; Cross correlation function and its properties; Covariance functions; Gaussian random processes; Poisson random process.	
Unit-V	**STOCHASTIC PROCESSES: SPECTRAL CHARACTERISTICS**
Power spectrum: Properties, relationship between power spectrum and autocorrelation function; The cross power density spectrum, properties, relationship between cross power spectrum and cross correlation function. Spectral characteristics of system response: Power density spectrum of response; cross-power density spectrums of input and output of a linear system. Introduction to white Gaussian noise process and its properties.	
Text Books:	
1. Peyton Z. Peebles, "Probability, Random Variables & Random Signal Principles", Tata McGraw Hill, 4th Edition, 2001. 2. Scott Miller, Donald Childers, "Probability and random process", Elsevier, 2nd Edition, 2012. 3. S.P. Eugene Xavier, "Statistical Theory of Communication", New Age Publications, 1st Edition, 2003.	
Reference Books:	
1. Athanasius Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", PHI, 4th Edition, 2002. 2. Henry Stark, John W. Woods, "Probability and Random Processes with Application to Signal Processing", Pearson Education, 3rd Edition, 2014. 3. George R. Cooper, Clave D. MC Gillem, "Probability Methods of Signal and System Analysis", Oxford, 3rd Edition, 1999.	

XIV. 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	Define probability through sets and probability and Relative frequency.	CLO 1	T1:1.1-1.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
2-5	Define sample spaces, Events and axioms of probability.	CLO 1	T1:1.3
6-7	Define Joint, Conditional, total probability, Baye‘s theorem and independent events.	CLO 1	T1: 1.4,1.5
8-10	Define random variable, conditions for a function to be a random variable.	CLO 2	T1:2.1
11-13	Define distribution and density functions definitions and their properties, standard random variables.	CLO 3	T1 : 2.2- 2.5
14-15	Explain Conditional distribution and density.	CLO 3	T1: 2.6
16-20	Explain expectation of random variable, moment’s central moments, variance and skew.	CLO 3	T1: 3.1-3.2
21-22	Demonstrate Characteristic function and Moment generating function.	CLO 3	T1:3.3
23-24	Distinguish monotonic and non monotonic transformations.	CLO 4	T1: 3.4
25-27	Define Vector random variables, joint distribution, density and their properties.	CLO 4	T1:4.1-4.4
28-32	Define point, interval conditioning, independence and central limit theorem where conditional probability has applied.	CLO 5	T1:4.5-4.7
33-35	Define Expected value, Joint moments, joint central moments and joint characteristic functions where multiple random variables have applied.	CLO 6	T1: 5.1-5.3
36-38	Explain Transformations where multiple random variables can be applied.	CLO 8	T1: 5.4
39-40	Define Covariance functions.	CLO 7	R1:5.4-5.6
41-42	Define random process, distribution and density functions, stationary and statistical independence.	CLO 11	T1:6.1-6.2
43-45	Define First order stationary and second order stationary.	CLO 10	R1:7.1-7.2
46-49	Distinguish time and statistical averages, auto and cross correlations of random process.	CLO 12	T1:6.2-6.6
50-54	Define Auto-correlation and cross correlation.	CLO 9	R3:9.4-9.6
55-56	Define Power spectrum and cross Power spectrum.	CLO 13	T1:7.1-7.5
57-58	Define Gaussian noise process and its properties.	CLO 15	R2:7.4-7.6
59-60	Derive Spectral characteristics of system response.	CLO 14	T1:8.2-8.4

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

S NO	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Elementary aspects of probability theory on random consideration.	Seminars / Guest Lectures	PO 1, PO 2	PSO 1
2	Principles of random signals and to provide tools to deal with systems involving such signals.	Seminars / NPTEL	PO 2, PO 4	PSO 2
3	Encourage students to solve problems based on random process in real time applications.	Seminars	PO 1, PO 3, PO 4	PSO 2

Prepared by:
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