INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPLEX ANALYSIS AND PROBABILITY DISTRIBUTIONS**				
Course Code	AHSB06				
Programme	B. Tech				
Semester	IV	EEE			
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Ch Soma Shekar, Assistant Professor				
Course Faculty	Mr. Ch Soma Shekar, Assistant Professor				

I. COURSE OVERVIEW:

The course focuses on more Advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes complex functions and differentiation, complex integration, power series expansion of complex function, Probability of single random variables and its distributions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Complex Analysis and Probability Distributions	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	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 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	Presentation on real-world problems
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	Seminar
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	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Problem Solving:** Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	1	Seminar
PSO 2	**Professional Skills:** Identify the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	-	-
PSO 3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the basic theory of complex functions to express the power series.
II	Evaluate the contour integration using Cauchy residue theorem.
III	Enrich the knowledge of probability on single random variables and probability distributions

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLO's	Course Learning Outcome
CO 1	Discuss about continuity/differentiability/ analyticity of a Complex function using Cauchy-Riemann Equations. Estimate complex conjugate using Milne	CLO 1	Recall continuity, differentiability, analyticity of a function using limits.
		CLO 2	Interpret the conditions for a complex variable to be analytic and/or entire function.
		CLO 3	Interpret the concepts of Cauchy-Riemann relations and harmonic functions.
		CLO 4	Analyze the Bilinear transformation by cross ratio property.

COs	Course Outcome	CLO's	Course Learning Outcome
	Thomson method and understand the concept of Bilinear transformation.	CLO 5	Identify the conditions of fixed and critical point of Bilinear Transformation.
CO 2	Recognize and apply the Cauchy's integral formula and the generalized Cauchy's integral formula. Evaluate complex functions as power series and radius of convergence of power series	CLO 6	Demonstrate the area under a curve using the concepts of indefinite integration.
		CLO 7	Interpret the concepts of the Cauchy's integral formula and the generalized Cauchy's integral formula.
		CLO 8	Demonstrate complex functions as power series and radius of convergence of power series.
		CLO 9	Interpret the concept of complex integration to the real-world problems of flow with circulation around a cylinder.
CO 3	Establish the contour integral with an integrand which has singularities lying inside or outside the simple closed contour. Expand complex function as power series using Taylor's and Laurent series.	CLO 10	Asses the Taylor's and Laurent series expansion of complex functions.
		CLO 11	Interpret the concept of different types of singularities for analytic function.
		CLO 12	Identify the poles, residues and solve integrals using Cauchy's residue theorem.
		CLO 13	Interpret the concept of Cauchy's residue theorem to the real-world problems of Quantum Mechanical scattering and Quantum theory of atomic collisions.
CO 4	Enrich the knowledge of Probability to discrete and continuous random variables.	CLO 14	Demonstrate an understanding of the basic concepts of probability and random variables.
		CLO 15	Classify the types of random variables and calculate mean, variance.
		CLO 16	Estimate moment about origin, central moments, moment generating function of probability distribution.
CO 5	Analyze probability distributions for Binomial, Poisson and normal distributions and study its properties.	CLO 17	Recognize where the Binomial distribution could be appropriate model of the distributions.
		CLO 18	Recognize where the Poisson distribution could be appropriate model of the distributions.
		CLO 19	Recognize where the Binomial distribution and Poisson distribution could be appropriate to find mean, variance of the distributions.
		CLO 20	Apply the inferential methods relating to the means of normal distributions.
		CLO 21	Interpret Binomial distribution to the phenomena of real-world problem like sick versus healthy.
		CLO 22	Identify the mapping of Normal distribution in real-world problem to analyze the stock market.
		CLO 23	Use Poisson distribution in real-world problem to predict soccer scores.
		CLO 24	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.

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
AHSB06.01	CLO 1	Recall continuity, differentiability, analyticity of a function using limits.	PO 1	3
AHSB06.02	CLO 2	Interpret the conditions for a complex variable to be analytic and/or entire function.	PO 1	3
AHSB06.03	CLO 3	Interpret the concepts of Cauchy-Riemann relations and harmonic functions.	PO 2	3
AHSB06.04	CLO 4	Analyze the Bilinear transformation by cross ratio property.	PO 4	1
AHSB06.05	CLO 5	Identify the conditions of fixed and critical point of Bilinear Transformation.	PO 2	2
AHSB06.06	CLO 6	Demonstrate the area under a curve using the concepts of indefinite integration.	PO 2	2
AHSB06.07	CLO 7	Interpret the concepts of the Cauchy's integral formula and the generalized Cauchy's integral formula.	PO 1	3
AHSB06.08	CLO 8	Demonstrate complex functions as power series and radius of convergence of power series.	PO 4	1
AHSB06.09	CLO 9	Interpret the concept of complex integration to the real-world problems of flow with circulation around a cylinder.	PO 2	3
AHSB06.10	CLO 10	Asses the Taylor's and Laurent series expansion of complex functions.	PO 1	3
AHSB06.11	CLO 11	Interpret the concept of different types of singularities for analytic function.	PO 1	3
AHSB06.12	CLO 12	Identify the poles, residues and solve integrals using Cauchy's residue theorem.	PO 1	2
AHSB06.13	CLO 13	Interpret the concept of Cauchy's residue theorem to the real-world problems of Quantum Mechanical scattering and Quantum theory of atomic collisions.	PO 4	2
AHSB06.14	CLO 14	Demonstrate an understanding of the basic concepts of probability and random variables.	PO 4	2
AHSB06.15	CLO 15	Classify the types of random variables and calculate mean, variance.	PO 4	2
AHSB06.16	CLO 16	Estimate moment about origin, central moments, moment generating function of probability distribution.	PO 2	3
AHSB06.17	CLO 17	Recognize where the binomial distribution could be appropriate model of the distributions.	PO 1	3
AHSB06.18	CLO 18	Recognize where the Poisson distribution could be appropriate model of the distributions.	PO 2	3
AHSB06.19	CLO 19	Recognize where the binomial distribution and Poisson distribution could be appropriate to find mean, variance of the distributions.	PO 2	3
AHSB06.20	CLO 20	Apply the inferential methods relating to the means of normal distributions.	PO 1, PO 2	3
AHSB06.21	CLO 21	Interpret binomial distribution to the phenomena of real-world problem like sick versus healthy.	PO 4	3
AHSB06.22	CLO 22	Identify the mapping of normal distribution in real-world problem to analyze the stock market.	PO 1	3
AHSB06.23	CLO 23	Use Poisson distribution in real-world problem to predict soccer scores.	PO 4	3

AHSB06.24	CLO 24	Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations.	PO 4	2

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)
	PO1	PO2	PO4	PSO1
CO 1	3			2
CO 2	3	3		1
CO 3	3	3		
CO 4		3	2	1
CO 5	3		2	2

3= High; 2 = Medium; 1 = Low

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	3												1		
CLO 2	3												1		
CLO 3		3											1		
CLO 4				1											
CLO 5		2											1		
CLO 6		2											1		
CLO 7	3														
CLO 8				1											
CLO 9		3											1		
CLO 10	3												1		
CLO 11	3														
CLO 12	2														
CLO 13				2											
CLO 14				2									1		
CLO 15				2											

CLO 16		3												
CLO 17		3											1		
CLO 18				3									1		
CLO 19	3	2											1		
CLO 20	3	2											1		
CLO 21				3											
CLO 22	3												1		
CLO 23				3											
CLO 24				2											

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

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

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

Module-I	**COMPLEX FUNCTIONS AND DIFFERENTIATION**
Complex functions differentiation and integration: Complex functions and its representation on argand plane, concepts of limit, continuity, differentiability, analyticity, Cauchy-Riemann conditions and harmonic functions; Milne-Thomson method.. Bilinear Transformation.	
Module-II	**COMPLEX INTEGRATION**
Line integral: Evaluation along a path and by indefinite integration; Cauchy's integral theorem; Cauchy's integral formula; Generalized integral formula; Power series expansions of complex functions and contour Integration: Radius of convergence.	
Modul -III	**POWER SERIES EXPANSION OF COMPLEX FUNCTION**
Expansion in Taylor's series, Maclaurin's series and Laurent series. Singular point; Isolated singular point; Pole of order m; Essential singularity; Residue: Cauchy Residue Theorem. Evaluation of Residue by Laurent Series and Residue Theorem. Evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta,\sin\theta)\,d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$	

Module-IV	SINGLE RANDOM VARIABLES
Random variables: Discrete and continuous, probability distributions, mass function-density function of a probability distribution. Mathematical expectation. Moment about origin, central moments, moment generating function of probability distribution.	
Module-V	**PROBABILITY DISTRIBUTIONS**
Binomial, Poisson and normal distributions and their properties.	
Text Books:	
1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 10th Edition, 2010 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.	
Reference Books:	
1. T.K.V Iyengar, B.Krishna Gandhi, "Engineering Mathematics - III", S. Chand & Co., 12th Edition, 2015. 2. T.K.V Iyengar, B.Krishna Gandhi, "Probability and Statistics", S. Chand & Co., 7th Edition, 2015. 3. Churchill, R.V. and Brown, J.W, "Complex Variables and Applications", Tata Mc Graw-Hill, 8th Edition, 2012.	

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	Analyze the complex function in Argand plane	CLO 1	T1:12.1 R1:4.2
2	Apply the limit of a complex function	CLO 1	T1:12.3 R1:4.4
3	Apply the continuity of a complex function	CLO 1	T1:12.3 R1:4.6
4	Apply the differentiability and analyticity of a complex function	CLO 1	T1:12.3 R1:4.7
5-6	Identify and Apply the of Cauchy-Riemann conditions in Cartesian and Polar forms	CLO 3	T1:12.4 R1:4.13
7	Estimate the Harmonic Conjugates	CLO 3	T1:12.4 R1:4.15
8-9	Apply the Milne-Thomson method to find the Analytic function	CLO 3	T1:12.4 R1:4.20
10-11	Demonstrate the Line Integral for a given path	CLO 5	T1:13.1 R1:5.3
12	Analyze the Cauchy's integral theorem in a given plane	CLO 5	T1:13.2 R1:5.5
13-14	Establish the Cauchy's integral formula	CLO 6	T1:13.3 R1:5.9
15-16	Analyze the Cauchy's general integral formula	CLO 6	T1:13.4 R1:5.10
17	Discuss the Power series expansions of complex functions and contour Integration	CLO 7	T1:14.1 R1:6.1
18	Estimate the Radius of convergence of power series complex function	CLO 7	T1:14.2 R1:6.1
19-20	Identify the types of power series expansions	CLO 7	T1:14.4 R1:6.2

21	Asses the types of Singularities and its nature	CLO 10	T1:15.2 R1:6.6
22	Discuss the concept of Residues	CLO 11	T1:15.1 R1:7.4
23-24	Estimate the Residue by Residue theorem	CLO 11	T1:15.1 R1:6.5
25	Identify the contour integrals	CLO 11	T1:15.3 R1:7.9
26	Analyze the properties of Bilinear transformation	CLO 12	T1:12.5 R1:8.8
27	Establish the basic concepts of Random variables	CLO 15	T2:26.7 R2:2.2
28-29	Analyze the types of Probability distributions	CLO 16	T2:26.8 R2:2.6
30-31	Discuss the Mass function, Density function	CLO 15	T2:26.8 R2:2.7
32	Asses the Expectations of Probability Distribution	CLO 16	T2:26.10 R2:2.6
33-34	Discuss and Estimate the Moment and Central moments	CLO 17	T2:25.9 R2:3.2
35-36	Discuss and Estimate the Moment Generating functions	CLO 17	T2:26.11 R2:3.5
37-39	Analyze and Apply the Binomial Distribution parameters	CLO 21	T2:26.14 R2:4.4
40-42	Analyze and Apply the Poisson Distribution parameters	CLO 23	T2:26.15 R2:4.10
43-45	Analyze and Apply the Normal Distribution parameters	CLO 20	T2:26.16 R2:4.15

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

S No	Description	Proposed Actions	Relevance With Pos	Relevance With Psos
1	Problem reductions, Conformal mapping	Seminars	PO 1	PSO 1
2	In order to monitor the quality of products to plan effective and efficient designs to improve standards to test and analyze the quality of items	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations	NPTEL	PO 2	PSO 1

Prepared by:
Mr. Ch Soma Shekar, Assistant Professor

HOD, EEE