University of Kerala

Discipline	Mathematics				
Course Code	UK3DSCMAT206				
Course Title	Complex Analysis				
Type of Course	DSC				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Complex numbers 2. Partial derivatives				
Course Summary	Equips students with the fundamental knowledge and skills necessary to understand and apply complex analysis in various scientific and engineering disciplines. Students will be prepared for more advanced studies in complex analysis and its applications.				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Analytic functions**	**9**
	1	Derivative-Analytic Function, Cauchy–Riemann Equations Laplace's Equation (Chapter 13: Section 13.3, 13.4 of Text[1])	
II		**Cauchy's Integral Theorem**	**9**
	2	Line Integral in the Complex Plane and is properties (Except Existence of Complex Line integrals and ML Inequality) (Chapter 14: Section 14.1 of Text[1])	
	3	Cauchy's Integral Theorems (without proof) Cauchy's Integral Formula (without proof) (Chapter 14: Sections 14.2, 14.3 of Text[1])	
III		**Series**	**9**

34

Module	Unit	Contents	Hrs
	4	Power Series, Radius of Convergence, Taylor and Maclaurian Series (Chapter 15: Section 15.2, 15.4 of Text[1])	
	5	Laurents Series Singularities, Zeros - (exclude Riemann's Sphere) (Chapter 16: Section 16.1, 16.2 of Text[1])	
IV		**Complex Integration**	9
	6	Evaluation of an Integral by means of a Residue (Chapter 16: Section 16.3 of Text[1])	
	7	Evaluation of an Integral by Means of a Residue, Formulas for Residues, Residue Theorem, Application of the Residue Theorem, (Chapter 16: Section 16.3 of Text [1])	
V		**Suggestion for Teacher Designed Module**	9
	8	Complex Numbers and Their Geometric Representation (Chapter 13: Section 13.1 of Text[1])	
	9	Polar Form of Complex Numbers-Powers and Roots (Chapter 13: Section 13.2 of Text[1])	
	10	Derivative of Analytic Functions (Chapter 13: Section 13.3 of Text [1])	
	11	Residue Integration of Real Integrals (Chapter 16: Section 16.4 of Text[1])	

Practical sessions and examinations – 30 hours

All the topics mentioned above should be used for practical sessions using SageMath software. Some useful resources for solving these problems using the SageMath software are given against each problem/type of problem.

1. Verifying Cauchy-Riemann equations analytic functions

2. Verifying Laplace equations for certain functions

3. Computing partial fractions of rational functions

4. Finding exact roots of polynomial functions

5. Computing Radius of convergence

6. Taylor series expansions

7. Maclaurin series expansions

A record should be maintained with atleast 7 problems from the main topics/teacher designed topics. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

Text books

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, Wiley Publishers, 2018

References

1. Anant R Shastri, *Basic Complex Analysis of One Variable*, Macmillan, 2010.

2. Edward B. Saff, Arthur David Snider, *Fundamentals of Complex Analysis with Applications to Engineering and Science*, 3rd Edition, Pearson Education India, 2017.

3. James Ward Brown and Ruel V Churchill, *Complex Variables And Applications*, Eighth Edition, McGraw Hill International Edition, 2013.

4. John H Mathews and Russel W Howell, *Complex Analysis for Mathematics and Engineering*, Sixth Edition, Jones and Bartlett Publishers, 2012.

5. Murray R Spiegel, Seymour Lipschutz, Schaum's Outline Series, *Complex Variables*, 2009.

6. B S Tyagi, *Functions of A Complex Variable*, Kedar Nath Ram Nath, 2021.

Resources for practical sessions

1. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

2. Sagemath documentation – Symbolic variables https://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

3. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

4. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

5. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

6. SageMath documentation – Complex plots https://doc.sagemath.org/html/en/reference/plotting/sage/plot/complex_plot.html

7. SageMath documentation – Double precision floating point complex numbers https://doc.sagemath.org/html/en/reference/rings_numerical/sage/rings/complex_double.html

8. Ask SageMath Q & A https://ask.sagemath.org/questions/scope:all/sort:age-desc/tags:complex-analysis/page:1/

36

Course Outcomes

CO No.	Upon completion of the course the graduate will be able to	PO/PSO	Cognitive Level	Knowledge Category	Lecture(L) Tutorial (T)	Practical (P)
CO 1	Understand complex numbers, analytic functions, Series, Residues and conplex integration	PSO 1, PO1, 2	U	F, C	L	
CO 2	Apply Residue theory to find real integrals	PSO 2, 3, PO2	Ap, An	P	L	
CO 3	Explore applications of complex analysis in various fields	PSO 3, 4, PO2, 3	Ap, An	P	L	
CO 4	Develop problem soving skills	PSO 3, 4, 5, PO2, 3	Ap, An , E	P , M	L	

(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)
(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)

Mapping of CO with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	3	3	-	-	-		-	-
CO2	-	3	3		-			3	-	-	-		-	-
CO3		-	3	3	-	-		3	3	-	-		-	-
CO4	-	-	3	3	3	-		2	2	-	-		-	-

(- -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)

Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar

- Midterm Exam

- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Examination	Assignment	Project Evaluation	End Semester Exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓	✓		✓

38