University of Kerala

Discipline	Mathematics				
Course Code	UK1DSCMAT105				
Course Title	Differentiation and Complex Numbers				
Type of Course	DSC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours per week
	4	3	-	2	5
Pre-requisites	1. Differentiation 2. Integration				
Course Summary	This course provides basics on differentiation and complex numbers				

Detailed Syllabus

Module	Unit	Contents	Hrs
I	**Differentiation**		**9**
	1	Tangent lines and rate of change, The derivative function. (Chapter 2 Sections 2.1, 2.2 of Text [1])	
	2	The Chain Rule, Implicit Differentiation (Chapter 2 Sections 2.6, 2.7 of Text [1])	
II	**Differentiation of exponential and logarithmic functions**		**9**
	3	Exponential and logarithmic functions (review only) (Chapter 6 Section 6.1 of Text [1])	
	4	Derivatives involving Exponential and logarithmic functions (Chapter 6 Section 6.2 of Text [1])	
	5	L'Hˆopital's rule (Chapter 6 Section 6.5 of Text [1])	
III	**Complex Numbers**		**9**
	6	Sums and Products, Basic Algebraic Properties (Chapter 1 Sections 1, 2 of Text [2])	

Module	Unit	Contents	Hrs
	7	Further Properties of complex numbers, Vectors and Moduli (Chapter 1 Sections 3, 4 of Text [2])	
	8	Complex Conjugates [Chapter 1 Section 5 of Text 2]	
IV	**Argument and roots of complex numbers**		**9**
	9	Arguments of Products and Quotients (Chapter 1 Section 8 of Text [2])	
	10	Roots of Complex Numbers, Examples (Chapter 1 Sections 9, 10 of Text [2])	
V	**Teacher designed module - suggested topics**		**9**
	11	Tangent lines and limits (review only), One sided limits (review only), Limits at infinity, Infinite limits, Continuity (up to continuity of composite functions) (Chapter 1 Sections 1.1, 1.3, 1.4 and 1.5 of Text [1])	
	12	Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions (review only) (Chapter 2: Sections 2.3, 2.4, 2.5 of Text [1])	
	13	Exponential Form, Products and Powers in Exponential Form (Chapter 1 Sections 6, 7 of Text [2])	

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 problems.

1. Introducing the SAGEMATH interface, SAGE cell server:
   (a) SageMath – documentation
   `https://doc.sagemath.org/html/en/tutorial/introduction.html`
   (b) Online SageMath server `https://sagecell.sagemath.org/`
2. Introduce basic arithmetic involving operators +,-,/, exponentiation; functions like $\sin$, $\cos$, $\tan$, e, $\log$, $sqrt$, constant π
3. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries.
4. Defining variables using var
5. Using `diff` command to find derivatives of standard functions and higher order derivatives.
6. Find derivatives of exponential and logarithmic functions.
7. Defining complex numbers, accessing its real and imaginry parts
8. Computing argument, modulus of complex numbers

9. Plotting Complex numbers as vectors on plane
10. Verifying the relation between arguments of individual complex numbers and their products, quotients
11. Finding roots of complex numbers

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.

Textbook

1. Howard Anton, Irl Bivens, Stephens Davis, Calculus 10th Edition ,Wiley,2012.
2. James Ward Brown, Ruel V. Churchill, Complex Variables and Applicatons, 8th edition, McGraw Hill, 2001.

Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. 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

P3. Sagemath documentation – Symbolic variables https://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P6. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

P7. SageMath documentation – Double precision floating point complex numbers https://doc.sagemath.org/html/en/reference/rings_numerical/sage/rings/complex_double.html

P8. Ask SageMath Q & A https://ask.sagemath.org/questions/scope:all/sort:age-desc/tags:complex-analysis/page:1/

References

1. G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.
2. K. F. Riley, .M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering, Third Edition, Cambridge University Press, 2006.
3. J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2008.
4. Mary L Boas, Mathematical Methods in Physical Science, 3rd Edition, 2006.
5. Dennis G. Zill, Patric D Shanahan, A First Course in Complex Analysis with Applications, Jones and Bartlett Publishers, 2003.
6. Edward B. Saff, Arthur David Snider, Fundamentals of Complex Analysis with Applications to Engineering and Science, 3rd Edition, Pearson Education India, 2017.

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	Calculate the solution of algebraic and transcendental equation using numerical methods	PO 2, PSO1, 2,3	U, Ap	F,C	L	
CO 2	Apply numerical techniques to interpolate data points effectively	PO1, PSO1, 2,3	U, Ap	F,C	L	
CO 3	Apply numerical techniques for differentiation and integration	PO2, PSO1, 2,3	U, Ap	F,C	L	
CO 4	Calculate the solution of ordinary differential equations using numerical methods	PO2, PSO1, 2,3	U, Ap	F,C	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	2	-	-	-	-	3	-	-	-	-	-	-
CO2	3	3	2	-	-	-	3	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	3	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	3	-	-	-	-	-	-

(- -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	✓	✓		✓