University of Kerala

Discipline	Mathematics				
Course Code	UK4DSCMAT201				
Course Title	Partial Differentiation and Introduction to Abstract Algebra				
Type of Course	DSC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical	Total Hours per week
	4	3		2	5
Pre-requisites	1. Awareness of Differential Calculus 2. Awareness of Set theory				
Course Summary	This course includes Partial differentiation and basic Abstract Algebra				

Detailed Syllabus

Module	Unit	Contents	Hrs
I		**Partial Derivatives**	**9**
	1	Functions of two or more variables, Limits and continuity, Partial Derivatives, The Chain Rule	
		Chapter 13: Section 13.1, 13.2, 13.4, 13.5 of Text [2]	
II		**Gradients, Maxima and Minima**	**9**
	2	Directional derivatives and gradients, Tangent planes and normal vectors, Maxima and minima of functions of two variables	
		Chapter 13: Section 13.6, 13.7, 13.8 of Text [2]	
III		**Groups**	**9**
	3	Groups, Abelian examples, Subgroups, Cyclic Groups.	
		Chapter 1 : Sections 2, 3, 5, 6 of Text [1]	
IV		**Permutations & Lagrage's theorem**	**9**

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Module	Unit	Contents	Hrs
	4	Groups of Permutations, Cosets and Theorem of Lagrange.	
		Chapter 2 : Sections 8 and 10 of Text[1]	
V		**Suggestions for teacher designed module**	**9**
		For internal assessment examinations only.	
	5	Differentiability, differentials and local linearity, Lagrange multipliers (Chapter 13 section 13.3, 13.9 of Text[2], Binary Operations Chapter 1 : Section 1 of Text [1], Non-abelian Examples Chapter 1 : Section 4 of Text [1]	

Topics and problems for Practical sessions and practical examinations using SageMath software – 30 hours

1. Defining functions of multiple variables, evaluating them at certain points

2. Evaluating limits and checking continuity of multivariable functions, differentiating them

3. Verifying chain rule for multi variable functions

4. Computing directional derivatives

5. Computing gradients

6. Computing normal vectors

7. Drawing tangent planes

8. Computing maxima and minima of two variable functions

9. Define congruence groups and list the elements in them

10. Perform various operations in the congruence groups

11. Prepare a group table of the congruence groups $\mathbb{Z}_n$ (for some selected values of n)

12. Compute symmetric groups, and perform operations among elements in them.

13. Create Cayley table of selected groups.

14. Define a group, find the cyclic group generated by an element in it.

A record should be maintained with atleast 7 problems from the above. 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, the student should be able to answer two problems selected by the examiner from the 7 available in the record .

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SageMath Problem resources

1. **SageMath — Documentation**
   https:
   //doc.sagemath.org/html/en/tutorial/introduction.html

2. **Online SageMath Server**
   https://sagecell.sagemath.org/

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

4. *Sage for Undergraduates* — Gregory V. Bard (Online Version)
   https://www.faculty.luther.edu/~bernatzr/Courses/M351/
   sage_for_ug_color.pdf

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

6. **SageMath Tutorial for Advanced 2D Plotting**
   https:
   //doc.sagemath.org/html/en/prep/Advanced-2DPlotting.html

7. **SageMath Reference Manual — Vector Calculus in the Euclidean Plane**
   https://doc-10-7--sagemath.netlify.app/html/en/thematic_
   tutorials/vector_calculus/vector_calc_plane.html

8. Group Theory and Sage — Online Tutorial
   https://doc.sagemath.org/html/en/thematic_tutorials/
   group_theory.html

9. Ajit Kumar, Vikas Bist, *Group Theory: An Expedition with SageMath*, Narosa
   Publications, New Delhi, 2021.

Texts

Text 1 J. B. Fraleigh, Neal.E.Brand A First Course in Abstract Algebra, Eighth Edition,
Pearson Education Inc, 2022

Text 2 Howard Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons, 2012.

References

Ref. 1 I. N. Herstein, Topics in Algebra, Second Edition, Wiley, 2006.

Ref. 2 Joel Hass, Maurice D. Weir, Thomas' Calculus Early Transcendentals, 12th Edition,
Addison-Weseley Publishing Company, 2004

Ref. 3 Joseph. A. Gallian, Contemporary Abstract Algebra, Eighth Edition, Brooks Cole
Cengage Learning, 2012.

Ref. 4 Michael Artin, Algebra, Second Edition, Pearson Education, 2023.

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Ref. 5 J Stewart, Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited, 2008.

Ref. 6 G B Thomas, R L Finney, Calculus, 9th Edition, Addison-Weseley Publishing Company, 2004.

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	Define multivariable functions and relate it to single variable functions	PSO5, PO1, 2, 3, 4, 5, 6, 7	R, U	F, C	L	
CO 2	Describe limits, continuity and partial derivatives	PSO1, PO1, 2, 3, 4, 5, 6, 7	U, E	P	L	
CO 3	Solve maximization and minimization problems using partial derivatives	PSO2, PO1, 2, 3, 4, 5, 6, 7	Ap	P	L	
CO 4	Explain the concepts of binary operations and groups and classify the groups as abelian, non-abelian and cycle groups	PSO4, PO1, 2, 3, 4, 5, 6, 7	U, An	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
CO1	2	2	1	1	3	1	2	2	1	3	1	2	2
CO2	3	2	2	2	2	1	2	3	2	2	1	2	1
CO3	2	3	2	2	2	1	2	3	2	2	1	2	1
CO4	2	2	3	2	1	3	2	2	2	2	1	2	1

(- -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	✓	✓		✓

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