Session: 2026-27			
Part A – Introduction			
Subject	Mathematics		
Semester	V		
Name of the Course	Abstract and Linear Algebra		
Course Code	CC-A5		
Course ID	240/MATP/CC501		
Course Type: (CC/MIC/ MDC/ /VOC/AEC/VA C/SEC)	CC		
Course Learning Outcomes(CLOs)	The course will enable the students to: 1. Understand the fundamental concepts of group theory. 2. Analyze and distinguish between different types of subgroups. 3. Understand the fundamental concepts of ring theory. 4. Understand the concept of vector spaces and subspaces. 5. Understand the concept of basis and dimension in finitely generated vector spaces and understand the existence theorem for basis.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	25	5	30
End Term Assessment Marks	50	20	70

Examination Time	3 Hours	--	100

Part B - Course Content

Instructions for Paper- Setter Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking Course Learning Outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topic	Contact Hours
I	Definition of a group with example and properties of groups, Subgroups, cyclic groups, Cosets, Lagrange's theorem and its consequences, Normal subgroups. Quotient groups.	**45 hrs**
II	Introduction of Homomorphisms and isomorphisms of a group, Fundamental Theorem on Homomorphism of Groups. Introduction to rings, subrings, integral domains and field.	
III	Vector spaces, subspaces, direct sum of subspaces, linear span, Linearly Independent and Linearly Dependent subsets of a vector space. Finitely generated vector space. Existence theorem for basis of a finitely generated vector space. Dimension.	
IV	Quotient space and its dimension. Homomorphisms and isomorphisms of a vector spaces, Linear transformation and linear forms of a vector spaces. Properties of linear Transformation.	

Practical

The practical component of the course has two parts — **30 hrs**

(A) Problem Solving- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook:

1. To verify whether the set $G = \{0,1,2,3, \ldots . n-1\}$ under addition modulo n forms a group.
2. To check whether the set of even integers forms a subgroup of integers under addition.

3. To find all generators of the cyclic group $\mathbb{Z}_n$.
4. To verify that the number of cosets equals the index of the subgroup.
5. To find all possible orders of subgroups of a group of order n.
6. To construct the quotient group G/H.
7. To find the kernel and image of a homomorphism.
8. To find zero divisors in a given ring.
9. To find the span of a given set of vectors.
10. To determine the dimension of a vector space.

(B)The following practicals will be done using MAXIMA software and their record will be maintained in the practical note book:

1. Write a program in Maxima to verify whether the set $G = \{0,1,2,3, \ldots \ldots n-1\}$under addition modulo n forms a group.
2. Write a program in Maxima to check whether integers under addition form a group.
3. Write a program in Maxima to find generators of $\mathbb{Z}_n$.
4. Write a program in Maxima to check whether a subgroup is normal.
5. Write a program in Maxima to check whether a function is a homomorphism.
6. Write a program in Maxima to find zero divisors in $\mathbb{Z}_n$.
7. Write a program in Maxima to find basis and dimension of a vector space.
8. Write a program in Maxima to find dimension of quotient space.
9. Write a program in Maxima to find image of a vector under transformation.
10. Write a program in Maxima to find kernel of a linear transformation.

Suggested Evaluation Methods

Internal Assessment:

➢ **Theory 25**

- Class Participation: 5
- Seminar/presentation/assignment/quiz/class test etc.: 10
- Mid-Term Exam: 10

➢ **Practicum 5**

- Seminar/Demonstration/Viva-voce/Lab records etc.: 5

End Term Examination:

➢ **Theory 50**

- Written Examination

➢ **Practicum 20**

- Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. J. A. Gallian (2017). *Contemporary Abstract Algebra* (9th ed.). Cengage Learning India Private Limited, Delhi.
2. M. Artin (2011). *Abstract Algebra* (2nd ed.). Pearson.

3. V. Sahai and V. Bist (2010). *Algebra* (3rd ed.). Narosa Publishing House.
4. I. N. Herstein (2008). *Topics in Algebra* (2nd ed.). Wiley India Pvt. Ltd.
5. J. J. Rotman (1995). *An Introduction to the Theory of Groups* (4th ed.). Springer-Verlag, New York.
6. D. S. Dummit and R. M. Foote (2016). *Abstract Algebra* (3rd ed.). Wiley.
7. D. A. R. Wallace (1998). *Groups, Rings and Fields*. Springer.
8. S. H. Friedberg, A. J. Insel, and L. E. Spence (2003). *Linear Algebra*. Pearson.
9. G. Strang (2006). *Introduction to Linear Algebra*. Wellesley-Cambridge Press.