University School of Automation and Robotics
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
East Delhi Campus, Surajmal Vihar
Delhi - 110092

Paper Code: ABS 201	L	T/P	Credits
Subject: Linear and Abstract Algebra	3	-	3

Marking Scheme

1. Teachers Continuous Evaluation: 25 Marks
2. End Term Theory Examination: 75 Marks

INSTRUCTIONS TO PAPER SETTERS: **Maximum Marks : 75**

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 15 marks.
3. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 15 marks.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required

Course Outcomes:

CO1:	Ability of students to utilize first approach to the subject of algebra, which is one of the basic pillars of modern mathematics.
CO2:	Ability of students to implement algebraic statements about vector addition, scalar multiplication, inner products projections, norms, orthogonal vectors, linear independence, spanning sets, subspaces.
CO3:	Ability of students to use certain structures called groups, some related structures along with application of matrices.
CO4:	Ability of students to depict good mathematical maturity and implement mathematical thinking and skill.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	1	-	-	-	-	-	1	2
CO2	2	3	3	3	1	-	-	-	-	-	1	2
CO3	2	3	3	3	1	-	-	-	-	-	2	3
CO4	3	3	3	3	1	-	-	-	-	-	2	3

Unit I **[14]**

Vector spaces: The n dimensional vectors, vector spaces, subspaces, spanning sets, linear dependence of vectors, basis and dimensions, linear transformation, null space and range space of a linear transformation, rank and nullity, rank and nullity theorem, inverse of a linear transformation, composition of linear map, matrices of a linear transformation and its transpose, the minimal polynomial

Unit II **[6]**

Inner product spaces: Inner product spaces, norm of a vector, Schwarz's inequality, normed vector space, orthonormal sets, Gram Schmidt orthogonalization process

Unit III **[6]**

Group theory: Introduction to groups, definition and example of groups, elementary properties of groups. Finite groups, subgroups and their examples. Cyclic groups. Permutation

Prof. Ajay S. Singholi
Professor In-charge, USAR
Guru Gobind Singh Indraprastha University
(East Delhi Campus)
Surajmal Vihar, Delhi-110092

groups, Caley theorem, cosets, Lagrange's theorem, Normal subgroups and factor groups, Isomorphism and homomorphism.

Unit IV **[14]**

Ring theory: Definition and examples of rings, Properties of rings, Subrings, Integral domains.

Text Books:

1. Herstein, I. N. (2006). *Topics in algebra*. John Wiley & Sons.
2. Deisenroth, M. P., Faisal, A. A., & Ong, C. S. (2020). *Mathematics for machine learning*. Cambridge University Press.

Reference Books:

1. Gallian, J. A. (2021). *Contemporary abstract algebra*. Chapman and Hall/CRC.
2. Bhattacharya P.B,Jain S.K., Nagpaul S.R. (1986). *Basic abstract algebra*. ISBN 0-521-30990-5,31107-1 Cambridge University Press.
3. Leversha G. (1987). *The Mathematical Gazett*. Cambridge University Press Online ISSN: 2056-6328.

Prof. Ajay S. Singholi
Professor In-charge, USAR
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