**Paper II**

**Total Marks: 100**

**Section A**

**Groups:** Definition and examples of Groups, Order of a Group, Order of an element of

a Group, Abelian and non-Abelian Groups and Cyclic groups. Lagrange theorem and

applications, Normal subgroups, Characteristic Subgroups of a group, Normalizer in a

group, Centralizer in a group. Fundamental Theorem of Homomorphism, Isomorphism

theorems of groups, Automorphisms

**Rings, Fields and Vector Spaces:** Examples of Rings, Subrings, Integral domains,

Fields, Vector spaces, Linear independence/ dependence, Basis and dimension of

finitely generated spaces, Examples of Field extension and finite fields, Examples of

finite and infinite dimensional vector spaces.

**Section B**

**Metric Spaces and Topological Spaces:** Definition and Examples of Metric spaces

and topological spaces, Closed and Open Spheres, Interior, Exterior and Frontier of a

Set, Sequences in Metric Spaces, Convergence of Sequences. Definition and examples

of Normed Spaces. Inner product spaces, Gram-Schmidt Process of Orthonormalization

**Matrices and Linear Algebra:** Linear transformations, Matrices and their algebra,

Reduction of matrices to Echelon and Reduced Echelon form. Solution of a system of

homogenous and Non-Homogenous equations, Numerical methods of solving

equations (Gauss-Siedal method, Jaccobi method) Properties of Determinants,

Eigenvalues and Eigenvectors and the Diagonalization of the Symmetric Matrices.

**Recommended Books:**

*1. Nicholson. W.K., Elementary Linear Algebra with Applications, Ed. 2, Prentice*

*Hall, Englewood, USA.*

*2. Herstein, I.N., Topics in Algebra, John Willey and Sons (New York) 1964.*

*3. Rowen, L., Rings (I & II). Academic Press, Ins.*

*4. Dar, K.H., First Step to Abstract Algebra, Feroz Sons Publishers, Lahore (1996).*

*5. Yusuf, S.M., Majeed A., Amin. M., Mathematical Methods, Ilmi Kitab Khana,*

*Lahore.*

*6. Atkinson, K. E., An Introduction to Numerical Analysis, Ed. 2 John Willey, New*

*York, 1989.*

*7. Ahmad. F and Afzal. M, Numerical Analysis, National Book Foundation,*

*Islamabad.*

*8. Simmons, F.J., Topology, McGraw Hill Company, New York.*

*9. Kreyszig, E., Introductory Functional Analysis with Applications, John Willey and*

*Sons, New York, 1978.*

*10. Majeed, A. Elements of Topology and Functional Analysis, Ilmi Kitab Khana,*

*Lahore.*