Course Title: Rings and Modules

Course Code: MATH-309

Course Type: Major Math

Prerequisites: Group Theory & Linear Algebra

Credit Hours: 3 (3 + 0)

Course Objectives:

After completion of this course, the students will be able to:

- Develop a solid understanding of the structure and theory of rings and modules for advanced mathematical exploration.
- Investigate integral domains and classify finitely generated modules as homomorphic images of free modules.
- Draw parallels between number systems and other algebraic structures to enhance algebraic comprehension.
- Pursue more advanced courses like Representation theory, Algebraic number theory and Homological Algebra.

Course Contents:

Ring theory: Ring structure with examples, Matrix rings, Quaternion rings, Special kinds of rings, Fields, Ideals, Quotient rings, Ring homomorphisms, Prime ideals and maximal ideals, Ring of polynomials, Division algorithm Factorization of polynomials, Divisibility in integral domains, Unique factorization domains, Euclidean domain, Principal ideal domain.

Module theory: Definition of module with examples, Submodules, Quotient modules, Direct sums of modules, Isomorphism theorems of modules, Composition series of modules, Schur's Lemma and its application, Zassenhaus butterfly lemma for modules, Modules with chain conditions, Finitely generated modules, Free modules, Exact sequences, Tensor product of modules.

Recommended Books:

1. Adhikari, M. R. and Adhikari, A., *Groups, Rings and Modules with Applications*, Hyderabad : Universities Press , 2003.
2. Beachy, J. A., *Introductory Lectures on Rings and Modules*, London Mathematical Society textbooks, 1999.
3. Cohen, P. M., *Introduction to Ring Theory*, Springer, 1st edition, 1999.
4. Dummit, D. S., Foote, R. M., *Abstract Algebra*, Third Edition, John Wiley & Sons, 2003.
5. Gallian, C. J., *Contemporary Abstract Algebra*, Chapman and Hall/CRC, 10th edition, 2020.
6. Herstein, I. N. *Topics in Algebra*, John Wiley & Sons, 2nd edition, 1991.

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