# RINGS AND MODULES

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**PRE-REQUISITES :**      Group Theory, Linear Algebra

**INTENDED AUDIENCE :** All learneres interested in Mathematics

## COURSE OUTLINE :

This course is a self-contained elementary introduction to Rings and Modules. We will cover basic topics of Ring Theory and Module Theory which is a core course in Algebra. This course is compulsory to those who want to pursue research in Algebra. This is a 12 weeks course. In the first six weeks we focus on the Ring Theory part and the last six weeks we focus on the Module Theory part.

## ABOUT INSTRUCTOR :

Prof. Mousumi Mandal is an Assistant Professor at the Department of Mathematics, IIT Kharagpur. Shedid her M.Sc and PhD from IIT Bombay. She works in the broad area of Commutative Algebra. After completing PhD she joined TIFR as a visiting Fellow. She was awarded the INdAM-COFUND Marie Curie Fellowship to pursue post doctoral work at the University of Genova, Italy. She was an INSA INSPIRE Fellow at IISc. Bangalore from 2013-2106. She joined IIT Kharagpur in 2016

Prof. Ramakrishna Nanduri did his M.Sc in Pure Mathematics from the University of Hyderabad. He did his Ph.D from IIT Madras. His broad research area is Commutative Algebra. He was awarded the INdAM-COFUND Marie Curie Fellowship to do post doctoral work at the University of Genova, Italy for a period of two years. Presently, he is an assistant professor at the Department of Mathematics, IIT Kharagpur since December 2014. He has various publications in reputed journals on various topics in Commutative Algebra and combinatorial aspects of Commutative Algebra.

## COURSE PLAN :

**WEEK 1 :** Introduction to rings, examples, ideals, ring homomorphisms, quotients with examples
**WEEK 2 :** Isomorphism theorems, Prime and maximal ideals, basic properties of ideals, local rings
**WEEK 3 :** Radical ideals, Nil radical, Jacobson radical
**WEEK 4 :** Integral domains, field of fractions, Euclidean Domains, Principal Ideal Domains
**WEEK 5 :** Unique factorization domains, Gauss lemma, Eisenstein's irreducibility criterion
**WEEK 6 :** Algebraic variety, Weak form of Hilbert's nullstellensatz
**WEEK 7 :** Introduction to Modules over arbitrary rings, examples, Free modules, submodules, quotient modules, module homomorphisms, direct sums, direct products
**WEEK 8 :** Generators of modules over commutative rings, rank of a free module, Simple modules
**WEEK 9 :** Modules over a PID
**WEEK 10 :** Modules with chain conditions, Noetherian modules, Noetherian rings
**WEEK 11 :** Artinian modules, Artinian rings, Hilbert Basis Theorem
**WEEK 12 :** Tensor product of modules, properties of tensor products