Course Contents

MATH5101 Ordinary Differential Equations 4(3+1)


MATH5301 Introduction to Discrete Structures 4(3+1)

MATH5311 Combinatorics 4(3+1)

Prerequisite (MATH 5301)
MATH5321 Ordered Sets


Prerequisite (Mat 5301)

MATH5391 Selected Topics in Mathematics

The course covers selected topics in mathematics suggested by the student's supervisor.

MATH5401 Group Theory and Modules

Group action on a set, Series of groups, Solvable groups, Supersolvable groups, Polycyclic groups and nilpotentl groups, Semi-direct product and group extensions, Free groups, group presentations, Finite and algebraic field extensions, Normal and separable extensions, Galois extensions, Galois group and Artin's Theorm.

MATH5411 Introduction to Rings and Modules

Modules, Module homomorphisms, Exact sequences, External direct product, Internal direct product, Complete direct sum, direct sum, Free modules, Projective and injective modules, Modules over principal ideal domain, Algebras, Tensor products, Localization, Primary decomposition, Integrally closed domains, Chain conditions, Noetherian and Artinian rings. Prerequisite (MATH5401)

MATH5421 Rings and Modules

Ring Extensions, Dedekind domains, Hilbert and Nullstellensatz Theorem. Simple and primitive rings, The Jacobson radical of a ring, Semi-simple rings, Wedderburn-Artin theorem for semi-simple Artinian rings, Essential and small submodules, Singular submodules, Radical of a module, Primitive rings and density theorem, prime ideals and lower nilradical. Prerequisite (MATH5401) and (MATH5411)

MATH 5431 Algebraic Number Theory

Number fields, Solvable and radical extensions, Abel's theorem, Kummer theorem, The ring of algebraic integers, Trace and norm, Discriminant and integral basis, Prime factorization of ideals, Norm of ideals, Quadratic and cyclotomic fields, Transcendence Bases, Linear Disjointness and Separability.

Prerequisite (MATH5401) and (MATH5411)
MATH5501 Numerical Analysis  

MATH5511 Numerical Linear Algebra 

MATH5521 Numerical Solutions of Ordinary Differential Equations  

MATH5701 Geometry and Topology  
Connected spaces, Path connected spaces, Connected components, Locally connected spaces, Quotient spaces, The separation axioms (Hausdorff, Regular, Normal). Differentiable manifolds, Submanifolds of $\mathbb{R}^n$ and Classical Lie groups, Tangent spaces, Differentiable mappings between manifolds, Inverse and Implicit function theorems on manifolds.

MATH5711 Algebraic Topology 
Homotopy of paths, the fundamental group, The fundamental group of the circle, the punctured plane, $S^n$ and surfaces, Covering spaces, lifting properties, The classification of covering spaces, universal cover and deck transformations, Chain complexes, simplicial homology, Homotopy invariance, Excision, Mayer-Vietoris sequence, Cellular homology.
MATH5721 Differential Geometry 4(3+1)

Definition and examples of manifolds, submanifolds, Immersions and submersions, Lie groups, Equivalence classes of curves and derivations, Tangent vectors, The tangent bundle of a manifold, Vector fields and flows, Lie derivatives and bracket, Differential forms, Integration on manifolds.

MATH5801 Measure Theory 4(3+1)

Rings, Algebra, $\sigma$-algebra, Monotone classes, Measure, elementary properties, outer measure, extension, completion and approximation theorems, Lebesgue’s measure, Lebesgue-Stieltje’s measure, measurable functions, integration with respect to a measure, the main theorems, the convergence of measurable functions, Radon-Nikodym theorem (absolutely continuous functions), Fubini-Tonelli theorem, $L^p$ spaces: Holder and Minkowski inequalities, completeness of $L^p$ spaces, $L^p$ space as a Banach space, the dual of $L^p$ space.

MATH5811 Functional Analysis 4(3+1)

Banach spaces: Basic properties and examples, convex sets, subspaces and quotient spaces, linear functional and the dual spaces, Hahn-Banach theorem, the uniform boundedness principle, the open mapping theorem and closed graph theorem, Hilbert spaces: the Riesz representation theorem, orthonormal bases, isomorphic Hilbert spaces, Operators on Hilbert spaces: Basic properties and examples, adjoints, projection, invariant and reducing subspaces, positive operators and the polar decomposition, self-adjoint operators, normal operators, isometric and unitary operators, the spectrum and the numerical range of an operator.

MATH5821 Complex Analysis 4(3+1)


MATH5831 Advanced Functional Analysis 4(3+1)

Spectrum of an operator, compact linear operators and their spectral properties, spectral properties of bounded self-adjoint operators, positive operators, product of positive operators, square root of positive
operator, projection operators: Theorem (positivity, norm), Theorem (partial order), Theorem (product of projections), Theorem (sum of projections), Theorem (difference of projections), Spectral family of a bounded self-adjoint operator, Banach algebras, Gelfand’ mapping, spectral theorem for normal operators.

MATH5991 Research Project 3(3+0)

The student undertakes a supervised independent study and review of current research papers in an active branch of Mathematics.