DEPARTMENT OF MATHEMATICS

The Department provides a two-years program of studies leads to the degree of Master of Science (M.Sc.) in Mathematics. The minimum requirements needed is 30 credit hours distributed as follows:

1) 15 credit hours for compulsory courses.
2) 9 credit hours for elective courses.
3) 6 credit hours for a dissertation.

Courses offered during the this program include:

1) **5 compulsory 3-credit courses**
   Compulsory courses aim to build up the necessary background required for students to complete this program. They are distributed over the first two semesters.

2) **Three elective 3-credit courses**
   Elective courses are specified and offered mainly to meet the need of students specializing in certain fields. They are given in the third semester. Dissertation aims usually to deepen the knowledge of a student in one area and to develop student's skill and independence to carry out mathematical research. Dissertation however, have to be submitted before the end of the second year of the program unless permission is obtained for a reasonable delay.

The Department can provide during this program supervision in the following areas: Algebra, Analysis, Topology, Differential Equations, Numerical Analysis and Calculus of Variations.

Literature survey and dissertation can be started only when a student has completed at least all compulsory courses. A dissertation can only be made in a field where a student has been completing or has already completed at least 2 related courses.

All details concerning examinations, evaluations, fulfillment of course prerequisites, title and specifications of dissertation and appointment of supervisors should be arranged by the department according to the above mentioned by laws. Medium of instruction and communication should be in English. Though courses and areas of supervision should remain unchanged during a declared two-year program, it is understandable the they may vary in

subsequent programs according to availability of staff members and their research interests and according to priorities considered by the department.

(1) Compulsory Courses

Code	Course Title	Credits
1501	Ring and Modules	3
1502	Theory of Diff. Equations	3
1506	Functional Analysis	3
1508	Topology	3
1512	Mathematical Methods	3

(2) Optional Courses

Code	Course Title	Credits
1500	Calculus of Variations	3
1503	Partial Diff. Equations	3
1504	Topics in Mechanics	3
1505	Numerical Analysis	3
1507	Mathematical Logic	3
1509	Topics in Geometry	3
1510	Algebraic Topology	3
1511	Topics in Number Theory	3
1513	Topics in Logic and Set Theory	3
1514	Finite Group Theory	3
1515	Topics in Group Theory	3
1516	Measure Theory	3
1517	Field Theory	3
1518	Topics in Analysis	3
1519	Topics in Topology	3
1520	Topics in Diff. Equations	3
1521	Topics in biomathematics	3
1522	Topics in Numerical Analysis	3
1540	Topics in Algebra	3
1551	Lattice and Universal Algebra	3
1570	Topics in Mathematical	3

(3) Thesis

Code	Course Title	Credits	Prerequisites
1501	Thesis	3	At least two related courses

Descriptions of Courses

1500 Calculus of Variations (3 Credits)

Classical Variational Problems, Spaces of Functions, Derivatives in Normed Spaces (Weak, Frechet, Strong), Linear and Nonlinear Functionals, First and Second Variations of Functionals, Necessary Conditions for Relative Maximum (Minimum), Weak and Strong Relative Extreme Values, Euler-Lagrange Equation, Discussion of Solutions, Boundary Conditions, Applications, Some Generalizations.

1501 Rings and Modules (3 Credits)

Definition and Basic Properties of Rings, Ideals, Quotient Rings Homomorphisms of Rings Prime Ideal Domains, Unique Factorization Domains, Rings of Polynomials, Simple Rings, Definition and Basic Properties of Modules (Left and Right, R-Modules), submodules, Bases Homomorphisms of Modules Exact Sequences of Modules, Diagram Chasing, Direct Product of Modules, External Direct Sum of Modules, Free Modules, Projective and Injective Modules, Finitely Generated Modules, Noetherian and Artinian Modules, Tensor Product of Modules.

1502 Theory of Diff. Equations (3 Credits)

Existence Theorems: Picard Lindelof, Peano, Caratheodory and Contraction Mapping Theorems, Uniqueness Theorems, Extension Solution, Maximum and Minimum Solutions, Stability and Asymptotic Behavior of Solution-Laplace, Liapunov and Poincare Stabilities, Liapunov Stability by Direct Methods, CheyshevInstabilitiy Theorem, Stability Based on First Approximation, Perron Theorem.

1503 Partial Differential Equations (3 Credits)

Classification of Second Partial Differential equations, Hyperbolic, Parabolic and Elliptic, Canonical Form of 2nd Order P.D.E., Eave Equation, Heat Equation, Cauchy Problems, Cauchy-Kowalewski Theorem for 2nd Order P.D.E.

1505 Numerical Analysis (3 Credits)

Numerical Solution of Ordinary Differential Equations: Taylor Series Method, Runge-Kutta Method, Multistep Method, Convergence Criteria, Errors, Systems of Equations and Higher Order Equations, Boundary-

Value Problems, Numerical Solution of Elliptic Partial Differential Equations: Representation as Difference Equation, Laplaces Equation on Rectangular Region, Poisson Equation, Derivative Boundary Conditions, Parabolic Partial Differential Equations: Explicit Method, Crank-Nicolson Method, Stability and Convergence Criteria, Hyperbolic Partial Differential Equations: Wave Equation, Stability of Numerical Method, Method of Characteristic.

1506 Functional Analysis (3 Credits)

Complete Metric Spaces, Normed Linear Spaces, Banach Spaces, Equivalent Norms in Banach Spaces, Convergence of Series, Bounded Linear Operators and Functionals, Dual Spaces, Open Mapping, Closed Graph and Hanhn-Banach Extension Theorems, Strong and weak Convergence, Hilbert Spaces, Spectral Theory of Self-Adjoint Bounded Linear Operators in Hilbert Spaces.

1507 Mathematical Logic (3 Credits)

Classical Logic: Statement Calculus and Predicate Calculus, Non-Classical Logic: Many valued-Logic, Fuzzy Logic, Modal Logic, and Intuiotionistic Logic, Consistency, Completeness, and Decidability, Gödel's Theorems.

1508 Topology (3 Credits)

Connectednes, path-Connectednes, Local Connectedness and Components, Compactness, Local Compactness and Compactifications, Function Spaces, Topological Groups and Orbit Spaces. Homotopy and Fundamental Groups.

1510 Algebraic Topology (3 Credits)

Homotopy, Fundamental Groups, Higher Homotopy Groups, Singular Homology, Singular Cohomology, and EilenbergSteenrod Axioms, CW-Complexes, Products.

1512 Advanced Mathematical Methods (3 Credits)

Laplace and Fourier transforms; theory and applications. Self-adjoint differential equations. Sturm-Louiville form. Eigenfunctions and eigenvalues Green functions. Orthogonal functions.

Gram-schmidtorthogonalization. Orthogonal polynomials generated by Gram-schmidt. General Integral transform. Sturm-Louiville transforms. Finite Hankel transforms.

1514 **Finite Group Theory** **(3 Credits)**

Sylows Theorems, P-groups, Free Groups, Group Presentations, Orbit Space, Burnside Theorem, Groups of orders ≤ 17.

1516 **MeasureTheory** **(3 Credits)**

Rings and Fields of sets, Measurable Spaces, Measure Spaces, Properties of Measure, Existence of Measure, Product Measure, Simple Functions, Measurable Functions and their Properties, Convergence a.e and in Measure, Lebesgue Integral, Properties, Limit Theorems, Fubini Theorem, Spaces of Integrable Functions.

1517 **Field Theory** **(3 Credits)**

Rings, Ideals, and Quotient Rings, Maximal and Prime Ideals Polynomial Rings, Field Extensions, Splitting Fields, Finite Fields, Galois Theory, Insolvability of Quintic.

1551 **Lattice and Universal Algebra** **(3 Credits)**

Poset, Lattice, Distributive Lattice, Algebraic Lattice, Closure Operators, Boolean Algebras, Universal Algebras, Subalgebras, Isomorphisms, Quotient Algebras, Homomorphisms, Direct Products, and Free Algebras.

1599 **Thesis** **(3 Credits)**

Remark: Topic courses (**1504-1509-1511-1513-1515-1518-1519-1520-1521-1522-1540-1570**) are to be decided by instructors.