

**MASTER OF SCIENCE  
MATHEMATICS  
Program code: 0410**

**INTRODUCTION**

The Department of Mathematics offers a graduate program that leads to Master of Science degree in **Mathematics**. The Program features a thesis and non-thesis option. The thesis option requires a successful conclusion of a thesis, and the non-thesis option requires the completion of a project. Passing a comprehensive examination is required for students who choose a non-thesis option. English is the Language of instruction and research.

*According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.*

**PROGRAM REQUIREMENTS** (non-thesis option in parenthesis)**30 (33) TOTAL COURSE CREDITS****3 (6) COMPULSORY COURSES (3 credits each)**

- 0410-510 Analysis I
- 0410-593 Project (for non-thesis option only)

**6-12 (6-12) BASIC COURSES (3 credits each)**

The student must take at least two courses from the following courses:

- 0410-501 Algebra
- 0410-512 Complex Analysis I
- 0410-513 Ordinary Differential Equations
- 0410-525 General Topology

**6-12 (15-21) ELECTIVES\* (3 credits each)**

- 0410-508 Topics in Algebra
- 0410-515 Functional Analysis
- 0410-517 Special Functions
- 0410-520 Boundary value Problems
- 0410-521 Variational Methods and Eigen value Problems
- 0410-522 Financial Mathematics Modeling & Computation
- 0410-523 Topics in Applied Mathematics
- 0410-526 Algebraic Topology
- 0410-530 Foundations of Geometry
- 0410-531 Differentiable Manifolds

0410-532	Topics in Differential Equations
0410-535	Graphs and Hyper Graphs
0410-537	Combinatorics
0410-560	Numerical Solution of ODE's
0410-561	Computational Linear Algebra
0410-568	Topics in Numerical Mathematics

\* With the approval of the Program Committee, the student can substitute up to (6) credit hours from 500-level courses from other graduate programs or 400-level courses from the undergraduate program in mathematics at Kuwait University for courses in the elective list.

## 9 COMPULSORY

0410-597	Thesis	(0)
0410-598	Thesis	(0)
2000-599	Thesis	(9)

## COURSE DESCRIPTION

### 0410-501: ALGEBRA

**CR: 3**

Sylow theorems. Direct Sums and free abelian groups. The dual groups and Jordan holder theorem. Rings and homomorphism, commutative rings. Modules, direct products and sums of modules. Finite algebraic extension, separable extensions. Galois theory. Finite fields.

### 0410-508: TOPICS IN ALGEBRA

**CR: 3**

Topics may differ from time to time, the course may be repeated for credit provided the topics are different.

### 0410-510: ANALYSIS I

**CR: 3**

Riemann-Stieltjes integral, sequences and series of functions, functions of several variables, Lebesgue measure and integration on the real line.

### 0410-512: COMPLEX ANALYSIS I

**CR: 3**

Analytic continuation, Harmonic function, Mapping theorems. The modular function, Entire function.

### 0410-513: ORDINARY DIFFERENTIAL EQUATIONS

**CR: 3**

Existence and uniqueness of solutions to initial value problems in n-dimensions.

Continuation (extendibility) of solutions and continuity with respect to initial conditions and parameters. Stability theory, linearization and Lyapunov methods. Sturmian theory and self-adjoint boundary value problems.

### 0410-515: FUNCTIONAL ANALYSIS

**CR: 3**

Normed linear spaces, Hilbert spaces, Hahn-Banach extension theorems, Banach-Steinhaus theorem, closed graph and open mapping theorem, topics selected from spectral theory.

### 0410-517: SPECIAL FUNCTIONS

**CR: 3**

Asymptotic expansions. Bessel functions and related functions, hypergeometric, confluent

hypergeometric and generalized hypergeometric functions. Jacobi polynomials, Meijer's G-functions.

**0410-520: BOUNDARY VALUE PROBLEMS**

**CR: 3**

Partial differential equations of mathematical physics and engineering, the well posed problem, Dirichlet, Neumann and the mixed problems, methods of solution, Green's function, integral equations, integral transforms.

**0410-521: VARIATIONAL METHODS AND EIGEN VALUE PROBLEMS**

**CR: 3**

Linear operators in Hilbert space, Generalized functions, eigenfunction expansions, the Raleigh-Ritz method, the Galerkin method, Methods of least squares, eigenvalue problems, lower and upper bounds, the Weinstein method, applications.

**0410-522: FINANCIAL MATHEMATICS – MODELING & COMPUTATON**

**CR: 3**

'Finance' is one of the fastest developing areas in the modern banking and corporate world. This, together with the sophistication of modern financial products, provides a rapidly growing impetus for new mathematical models and modern mathematical methods. The course describes the modeling of financial derivative products, through analysis to elementary computaton. Topics include: basic option theory, tree models, continuous time models and Black-Scholes, analytic approach to Black-Scholes, hedging numerical and binomial methods, bonds and interest rate derivatives models, computational methods for bonds, further theory of exotic and path-dependent options, foreign currency markets and exchange risks.

**0410-523: TOPICS IN APPLIED MATHEMATICS**

**CR: 3**

Topics may differ time to time, the course may be repeated for credit whenever the topics are different.

**0410-525: GENERAL TOPOLOGY**

**CR: 3**

Abstract topological spaces; connectedness, compactness, continuous functions. Metric spaces, complete metric spaces and metrizable spaces.

**0410-526: ALGEBRAIC TOPOLOGY**

**CR: 3**

Fundamental groups, surfaces, and homology theory.

**0410-530: FOUNDATIONS OF GEOMETRY**

**CR: 3**

Coordinatization, planar ternary rings and their algebraic properties, coordinatizing the dual plane, conditions for linearity, division rings with inverse properties, alternative division rings, the Artin-Zorn theorem, quasi fields and translation planes, division ring planes, some non-desarguesian planes.

**0410-531: DIFFERENTIABLE MANIFOLDS**

**CR: 3**

Manifolds, the topology of manifolds, differentiation on a manifold, vector fields, linear and affine connections, distributions, Riemannian manifolds.

**0410-532: TOPICS IN DIFFERENTIAL EQUATIONS**

**CR: 3**

Special topics not covered in other courses. May be repeated for credit under different subtitles.

**0410-535: GRAPHS AND HYPER GRAPHS**

**CR: 3**

The path problem, the flow problems, Vizing theorem, the Shannon theorem, chromatic number, chromatic polynomials, perfect graphs, hyper graphs.

**0410-537: COMBINATORICS**

**CR: 3**

System of distinct representatives of a family of sets, Hall's theorem and its generalizations, transversals, common transversals. Designs,

Steiner Triple Systems, sufficient conditions for existence of a block design. Latin squares, orthogonal Latin squares.

**0410-560: NUMERICAL SOLUTION OF ODE'S  
CR: 3**

Concepts of discretization (initial value problems, boundary value problems, integral equations). Difference methods and Galerkin methods. Consistency, stability and convergence. Linear multistep methods, stability theory, spline collocation methods, stiff equations. Two-point boundary value problems, difference methods, shooting techniques, finite elements.

**0410-561: COMPUTATIONAL LINEAR  
ALGEBRA  
CR: 3**

Basic concepts, Gaussain Elimination and LU-decomposition, QR-Factorization and Lease Square problems, Eigenvalue problems and SVD, Iterative Methods.

**0410-568: TOPICS IN NUMERICAL  
MATHEMATICS  
CR: 3**

Topics may differ time to time, the course may be repeated for credit provided the topics are different.

**0410-593: PROJECT  
CR: 3**

**0410-597: THESIS  
CR: 0**

**0410-598: THESIS  
CR: 0**

**2000-599: THESIS  
CR: 9**