Doctor of Philosophy in Mathematics
Program code: 041070

INTRODUCTION

The Department of Mathematics (College of Science) offers a Ph.D. program in **Mathematics**. Current research interests of the faculty include: Differential Equations, Numerical analysis, Integral Transforms, Fractional Calculus, Algebra (Ring Theory); analysis (Functional Analysis, Operator Theory); Approximation Theory and Fourier Analysis, Geometry, (General Topology), Differenial Geometry, Algebraic Topology Combinatorics, and Dynamical Systems.

PROGRAM REQUIREMENTS

36 TOTAL COURSE CREDITS

6 COMPULSORY COURSES (3 credits each)

0410-501 Algebra I
0410-510 Analysis I
0410-512 Complex Analysis I
0410-513 Ordinary Differential Equations
0410-515 Functional Analysis
0410-525 General Topology

9 ELECTIVES COURSES* (3 credits each)

*The student must take at least 9 credit hours of the 600-level courses listed below (each is 3 credits) that are offered by the department of Mathematics, with the consent of the Program Director.

0410-601 Algebra
0410-603 Ring Theory
0410-606 Group Theory
0410-608 Advanced Topics in Algebra
0410-610 Measure and Integration Theory
0410-612 Complex Analysis
0410-614 Operator Theory
0410-615 Functional Analysis
0410-616 q-Analysis
0410-617 Methods of Mathematical Physics
0410-618 Advanced Topics in Analysis
0410-623 Advanced Topics in Applied Mathematics
0410-625 Topology

0410-626 Algebraic Topology
0410-635 Advanced Topics in Geometry and Topology
0410-636 Graph Theory
0410-637 Theory of Linear Programming
0410-638 Advanced Topics in Discrete Mathematics
0410-650 Approximation and Optimization
0410-661 Numerical Solution of Partial Differential Equations
0410-668 Advanced Topics in Numerical Mathematics
0410-690 Seminar in Mathematics

3-6 Free Electives

A student may include in the program of study up to 6 credit hours from 500 or 600 - level courses offered by other graduate programs within Kuwait University with the consent of the Program Director.

(18) COMPULSORY COURSES

0410-697	Dissertation	(0)
0410-698	Dissertation	(0)
0410-699	Dissertation	(18)

COURSE DISCRIPTION

0410-601: ALGEBRA
CR: 3

Monoids, groups and subgroups; normal and quotient groups. Direct products, direct sums and free groups. Free products, generators and relation. Rings, factorization of commutative rings, rings of quotients and localization. Rings of polynomials and formal power series. Factorization in polynomial rings. Modules and exact sequences, injective and projective modules. Matrices, rank and equivalence.

0410-603: RING THEORY
CR: 3

Primitive rings, simple rings with minimal ideals, Jacobson radical, semi-simple rings , and Artinian semi-simple rings,. Completely reducible modules. Tensor product (elementary properties). Inductive and projective modules and semi perfect rings.

0410-606: GROUP THEORY
CR: 3

Automorphisms of group. The holomorph, complete groups and semi-direct product of groups. Free groups and Schreier method. Solvable groups and extended Sylow theorems and Frattini subgroups. Abelian groups: torsion, torsion free, divisible and pure subgroups.

0410-608: ADVANCED TOPICS IN ALGEBRA
CR: 3

Selected Advanced Topics in Algebra that will reflect recent advances.

0410-610: MEASURE AND INTEGRATION THEORY
CR: 3

Abstract measure and integration, the Lebesgue integral, Dini derivatives and the fundamental theorem of Calculus.

0410-612: COMPLEX ANALYSIS
CR: 3

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

0410-614: OPERATOR THEORY
CR: 3

Hilbert spaces and Banach spaces. Duality, linear operators, compact operators, and Fredholm operators.

0410-615: FUNCTIONAL ANALYSIS
CR: 3

Function spaces, linear functionals and distributions. Convolutions and Fourier transforms. sobolev spaces, embedding theorems.

0410-616: Q-ANALYSIS
CR: 3

q-binomial theorem. Basic hypergeometric series and summation formula. q-analogues of the classical orthogonal polynomials. Applications in analysis, number theory, combinatorics, Physics and computer Algebra.

0410-617: METHODS OF MATHEMATICAL PHYSICS
CR: 3

Linear transformations and quadratic forms. Orthogonal systems. Fourier series and the Fourier integral. Linear integral equations. Calculus of variations. Eigenvalue problems. Special functions defined by eigenvalue problems and fractional calculus. Heat and wave equations.

0410-618: ADVANCED TOPICS IN ANALYSIS
CR: 3

Advanced Topics in Analysis will include recent advances.

0410-623: ADVANCED TOPICS IN APPLIED MATHEMATICS
CR: 3

Advanced Topics in Applied Mathematics will include recent advances.

0410-625: TOPOLOGY
CR: 3

Advanced Topics in function spaces, uniform spaces, compacitifications and applications. Surfaces, fundamental groups and covering spaces.

0410-626: ALGEBRAIC TOPOLOGY
CR: 3

Simplicial homology, homotopy theory, homotopy groups. Cohomotopy, singular homotopy.

0410-635: ADVANCED TOPICS IN GEOMETRY AND TOPOLOGY
CR: 3

Advanced Topics in Geometry and Topology will include recent advances.

0410-636: GRAPH THEORY
CR: 3

Matchings in bipartite graphs, perfect matchings, Konig's theorem. Matchings in a general graph. Tutte's theorem, f-factor theorem. Colorings of graphs, vertex coloring, Brook's theorem, edge colorings, Vising's theorem . Ramsey theory and other external problems.

0410-637: THEORY OF LINEAR PROGRAMMING
CR: 3

Theory of linear optimization and modeling techniques. Convex analysis, duality theory and KKT optimality conditions. Sensitivity analysis, primal, dual and primal-dual simplex algorithm. Convergence and implementation issues.

0410-638: ADVANCED TOPICS IN DISCRETE MATHEMATICS
CR: 3

Advanced Topics in Discrete Mathematics, in particular in combinatorics, graph theory and/or linear programming, will include recent advances.

0410-650: APPROXIMATION AND OPTIMIZATION
CR: 3

Formulation of Approximation and Optimization problem in function spaces. Normal spaces, and dual spaces. Convex sets, separation theorem and differentiability properties of convex function. Optimality criteria (Karush-Kuhn-Tucker variational inequalities). Least square problems in Hilbert spaces, finite dimensional approximation, and Chebychev approximation. Duality and saddle points.

0410-661: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS
CR: 3

Characteristics and boundary conditions for first and second order PDEs. Finite different methods. Semi-discretization (MOL). Finite elements,

Petrov-Galerkin methods. Discretization of eigenvalue problems.

0410-668: ADVANCED TOPICS IN NUMERICAL MATHEMATICS
CR: 3

Advanced Topics in Numerical Mathematics will include recent advances.

0410-690: SEMINAR IN MATHEMATICS
CR: 3

The aim of the seminar in Mathematics is to have the student learn about the state of the art of current research in a specific area of Mathematics and gain experience in presenting and discussing material assigned by the seminar instructor.

0410-697: DISSERTATION
CR: 0

0410-698: DISSERTATION
CR: 0

0410-699: DISSERTATION
CR: 18