

MASTER OF SCIENCE MATHEMATICS

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.

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

The program requirements are (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

* The student can substitute 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. The Graduate Programs Committee must approve the substitution and the total number of credits substituted in any combination cannot exceed (6) credit hours.

9 COMPULSORY

2000-597-599 Thesis

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

Analyticity, Cauchy's integral formula, residues. Infinite products. Conformal mappings. Riemann mapping theorem.

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 Lipsunov 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.

COLLEGE OF SCIENCE

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

2000-597 to 599: THESIS

CR: 9

Ph.D in MATHEMATICS**INTRODUCTION**

The Department of Mathematics (College of Science) offers a Ph.D. program in **Mathematics**. Only full-time students are admitted to this program. 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), Differential Geometry, Algebraic Topology Combinatorics, and Dynamical Systems.

PROGRAM REQUIREMENTS

The program requirements are:

18 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* (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 Committee.

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

3-6 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.

NC COMPULSORY (Non-credit)

0410-697 to 699 Dissertation

COURSE DESCRIPTION

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, compactifications 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 to 699: DISSERTATION

MASTER OF SCIENCE MATHEMATICAL SCIENCES

INTRODUCTION

The Department of Mathematics & Computer Science offers a graduate program that leads to the degree of Master of Science in **Mathematical Sciences**. The (MMS) program is intended for students who are interested in interdisciplinary program with a major emphasis in mathematics and a minor emphasis in a related subject outside mathematics. The objective of the MMS program is to bridge the gap between mathematics as a discipline and other subjects outside mathematics.

The Program features a non-thesis option. The non-thesis option requires the completion of a project, and require a minimum course work and passing a comprehensive examination.

PROGRAM REQUIREMENTS

The program requirements are:

33 TOTAL COURSE CREDITS

6 COMPULSORY COURSES (3 credits each)

0410-510 Analysis I
0410-593 Project

6-9 BASIC COURSES (3 credits each)

Students must take at least 6 credits from the core courses. If the student chooses to take 9 credit hours from the core courses list, the additional 3 credits will count towards the elective course requirements. The total number of credits of core courses and elective courses must add up to **15 credit hours**.

0410-512 Complex Analysis I
0410-513 Ordinary Differential Equations
0415-542 Scientific Computing: Mathematical Models and Algorithms

6-9 ELECTIVES* (3 credits each)

0410-501 Algebra
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
0410-525 General Topology

0410-526	Algebraic Topology
0410-531	Differentiable Manifolds
0410-532	Topics in Differential Equations
0410-535	Graphs and Hyper Graphs
0410-537	Combinatorics
0415-543	Advanced Numerical Computing
0410-560	Numerical Solution of ODE's
0410-561	Computational Linear Algebra
0410-568	Topics in Numerical Mathematics

12 MINOR COURSES (non-mathematical courses) (3 credits each)

The student must take 12 credits of non-mathematics courses from an outside area and must be approved by the student's committee. The outside area can be from any department of the following colleges: Faculty of Science, Faculty of Engineering, and Faculty of Medicine, Faculty of Business Administration and Faculty of Education.

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

Analyticity, Cauchy's integral formula, residues. Infinite products. Conformal mappings. Riemann mapping theorem.

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 Ljapunov 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
EIGENVALUE 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**

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.

**0410-531: 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 Least Square problems, Eigenvalue problems and SVD, Iterative Methods.

**0410-568: TOPICS IN NUMERICA
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**

MASTER OF SCIENCE COMPUTER SCIENCE

INTRODUCTION

The Department of Computer Science (College of Science) offers a graduate program that leads to the degree of Master of Science in **Computer Science**. The program features a thesis and a non-thesis option. The thesis option requires a successful completion of a thesis, and the non-thesis option requires the completion of a project. Both part-time and full-time students are admitted to this program. The graduate program in Computer Science places equal emphasis on fundamentals and practical aspects of Computer Science. Current research interests of the faculty include: algorithms, artificial intelligence, database systems, networks and distributed systems, and software engineering. The aim of this program is to prepare students for industrial and research work.

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

According to the Graduate College Council decision dated 12/4/2011, all courses with code (0415) are equivalent to courses with code (0418) until the graduation of all students who have been enrolled in the program before this decision.

PROGRAM REQUIREMENTS

The program requirements are (non-thesis option in parenthesis):

31 (34) TOTAL COURSE CREDITS

10 (13) COMPULSORY (credits in parenthesis)

0418-512	Automata and Formal Languages	(3)
0418-513	Theory of Complexity	(3)
0418-521	Programming Paradigms	(3)
0418-590	Research Seminar in Computer Science	(1)
0418-593	Project (non-thesis option only)	(3)

12 (21) ELECTIVES* (3 credits each)

0418-511	Algebraic Structures and Logic
0418-514	Principles of Programming Languages

0418-515 Program Specification and Verification
 0418-522 Distributed Systems
 0418-523 Advanced Databases
 0418-524 Expert Systems
 0418-525 Operating Systems
 0418-526 Advanced Computer Networks
 0418-534 Parallel Computing
 0418-536 Advanced Computer Graphics
 0418-541 Advanced Artificial Intelligence
 0418-542 Scientific Computing: Mathematical Models and Algorithms
 0418-543 Advanced Numerical Computing
 0418-544 Software Engineering
 0418-545 Computer Systems Architecture
 0418-546 Design of Microprocessor-based Systems
 0418-547 Modeling and Computer Simulation
 0418-551 Introduction to Cryptography
 0418-552 Data Mining
 0418-554 Wireless and Mobile Networks
 0418-555 Design and Test of Digital Systems
 0418-580 Topics in Computer Science

* Students may study up to 6 credit hours from the 400 level undergraduate courses offered by the Department of Computer Science or any 400/500 level courses offered by other Departments at Kuwait University with the approval of the Program Committee.

9 COMPULSORY

2000-597 to 599 Thesis (Thesis Option Only)

COURSE DESCRIPTION

0418-511: ALGEBRAIC STRUCTURES AND LOGIC

CR: 3

Signature, algebras, semigroups, monoids, groups, rings. Homomorphisms and congruences. Term algebras. Signatures with predictable symbols, clauses, models. Conclusion and derivation, soundness and completeness. Predicate calculus. Skolem normal forms: clauses with variables, resolution principle.

0418-512: AUTOMATA AND FORMAL LANGUAGES

CR: 3

The classes of regular, context-free, context sensitive and recursively enumerable languages. Characterization by grammars. Deterministic and non deterministic automata, pumping lemmata. Undecidable problems. Algebraic and decidability properties of the language classes.

0418-513: THEORY OF COMPLEXITY

CR: 3

Algorithm, Turing machines, computability. Complexity measures based on formal models, time and space, complexity. Tractable and intractable problems. Algorithm design techniques and analysis of the resulting algorithms. Complexity cases. P-NP problem, examples of NP-complete problems. Complexity of parallel computations.

0418-514: PRINCIPLES OF PROGRAMMING LANGUAGES

CR: 3

Imperative and applicative programming languages. Syntax, semantics, pragmatics. Compilation and interpretation. Syntactic domains, concrete and abstract syntax.

Semantic domains, operational, denotational, and axiomatic semantics. Lambda calculus and typed lambda calculus.

0418-515: PROGRAM SPECIFICATION AND VERIFICATION

CR: 3

Total and partial correctness; Pre- and post conditions, verification rules, predicate transformers. Modal and temporal logic. Algebraic specifications, heterogeneous algebras, equations and conditional equations. Structured specifications, specification languages.

0418-521: PROGRAMMING PARADIGMS

CR: 3

Features of imperative (procedural) programming languages, impacts of von Neumann computer architecture. Object-oriented programming paradigm, objects, classes, inheritance. Concepts of functional programming and LISP, functionals in programming. Concepts of logic programming and PROLOG.

0418-522: DISTRIBUTED SYSTEMS

CR: 3

Introduction to distributed systems: hardware and software concepts. Communication in distributed systems. Language support. Processing Concepts. Synchronisation scheduling and resource allocation. Distributed transaction processing.

0418-523: ADVANCED DATABASES

CR: 3

New data modelling concepts. Advanced transactions models. Conventional and parallel query processing. Database extensions (temporal databases). Data mining concepts.

0418-524: EXPERT SYSTEMS

CR: 3

Structure of Expert System. Classification of Experts Systems and main application areas. Basic cycle of work. Principles of Knowledge Engineering. Probability computations for Expert Systems. Reasoning under certainty and inexact reasoning. Fuzzy logic. Rete algorithm. Data structures for Expert Systems. Designing and developing Expert Systems with shells. CLIPS shell. Life cycles for Expert Systems.

0418-525: OPERATING SYSTEMS

CR: 3

Modern Operating systems design and construction techniques. Concurrent programming, operating system Kernels, correctness, transaction processing, synchronization problems, fault-tolerance, deadlocks, distributed system structures, distributed file systems and distributed coordination, protection and security, network operating systems, comparative structure of different kinds of operating systems, and other research topics.

0418-526: ADVANCED COMPUTER NETWORKS

CR: 3

Local area and wide-area networks, Internet protocols, TCP/IP, advanced topics in computer networking cellular and wireless, mobile communication systems and mobility management, ad hoc networks, sensor networks satellite networks, mobile IP, Bluetooth, network security and reliability.

0418-534: PARALLEL COMPUTING

CR: 3

Sequential and Parallel programs. A descriptive view at sequential and concurrent program execution. Parallel processing models and terminology. Architecture classifications. Communication topologies. Performance measures.

Principles of organizing parallel algorithms and examples. Concurrent programming languages.

0418-536: ADVANCED COMPUTER GRAPHICS
CR: 3

Modeling real world with computer graphics. Data structures and data bases for computer graphics. Difficulties and methods for extracting spatial relation of objects. Simulating dynamics of objects. Interacting objects. Particle systems. Constrains in computer graphics. Textures and its designing. Architectures of advanced graphics workstations. Virtual reality systems.

0418-541: ADVANCED ARTIFICIAL INTELLIGENCE
CR: 3

Mathematical logic, resolution techniques and automated theorem proving. Problem solving methodology. Computational systems for problem solving. Sequential and parallel inference machines. Quasi-chaotic models of computations: Genetic algorithms. Game playing. Machine learning. Natural language processing: syntactic processing, semantic analysis. Selected application of AI.

0418-542: SCIENTIFIC COMPUTING: MATHEMATICAL MODELS AND ALGORITHMS
CR: 3

Mathematical modeling, using systems of differential equations to model real situations, large systems of linear equations, sparse matrices, pseudoinverse matrices, multilevel methods, factorization.

Ordinary differential equations, initial-value problems, one step and multi-step methods for solution, stiff equations, boundary value problems, shooting, difference and variational methods.

0418-543: ADVANCED NUMERICAL COMPUTING
CR: 3

Fitting of data, B-spline representations, calculating with B-splines, knot insertion algorithms, curve fitting with splines, surface fitting, mesh data methods, scattered data methods. Transforms and filtration of data, Fourier transforms, convolution and correlation, sampling interpolation, deconvolution problem, reconstruction from projections, discrete projections, iterative image reconstruction. Data fitting with fractals, fractal image, fractal

dimension, attractor, compression with quadtree, fractal image coding.

0418-544: SOFTWARE ENGINEERING
CR: 3

Models, notations, the process for software requirement identification, representation, validation, and analysis. Software design process and its models, design state assessment and quality assurance, design verification. Systematic testing of software systems and verification. Measurement and prediction of software reliability. Software project management.

0418-545: COMPUTER SYSTEMS ARCHITECTURE
CR: 3

Computational models and computer architecture. Instruction set design, processor architecture, memory organisation, I/O and interrupt system. Multiprocessor systems and interconnection networks, resource handling, case studies.

0418-546: DESIGN OF MICROPROCESSOR-BASED SYSTEMS
CR: 3

Microprocessor systems and components; use of microprocessor systems for control applications. Design, implementation and test of several projects dedicated to microprogrammed control units, embedding microprocessors in control systems, and multiprocessor systems.

0418-547: MODELLING AND COMPUTER SIMULATION
CR: 3

Basic concepts of modelling, performance metrics, workload selection, data representation. Time-based vs. discrete-event simulation. Simulation of a single server system. Model validation and verification techniques. Random number generators, random variate generation, commonly used distributions. Simulation model analysis, initial transients, confidence intervals, output data analysis. Case studies.

0418-551: INTRODUCTION TO CRYPTOGRAPHY
CR: 3 PR: 0410-102, 111

The course starts with some examples of classical cipher systems such as affine cipher, substitution cipher, etc. Next we study some modern symmetric and asymmetric cipher systems and their security. Chaos-based cipher systems are also introduced. The diffie-hellman key exchange protocol is

discussed. Digital signatures, hash functions and message authentication codes which are important tools for authentication and data integrity are also presented.

0418-552 : DATA MINING

CR: 3

Basic concepts, data preprocessing; Association rules, Classification and Prediction;. Cluster analysis; Evaluation Techniques; Specialized Techniques.

0418-554 : WIRELESS AND MOBILE NETWORKS

CR: 3 PR: 0410-413 (or equivalent)

Fundamentals of wireless local area networks and wireless personal communication networks, network protocols, mobile and ad hoc networks, clustering and multicasting algorithms, mobile telecommunication protocols, handoff and channel allocation algorithms, cellular concepts, tradeoff between capacity and coverage, and frequency reuse, sensor networks, satellite networks, network reliability and performance measures.

0418-555: DESIGN AND TEST OF DIGITAL SYSTEMS

CR: 3 PR: 0410-356,455

Logic design principles, Boolean algebra; logic simulation methods, structural hazards; manufacturing test fundamentals, fault modeling and simulation, automatic test pattern generation algorithms; enhancing testability of digital systems; design for testability; advanced testing techniques: test data compaction and compression techniques; integrated circuits vs system-on-A-chip (SOC) design styles and their manufacturing test implications.

0418-580: TOPICS IN COMPUTER SCIENCE A

CR: 3

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

0418-590: RESEARCH SEMINAR IN COMPUTER SCIENCE

CR: 1

The aim of the research seminar is to allow the M.Sc. candidate to gain experience in preparing and presenting his/her research work.

0418-593: PROJECT

CR: 3

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE CHEMISTRY

INTRODUCTION

The Department of Chemistry (College of Science) offers a Master of Science program in **Chemistry**. Full-time and Part-time students are admitted to this program. The program is designed to prepare individuals for a career in: College or University teaching, a leadership role in secondary school science education, employment in government or industrial laboratories, or technically oriented positions in government and business. A wide range of potential areas for research is available for students to choose from. Among the current areas of faculty research are the following: Physical Chemistry, Organic Chemistry, and Inorganic and Analytical Chemistry.

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

The program requirements are:

31 TOTAL COURSE CREDITS

10 COMPULSORY (credits in parenthesis)

0420-512	Advanced Thermodynamics	(3)
0420-541	Advanced Inorganic Chemistry	(3)
0420-552	Advanced Organic Chemistry I	(3)
0420-591	Seminar	(1)

12 ELECTIVES* (3 Credits each)

0420-521	Surface Chemistry & Heterogeneous Catalysis
0420-522	Advanced Electrochemistry
0420-523	Physico-chemical Aspects of Analytical Separations
0420-524	Advanced Quantum Chemistry
0420-525	Structure and Properties of High Polymers
0420-530	Selected Topics in Applied Physical Chemistry
0420-532	Chemical Application of Group Theory
0420-542	Selected Topics in Inorganic Chemistry
0420-543	Selected Topics in Analytical Chemistry
0420-544	Advanced Environmental Chemistry
0420-561	The Chemistry of Heterocyclic Compounds
0420-562	Synthetic Organic Chemistry
0420-563	Physical Methods in Organic Chemistry
0420-564	Selected Topics in Organic Chemistry
0420-565	Topical Organic Chemistry

*Students may substitute up to 6 credit hours from the (400 level) elective chemistry undergraduate courses with the approval of the Program Committee.

9 COMPULSORY

2000-597 to 599 Thesis

COURSE DESCRIPTION

**0420-512: ADVANCED THERMODYNAMICS
CR: 3**

Equilibria, solution, separation techniques and molecular interpretation of the properties of chemical system. These include: Homogeneous and heterogeneous equilibria, thermodynamics of mixtures, activity and fugacity, Raoultian and Henryan scales, distillation and statistical thermodynamics.

**0420-521: SURFACE CHEMISTRY &
HETEROGENEOUS CATALYSIS
CR: 3**

Capillarity; electrical aspects of surface chemistry; long-range forces; surfaces of solids; physisorption and surface texture; spectroscopy and surface structure; chemisorptions and surface catalysis.

**0420-522: ADVANCED
ELECTROCHEMISTRY
CR: 3**

Electrode/electrolyte interface & structure of the double layer; mechanistic information through electrochemical techniques; corrosion & passivation; electrochemical energy conversion & fuel cells.

**0420-523: PHYSICO-CHEMICAL ASPECTS OF
ANALYTICAL SEPARATIONS
CR: 3**

Classification of separation methods; thermodynamic and kinetic aspects; chromatographic methods and selection procedures and optimization.

**0420-524: ADVANCED QUANTUM
CHEMISTRY
CR: 3 PR: 428**

Quantum mechanical aspects of molecular stability; modern concepts of chemical bonds; relations between theoretical predictions and experimental findings.

**0420-525: STRUCTURE AND PROPERTIES
OF HIGH POLYMERS
CR: 3**

Structure and classification of polymers; structure of polymers in condensed states; rheology of polymers; mechanical properties and strength; chemical reactions of macromolecules; possibilities and limitations of chemical modification.

**0420-530: SELECTED TOPICS IN APPLIED
PHYSICAL CHEMISTRY
CR: 3**

Colloids and surfaces; Magnetic resonance spectroscopy, Advanced chemical Kinetics; Application of surface active agents; Applied polymer science; Hybrid and composite materials; Applied catalysis Nanomaterials; Material characterization; Other applied topics.

**0420-532: CHEMICAL APPLICATION OF
GROUP THEORY
CR: 3**

Definitions and theorems of group theory; molecular symmetry and the symmetry groups; representations of groups. Applications: Hybrid orbitals and molecular orbitals for AB_n type molecules; ligand field theory; molecular vibrations.

0420-541: ADVANCED INORGANIC CHEMISTRY**CR: 3**

Inorganic reaction mechanisms; bioinorganic reactions and nuclear chemistry.

0420-542: SELECTED TOPICS IN INORGANIC CHEMISTRY**CR: 3**

Physical methods in inorganic chemistry; advanced aspects in boron chemistry; inorganic chains, rings and metal clusters; crown ethers, macro cycles and cryptands; advanced treatment of solid state chemistry and inorganic photochemistry.

0420-543: SELECTED TOPICS IN ANALYTICAL CHEMISTRY**CR: 3**

Equilibria in aqueous and non-aqueous media; instrumental and miscellaneous methods of analysis.

0420-544: ADVANCED ENVIRONMENTAL CHEMISTRY**CR: 3**

Chemical pollutants and their effect on the environment; analytical chemistry applied to environmental samples.

0420-552: ADVANCED ORGANIC CHEMISTRY I**CR: 3**

Linear free energy relationships; molecular rearrangements: (i) 1,2-shifts to electron deficient carbon, nitrogen and oxygen, (ii) pericyclic rearrangements.

Reduction. Hydroboration. Oxidation.

0420-561: THE CHEMISTRY OF HETEROCYCLIC COMPOUNDS**CR: 3**

Nomenclature rules; heterocyclic analogues of cyclopropane, cyclobutane and cyclopenta-dienes; chemistry of pyridine and quinolines; monocyclic compounds; fused ring systems; Compounds with two or more heteroatoms; natural occurrence.

0420-562: SYNTHETIC ORGANIC CHEMISTRY**CR: 3**

Functionalization and interconversion of functional groups; formation of carbon-carbon bonds: the principles and reactions of organometallic compounds; use of stabilized carbanions and related nucleophiles; formation of carbon-heteroatom bonds: the principles; ring closure and ring opening; protective groups; phosphorus reagents; silicon reagents; asymmetric synthesis; selected syntheses.

0420-563: PHYSICAL METHODS IN ORGANIC CHEMISTRY**CR: 3**

The application of physical methods for the elucidation of structure of organic compounds: U.V., visible, Raman and NMR spectroscopy; mass spectrometry; optical rotation, optical rotatory dispersion and circular dichroism.

0420-564: SELECTED TOPICS IN ORGANIC CHEMISTRY**CR: 3**

Carbenes, nitrenes, arynes, carbocations, and carbanions; M.O. method and organic reactions: electrophilic substitutions, sigmatropic rearrangements, electrocyclic and pericyclic reactions; organic electrochemical and polarographic reactions; organometallic reactions, ylides; photophysical processes.

0420-565: TOPICAL ORGANIC CHEMISTRY**CR: 3**

Molecular recognition processes and supramolecular assemblies; fullerenes; nanotechnology materials and devices; organic reactions in unusual solvents (including room-temperature reactions in ionic liquids and supercritical fluids); solid-supported reagents and catalysts in organic chemistry; green chemistry; organic reactions under extreme conditions.

0420-591: SEMINAR**CR: 1**

Library-based review of an advanced topic or recent development in chemistry to be presented in dissertation form and as a departmental seminar.

2000-597 to 599: THESIS**CR: 9**

Ph.D. in CHEMISTRY**INTRODUCTION**

The Department of Chemistry (College of Science) offers a Ph.D. program in **Chemistry**. Only full-time students are admitted to this program. A graduate successfully completing this program will be expected to have an in-depth knowledge in specific areas of Chemistry. In addition, he/she would be trained to become an independent thinker, planner and executor of specific ideas relevant to Chemistry. A major part of the program is the dissertation, which requires high quality research in a specific area of Chemistry.

PROGRAM REQUIREMENTS

The program requirements are:

15 TOTAL COURSE CREDITS**9 COMPULSORY (3 credits each)**

- 0420-620 Advanced Topics in Physical Chemistry
- 0420-641 Selected Topics in Advanced Inorganic and Analytical Chemistry
- 0420-651 Advanced Organic Chemistry -II

6 ELECTIVES* (3 Credits each)

- 0420-611 Catalytic Chemistry
- 0420-621 Thermo Chemistry of Solids
- 0420-622 Colloid and Surface Chemistry
- 0420-623 Photo-Electrochemistry & Solar Energy Conversion
- 0420-625 Structure and Bonding
- 0420-626 Molecular Modeling
- 0420-627 Corrosion and Protection of Metallic Materials
- 0420-628 Surfactant Science
- 0420-642 Bio-Inorganic Chemistry
- 0420-643 Advanced Chemistry of Coordination Compounds and Homogeneous Catalysis
- 0420-644 Physical Methods and Data Analysis in Inorganic Chemistry
- 0420-652 Non-Thermal Reactions in Organic Chemistry
- 0420-653 Advances in Organic Synthesis

* Students may substitute up to 3 credit hours from the (500 level) graduate courses offered by the Department of Chemistry and which has not been previously studied by the student.

NC COMPULSORY (Non-credit)

- 0420-697 to 699 Dissertation

COURSE DESCRIPTION**0420-611: CATALYTIC CHEMISTRY
CR: 3**

Catalysis in solution: Acid-base catalysis by electron transfer, organometallic catalysis, catalysis by macromolecules, phase transfer catalysis, and catalysis by micelles.

Catalysis by enzymes: Composition and structure of enzymes, reactions catalyzed by enzymes, nature of catalytic sites, and supported enzyme catalysts.

Catalysis by polymers: The nature of polymers, catalysis by polymer gels, kinetics of polymer-catalyzed reactions, bi-functional and multi-functional catalysis, porous polymers and surface catalysis, and applications of polymer catalysts.

Catalysis in molecular-scale cavities: Structure of crystalline solids, structure of zeolites, families of zeolites, adsorption and diffusion in zeolites, the solvent-like nature of zeolite pores, catalysis by zeolites.

Catalysis on surfaces: surface structure, adsorption, surface catalysis, industrial catalysis, and catalytic surfaces.

**0420-620: ADVANCED TOPICS IN PHYSICAL CHEMISTRY
CR: 3**

Chemical Kinetics, quantum Chemistry, electrochemistry, colloid and surface chemistry, molecular spectroscopy, macromolecular chemistry, nanoparticles and nanotechnology, and other topics.

**0420-621: THERMOCHEMISTRY OF SOLIDS
CR: 3**

Heterogeneous equilibria: Generalization of equilibrium conditions, thermodynamic properties of substances, energy balance, thermodynamics of phase changes and chemical reactions, and thermodynamics of interfaces.

Study of equilibrium states by methods of thermal analysis: Calorimetric measurements, measurements of other thermo-physical properties, direct investigations of equilibria (condensed state, solid-gas equilibria, solid-liquid equilibria), and calculation of standard enthalpy changes of phase transitions from phase diagrams.

Theory of kinetics and mechanism of solid state heterogeneous processes: Types of processes, activated state concept, homogeneous-like descriptions of heterogeneous processes, physico-geometrical description of heterogeneous

processes, and molecular description of heterogeneous processes

Study of kinetics under non-isothermal conditions: Fundamental problems, methods of kinetic data evaluation, study cases, kinetic parameters by differential thermal measurements.

**0420-622: COLLOID AND SURFACE CHEMISTRY
CR: 3**

1. *The Colloidal State:* Classification of colloidal systems, structural characteristics, preparation and purification of colloidal systems.

2. *Kinetic properties:* Brownian motion, osmotic pressure.

3. *Optical Properties:* Optical and electron microscope, light scattering.

4. *Surfaces and interfaces:* General concepts: surface free energy, the molecular nature of interfacial region, the Gibbs surface energy, adsorption, the Gibbs adsorption equation.

5. *Liquid-gas and liquid-liquid interfaces:* Surface and interfacial tension. orientation at interfaces, surfactant and the reduction of surface tension, micelle formation, spreading, mono-molecular films.

6. *Charged interfaces:* The electric double layer, electro-kinetic phenomena and electro-kinetic theory.

7. *Colloidal stability:* DLVO theory, reversible flocculation and secondary minimum, kinetic of coagulation, steric stabilization. depletion flocculation,. solvent effects in steric stabilization.

8. *Rheology:* Viscosity, non-Newtonian flow viscoelasticity.

9. *Emulsions:* Formation and stability, surfactants, emulsion type. The Hydrophilic-Lipophilic Balance (HLB),. multiple emulsions, microemulsion.

10. *Foams*

11. *Industrial importance of colloids:* Medical and pharmaceutical. applications in food industry, cosmetic emulsion.

**0420-623: PHOTO-ELECTROCHEMISTRY & SOLAR ENERGY CONVERSION
CR: 3**

Introduction: The sun: ultimate origin of most of the energy available, heat energy wind-hydroelectric power. fossil fuels, radioactivity, sun model.

Semiconductors: Origin of semi-conductivity, types of semiconductors, mechanism of excitation,

temperature effects. Photo effects, examples and problems.

Photovoltaic effects: The p-n junction, current transport phenomena, forward current, reverse saturation current, the junction photovoltaic, electronic model, mechanism of energy conversion. *Schottky barrier solar cells:* SIS, SIM cells, SnO solar cells, principle of operation, current transport, improvement of the characteristics for practical applications.

Spectral responsivity of the photocurrent: Maximum theoretical efficiency of a solar cell, solar arrays and systems, examples and problems.

Semiconductor electrochemistry:

Semiconductor/electrolyte interface, energy barrier and redox potentials, principle of photoelectrochemical energy conversion.

Photoelectrochemical cells: Different types, applications.

Photoelectrochemical semiconductors: Advantages and disadvantages of photoelectrochemical cells, corrosion of semiconductors, stabilization of semiconductors, applied systems.

0420-625: STRUCTURE AND BONDING
CR: 3

Introduction to atomic structure and molecular properties and Valence bond theory; the molecular orbital theory of electronic structures and the spectroscopic properties of diatomic molecule; electronic structures; photoelectronic spectroscopy and frontier molecular orbital theory of reactions of polyatomic molecules; bonding in solids and liquids; correlation diagram; walsh diagram (triatomic); Polyatomic molecules: Huckel theory, Woodward-Hoffman rules, Bond theory of solids; insulators and semiconductors.

0420-626: MOLECULAR MODELING
CR: 3

Building and Visualizing molecules; building small and large molecules and coordination complexes; Molecular geometry and properties; bond length and angles; electron affinity; structure stability relationship; molecular orbitals and bonding; formation of MO; Walsh diagram; Jahn-Teller Effect; conformational analysis; small and large conformation analysis; inversion barrier in ammonia; thermodynamics; heat of formation; combustion; hydrogen bonding; steric effects tautomerism; resonance energy; charge

distribution; dipole moment, charge transfer and excited states; spectroscopy, UV, vibrational spectra; solvent effects n spectra; molecular dynamics; stability or carbocations; conformation searches; stimulated annealing; langevin dynamics and intramolecular vibration.

0420-627: CORROSION AND PROTECTION OF METALLIC MATERIALS
CR: 3

Electrochemical equilibria, free energy calculations, phase diagrams, grain boundaries, inclusion, crystal structure, diffusion in solids, electrical double layer, thermodynamics and kinetics of electrode reactions.

0420-628: SURFACTANT SCIENCE
CR: 3

Micellization and surfactants absorption at interfaces; liquid crystals, emulsion and microemulsions; thin films and foams; Rheology of surfactant solutions; Self-assemblies as templates for nanoparticles and porous materials; characterization of self-assembles systems; Industrial applications; relevant legislation.

0420-641: SELECTED TOPICS IN ADVANCED INORGANIC AND ANALYTICAL CHEMISTRY
CR: 3

Part (I) Inorganic Chemistry

1. Solid state chemistry
2. Mechanism of Inorganic Reactions.
3. Chemical crystallography
4. Organometallic Chemistry
5. Advanced Inorganic spectroscopy
6. Advanced magnetochemistry

Part (II) Analytical Chemistry

1. Analytical Spectroscopy
2. Electrochemical methods
3. Separation methods

0420-642: BIO-INORGANIC CHEMISTRY
CR: 3

1. The identification of the functions of metal ions and main groups compounds in biological systems. The chemistry of model and isolated biological compounds.
2. Study of metalloproteins and other metal-containing biological molecules.
3. The tradition metals in biological redox reactions.
4. Nitrogen fixation.

5. The biochemistry of iron.
6. Metal ions and chelating agents in medicine

0420-643: ADVANCED CHEMISTRY OF COORDINATION COMPOUNDS AND HOMOGENEOUS CATALYSIS
CR: 3

Part (I)

1. Review of the chemistry of transition and inner transition elements.
2. Theories of bonding.
3. Structure and reactivity
4. Coordination compounds in biological systems.

Part (II)

1. Theories
2. Homogeneous and heterogeneous catalysis
3. Recent developments

0420-644: PHYSICAL METHODS AND DATA ANALYSIS IN INORGANIC CHEMISTRY
CR: 3

Part (I)

1. Physical methods in inorganic chemistry.
2. Nuclear magnetic resonance. Mossbauer effect, optical rotary dispersion and circular dichroism, electron paramagnetic resonance, nuclear quadrupole resonance and photoelectron spectroscopy.
3. Theoretical principles and applications of physical methods relevant to characterization and organometallic compounds.

Part (II)

The application of mathematical and statistical techniques to chemical measurements. These applications include the theory of single detection,

filtering and smoothing, curve fitting, uni- and multi-component calibration and analysis.

0420-651: ADVANCED ORGANIC CHEMISTRY - II
CR: 3

Specific and general acid and base catalysis. Enzyme mimics and catalysis. Stereoelectronic effects. Treatment of steric effects. T.S. recognition and molecular recognition processes. Physical organic chemistry of macromolecular systems and supermolecular assemblies. Structure/reactivity correlation analysis with emphasis on LFER. Interpretation of isotope effects. Non-catalytic thermal gas-phase free radical and molecular processes. Organic reactions involving carbocations, carbanions, and radical cations and anions; tautomerism; resonance energy; charge; charge distribution.

0420-652: NON-THERMAL REACTIONS IN ORGANIC CHEMISTRY
CR: 3

1. Photochemistry
2. Sonochemistry
3. Biotransformations

0420-653: ADVANCES IN ORGANIC SYNTHESIS
CR: 3

1. Organometallics in Synthesis
2. Free radicals in organic chemistry
3. Asymmetric synthesis
4. Classical and modern natural products total synthesis.
5. Computer assisted routes to organic synthesis

0420-697 to 699: DISSERTATION

MASTER OF SCIENCE PHYSICS

INTRODUCTION

The Department of Physics (College of Science) offers a Master of Science program in **Physics**. Both part-time and full-time students are admitted to this program. The program is designed to prepare individuals for a career in college or university teaching and research; a leadership role in secondary school science education; employment in technically oriented positions in government, business, or industrial laboratories, and to continue graduate education towards the Ph.D. degree. A wide range of potential areas for research are available for students to choose from. This includes: Atomic, Molecular, Solid State, Nuclear and Digital Electronics.

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

The program requirements are:

31 TOTAL COURSE CREDITS

13 COMPULSORY (credits in parenthesis)

0430-501	Classical Mechanics	(3)
0430-503	Classical Electrodynamics	(3)
0430-505	Quantum Mechanics I	(3)
0430-507	Mathematical & Computational Methods	(3)
0430-590	Seminar	(1)

9 ELECTIVES* (3 credits each)

0430-508	Special Topics I. Physics
0430-509	Special Topics II. Engineering Physics
0430-510	Atomic Spectra
0430-512	Laser Physics
0430-514	Theory of Atomic Collisions
0430-520	Molecular Spectroscopy I
0430-521	Molecular Spectroscopy II
0430-523	Photo physics
0430-525	Raman Spectroscopy
0430-530	Solid State Physics I
0430-531	Solid State Physics II
0430-533	Semiconductors
0430-535	Thermal Solar Processes
0430-540	Quantum Mechanics II
0430-542	Field Theory
0430-545	Particles and Symmetries
0430-550	Nuclear Physics I
0430-551	Nuclear Physics II

0430-560	Electronics
0430-562	Digital Design II
0430-563	Advanced Digital Signal Processing
0430-564	Quantum Computing
0430-570	Physics and Applications of GPS
0430-571	Synthetic Aperture Radar Interferometry
0430-572	Synthetic Aperture Radar Processing
0430-574	Solar Plasma and Cosmic Rays

*Students may substitute up to 6 credit hours from the upper elective Physics undergraduate courses (400 level) with the approval of the Program Committee.

9 COMPULSORY

2000-597 to 599 Thesis

COURSE DESCRIPTION

0430-501: CLASSICAL MECHANICS

CR: 3

Mechanics in the Lagrangian formulation; two body central force problem; rigid body dynamics; Hamiltonian formulation; canonical transformations; covariant relativistic mechanics; small oscillations.

0430-503: CLASSICAL ELECTRODYNAMICS

CR: 3

Electrostatics; boundary value problems; multiple expansion; Maxwell's equations; electromagnetic waves; radioactive systems.

0430-505: QUANTUM MECHANICS I

CR: 3

Theory of states and operators in Hilbert space; the Schrodinger equation. Heisenberg and interaction representation; perturbation theory; approximation methods; spin and the identity of particles; scattering theory; application to actual quantum systems.

0430-507: MATHEMATICAL AND COMPUTATIONAL METHODS

CR: 3

Special functions; integral equations; integral transforms; Green's functions; computer programming techniques; programming languages; computer operating systems; computer-aided solutions of physical problems.

0430-510: ATOMIC SPECTRA

CR: 3 PR:0430-505 or equivalent

Methods of atomic structure calculations; many-electron configurations; coupling schemes in complex spectra; fine structure and multiple analysis; series perturbations and ionization limits; Zeeman and Stark effects; spectral line shape theory; plasma spectroscopy.

0430-512: LASER PHYSICS

CR: 3 PR:430-408/0430-505 or equivalent

Interaction of atomic systems with radiation field; semiclassical theory of laser; multimode operation; quantum theory of radiation and laser; coherent states; laser fluctuations, photon statistics and noise.

0430-514: THEORY OF ATOMIC COLLISIONS

CR: 3 PR:0430-505 or equivalent

Quantum statement of the problem; partial wave analysis; Ramsauer effect; variational principles for phase shift; electron hydrogen scattering problem; Pauli principle and spin in collision processes; Stueckelberg theory; Coulomb scattering; excitation and ionization by electron and heavy ion impact.

0430-520: MOLECULAR SPECTROSCOPY I

CR: 3 PR:0430-505 or equivalent

Angular momentum and symmetry in diatomic and polyatomic molecules; molecular orbital theory.

0430-521: MOLECULAR SPECTROSCOPY II

CR: 3 PR: 0430-520 or equivalent

Ligand field theory; group theory; applications.

0430-523: PHOTOPHYSICS

CR: 3 PR:0430-520 or equivalent

Excited states of polyatomic molecules; absorption, fluorescence, and phosphorescence; excimers (liquids and crystals); molecular complexes and exciplexes; energy migration and transfer (liquids and crystals); quenching of excited states; delayed emission.

0430-525: RAMAN SPECTROSCOPY

CR: 3 PR:0430-520 or equivalent

Introduction to the Raman effect; polarisability tensor and selection rules; symmetry effects; vibrational Raman effect; rotational and electronic Raman effect; applications.

0430-530: SOLID STATE PHYSICS I

CR: 3 PR:0430-404 , 0430505

A review of band structure of solids, Fermi surfaces and metals; Optical processes, dielectrics and optical properties of solids, ferroelectrics; Magnetism and its applications, superconductivity.

0430-531: SOLID STATE PHYSICS II

CR: 3 PR:0430-530, 0430-505

Interacting electron gas model of solids, Hartree-Fock Approximation, Inhomogeneous interacting electron gas, the Thomas Fermi theory leading to the density functional theory, one-electron band theory of solids, Band structure calculation methods, the tight-binding and multiple scattering approaches, Metallic magnetism-local magnetic moments, mean-field theory of magnetic.

0430-533: SEMICONDUCTORS

CR: 3 PR: 0430-404 or equivalent

Physical principles of semiconductors and their application to various electronic and optical devices; band structure; intrinsic and extrinsic semiconductors and their statistical transport properties; optical properties; the junction diode

and the transistor; tunnel diode; Gunn diode; infrared detectors; solar cell; semiconductor lasers; etc.

0430-535: THERMAL SOLAR PROCESSES

CR: 3 PR:0430-425 or equivalent

Solar insulation; absorption, transmission and reflection of radiation by surfaces; blackbody radiation and absorption; solar collectors, application of solar thermal energy to heating and cooling of buildings; solar thermal stations; advanced applications.

0430-540: QUANTUM MECHANICS II

CR: 3 PR: 0430-505 or equivalent

Theory of angular momentum, symmetry; coherence of states; the density matrix; the Dirac equation; quantization of the electromagnetic field; applications.

0430-542: FIELD THEORY

CR: 3 PR:0430-501, 0430-503 & 0430-505 or equivalent

Klein-Gordon equation; Dirac equation; second quantization of fields with spins 0, 1/2 and 1, interaction between fields; scattering and the S-matrix; Feynman diagrams; renormalization theory.

0430-545: PARTICLES AND SYMMETRIES

CR: 3 PR:0430-542 or equivalent

Hadrons and leptons; conservation laws; resonance; Lie algebras; SU(2) and SU(3); Young diagrams and representations; multiplets; mass formulas; cross sections; strong and weak interactions; gauge symmetries.

0430-550: NUCLEAR PHYSICS I

CR: 3 PR:0430-402 or equivalent

Static properties of nuclei; nuclear forces; nuclear models; single particle and shell models; vibrational and collective models; liquid drop model; nuclear fission.

0430-551: NUCLEAR PHYSICS II

CR: 3 PR:0430-550 or equivalent

Nuclear reactions; direct and compound nuclear reactions; deep inelastic collisions; alpha decay; beta decay; electromagnetic transitions.

0430-560: ELECTRONICS

CR: 3 PR:0430-406 or equivalent

Solid state devices; integrated circuits; op.amps.; pulse amplifiers and discriminators; gater; A-D and D-A conversion circuits; scalers; memory units; system design.

0430-562: DIGITAL DESIGN II

CR: 3 PR:0430-243, 0430-380

Theoretical and practical aspects of the modern methods of digital logic design, (VHDL VHSIC Hardware Description Language), and modern design methodologies (Design Entry, Synthesis, Implementation [place and route], and Simulation), Programmable Device Architectures, Developing structural, behavioral, and dataflow VHDL models for familiar logic and arithmetic circuits, and state machines targeting both FPGA and CPLD devices, Writing test benches for simulation. The differences between Behavioral, Functional, and Timing simulations. The difference in coding for synthesis and coding for simulation, Further development of VHDL Language skills in the context of an introduction to Computer Architecture and DSP.

0430-563: ADVANCED DIGITAL SIGNAL PROCESSING

CR: 3 PR:0430-340, 0430-382 or 0430-482

Review of discrete transforms for LTI analysis, Digital filters, Multirate DSP, Design of Linear Filters for Prediction and Optimization, Adaptive filters, Power spectrum analysis, Wavelets, Digital speech processing, Digital image processing, Applications and examples.

0430-564: QUANTUM COMPUTING

CR: 3 PR:0430-303, 0430-340 or 0430-482

Review of classical computing techniques, Quantum bits and quantum computations, Quantum states, Quantum algorithms, Quantum information

theory' Quantum error detection and correction, Quantum hardware, Additional quantum theories, Applications and examples.

0430-570: PHYSICS AND APPLICATIONS OF GPS

CR: 3 PR:0430-340

Precession position measurement, three dimensional transformation equations, atmospheric and relativist error sources, signal characterization and analysis, correlation studies, GAMIT software.

0430-571: SYNTHETIC APERTURE RADAR INTERFEROMETRY

CR: 3 PR:0430-312

Concepts of interferometry, review of radar fundamentals, statistical techniques, image formation, Digital Elevation Models, GPS, land subsidence and deformation vectors.

0430-572: SYNTHETIC APERTURE RADAR INTERFEROMETRY

CR: 3 PR:0430-312

Radar systems, SAR geometry, range compression, azimuth compression, pixel migration, focusing, band width and phase concepts.

0430-574: SOLAR PLASMA AND COSMIC RAYS

CR: 3 PR:0430-312

Start with our nearest star and its atmosphere, solar plasma and interplanetary magnetic field, transport and acceleration of particles in space, galactic cosmic rays, solar flares and coronal mass ejections, space weather and geomantic activity, time series analysis.

0430-590: SEMINAR

CR: 1

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE ZOOLOGY

INTRODUCTION

The Department of Biological Sciences (College of Science) offers a Master of Science program in **Zoology**. Only full-time students are admitted to this program. The program is designed to prepare individuals for a variety of career opportunities. These include further education, a leadership role in secondary school education, employment in government or private sector laboratories, technically oriented positions in government or business and in environmental conservation. The discipline Zoology currently offers courses and research opportunities in several main fields. These include: Marine Biology/Ecology, Desert Biology/Ecology, Parasitology, Reproductive Biology, Genetics, Animal Behaviour, Embryology and Physiology.

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

The program requirements are:

30 TOTAL COURSE CREDITS

9 COMPULSORY (3 credits each)

- 0440-501 Retrieval, Interpretation and presentation of Zoological Data
- 0440-502 Principles of Taxonomy
- 0440-503 Reproductive Biology

3 PARTIALLY ELECTIVE (3 credits each):

- 0440-504 Marine Biology/Ecology
- 0440-505 Desert Biology/Ecology

9 ELECTIVES* (3 credits each)

- 0440-504 Marine Biology/Ecology
- 0440-505 Desert Biology/Ecology
- 0440-511 Parasitology
- 0440-512 Animal Behaviour
- 0440-513 Physiology
- 0440-514 Embryology
- 0440-515 Malacology
- 0440-516 Molecular Genetics

*The graduate students will be allowed to take 6 credit hour courses from different disciplines of the Department of Biological Sciences. **The student can only take these courses with the approval of the thesis supervisor.**

The graduate students in the Department of Biological Sciences will be allowed to take three credit hour course/s in Medical/Science faculty **with the approval of thesis supervisor.**

9 COMPULSORY

2000-597 to 599 Thesis

COURSE DESCRIPTION

0440-501: RETRIEVAL, INTERPRETATION AND PRESENTATION OF ZOOLOGICAL DATA
CR: 3

A course based on all literary aspects of Zoology involving both formal instruction and set exercises covering the following topics: (a) Search techniques (abstract journals; computer search by key words; journal selection; world-lists of periodicals and inter-library loan systems). (b) Processing of papers in different languages: translation services and selection of important data. (c) Application of statistical methods in the interpretation and presentation of data including the re-evaluation of published data. (d) Establishing a personal filing system for references. (e) Writing of scientific papers including guidance on the preparation and presentation of art work. (f) Oral presentation of data and proper use of visual aids.

0440-502: PRINCIPLES OF TAXONOMY
CR: 3

The role of taxonomy in Biology. Hierarchy and systematic units; phena, taxa, and categories. The species problem and definitions. Infra specific units; monotypic and polytypic species; allopatric and sympatric species; sibling species; biological and host races; the cline; sub-species and geographical races. Genus and higher units. Theories of biological classification: essentialism, nominalism, empiricism, cladism...etc. Newer approaches: Cytotaxonomy; Biochemical and

Immunological Taxonomy; "quantitative taxonomy"; monethetic and polythetic groups; population taxonomy. Zoological nomenclature: Briet history; the "code"; the "law of priority", and the type concept. Sound taxonomic procedures. Systematic notations.

0440-503: REPRODUCTIVE BIOLOGY
CR: 3

Biology of gametes. Gametogenesis in seasonal and non-seasonal animals utilising examples from local fauna. Influence of circadian, semi-lunar and lunar rhythms. Physiology of sperm motility and the structure of the axoneme. Immunological aspects. Endocrine system and reproduction-positive and negative-feedback systems. Hypothalamus and FSH-LH releasing factor. Roles of FSH and LH. Biosynthesis of steroid hormones; effects of steroid hormones on target tissues in the reproductive system. In both the theory and practical parts of the course, the opportunity is taken to expose the student to the principles and practice of modern techniques of wide application including phase and differential interference contrast microscopy; transmission, scanning and analytical electron microscopy; chromatography; use of radio isotopes and photographic techniques at the micro and macro levels.

0440-504: MARINE BIOLOGY/ECOLOGY
CR: 3

A course consisting of two main parts: (a) Adaptive radiation in marine organisms and (b) Economic aspects. In the first part, emphasis will be placed on the principal factors involved in adaptive radiation including choice of habitat, selection pressure and the physiological and anatomical features of animals living in such habitats. The second part will be mainly concerned with recent advances in fisheries and mariculture including the economic effects of pollution. The course includes laboratory and field exercises on the local marine fauna.

0440-505: DESERT BIOLOGY/ECOLOGY
CR: 3

An advanced course concerned with the study of the desert ecosystem as a functional unit. Emphasis will be on the community structure, diversity, population dynamics of desert fauna and flora physiological and ecological adaptations for life in the desert. Field exercises and laboratory experiments will be based on the local fauna and flora.

0440-511: PARASITOLOGY
CR: 3

A course consisting of two main parts: (a) Theoretical aspects of parasitology in general (b) Special study of certain parasites or groups of parasites. The theoretical aspects include: Parasites and degrees of animal associations; host-parasite relationships; immunological aspects; types of life-cycles and hosts; zoonosis; ecological aspects of parasitism; parasitocoenosis; the immediate environment; distribution of parasites and parasite-host specificity; behavioural aspects of parasitism; evolution of parasitism.

0440-512: ANIMAL BEHAVIOUR
CR: 3

A course consisting of two main sections: (a) Concepts in animal behaviour and (b) Behaviour in particular group of groups of animals. Concepts in animal behaviour include: The organisation of animal behaviour; animal communication; neural and hormonal aspects; evolution and survival value of behaviour. For (b) above, course participants will be required to review an area of research and identify and experiment on a problem which remains to be solved.

0440-513: PHYSIOLOGY
CR: 3

The course presents an advanced study of selected topics in physiology which emphasize problems pertaining to marine and desert animal. These topics include: respiratory pigments and their distribution; O₂ consumption, its modifying agents and regulation; metabolism as regulated to environmental oxygen; nitrogen excretion and its relation to availability of water; osmotic and ionic regulation and physiological problem of heat and water in desert animals, and temperature regulation in poikilothermic and homeothermic animals.

0440-514: EMBRYOLOGY
CR: 3

An advanced study of selected topics of special interest in developmental biology, such as: development in lower animals, morphogenesis in the protozoa and developmental problems in some invertebrate examples. Problems of differentiation, gene regulation and ontogenetic development. Differential gene activity during differentiation. Embryonic induction. Effects of environment in differentiation. The experimental approach in the study of developmental biology. Differentiation in regulation. Tissue culture. transplantations. Cell Fusion. Cloning.

0440-515: MALACOLOGY
CR: 3

A course, consisting of two main parts: (a) General Malacology and (b) Applied aspects. The first part includes a general review of the Phylum Mollusca and a systematic description of its major classes. The evolution of various functions and organ systems within the phylum and the relationships between and within the different classes. Ecology, behaviour and adaptations of various marine, freshwater and terrestrial molluscs. Recent systems for classification and nomenclature of molluscs. The second part includes a study of the role played by certain molluscs as intermediate hosts for parasitic diseases of man and domestic animals, and of molluscs of commercial value and economic importance. The practical work includes laboratory studies of the morphology and biology of selected examples of various molluscs as well as field and laboratory exercises on methods of

collection, preservation and identification of common molluscs of the local fauna.

0440-516: MOLECULAR GENETICS

CR: 3

Genome structure in prokaryotes and eukaryotes.
Molecular organization of nucleosomes and

chromosomes. Gene expression and its regulation. Mutations and recombination at molecular level. Plasmids, transposable genetic elements and principle of recombinant DNA technology.

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE BOTANY

INTRODUCTION

The Department of Biological Sciences (College of Science) offers a Master of Science program in **Botany**. Only full-time students are admitted to this program. The program is designed to offer research opportunities in Cytogenetics and Chemical Mutations, the effect of the most common drugs on the process of mitosis and the chromosome structure, detection, identification and evaluation of the environmental mutagens and carcinogenesis, ecology, desert ecology, synecology to environmental factors, biotic influence, plant taxonomy, flora of arid regions and flora of Kuwait and the Gulf States. Plant physiology particularly the biochemistry of photosynthesis and related processes and the development and structure of chloroplasts.

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

The program requirements are:

30 TOTAL COURSE CREDITS (credits in parenthesis)

9 COMPULSORY

- 0480-385 Statistical Methods in Research (3)
- 0451-501 Research Techniques (3)
- 0451-502 Seminar (1)
- 0451-503 Advanced Topics in Botany (2)

12 ELECTIVES* (3 credits each)

- 0451-526 Phytoplankton
- 0451-533 Developmental Genetics
- 0451-535 Molecular Plant Biology
- 0451-537 Pollution and Genotoxicity
- 0451-543 Plant Biotechnology
- 0451-545 Advanced Plant Breeding
- 0451-547 Advanced Plant Taxonomy
- 0451-556 Advanced Plant Ecology
- 0451-565 Stress Ecophysiology
- 0451-571 Plant Growth and Development
- 0451-573 Photobiology
- 0451-582 Plant Disease Management

*The graduate students will be allowed to take 6 credit hour courses from different disciplines of the Department of Biological Sciences. **The student can only take these courses with the approval of the thesis supervisor.**

The graduate students in the Department of Biological Sciences will be allowed to take three credit hour course/s in Medical/Science faculty **with the approval of thesis supervisor.**

9 COMPULSORY

2000-597 to 599 Thesis

COURSE DESCRIPTION

0451-501: RESEARCH TECHNIQUES
CR: 3

Exercises and demonstrations dealing with theoretical and practical aspects of modern techniques in different disciplines of botany.

0451-502: SEMINAR
CR: 1

Reading and discussions of current literature and research. Seminars can be arranged to suit interests and demands of different sub disciplines.

0451-503: ADVANCED TOPICS IN BOTANY
CR: 2

Detailed study and analysis of aspects of botany beyond those covered in regular classes. Topics vary from term depending on staff member's field of specialization.

0451-526: PHYTOPLANKTON
CR: 3

Diversity of phytoplankton. Physical and chemical environment of phytoplankton. Physical ecology of phytoplankton. Phytoplankton populations. Phytoplankton physiology. Mechanisms of phytoplankton buoyancy. Nutrients uptake and assimilation in phytoplankton. Growth and mortality of phytoplankton.

0451-533: DEVELOPMENTAL GENETICS
CR: 3

Regulation of gene expression in eukaryotes and prokaryotes – Genetic control of development in selected organisms (drosophila, plant and animal examples) – Genetic control of gametogenesis –

Genetic analysis of cell cycle development – Programmed cell death and normal development.

0451- 535: MOLECULAR PLANT BIOLOGY
CR: 3

Structural details of plant genomes such as nuclear. Chloroplast, mitochondria and disposable elements. Plant transformation. The genome of Arabidopsis. The molecular aspects of nitrogen fixation, development of flower and seed, and pest resistance. Application of genetic engineering in plants

0451-537: POLLUTION AND GENOTOXICITY
CR: 3

Changes in eukaryotic gene expression in response to environmental stress. Methodology for detecting mutations and clastogenic effects at the molecular, cellular and entire organism levels. Mutagens in the environment. Genetic risk of atomic energy. Biological indicators of environmental pollution.

0451-543: PLANT BIOTECHNOLOGY
CR: 3

The course emphasizes the use of molecular biology techniques to improve cultivated plants. It will address basic, and applied sciences and also taking into consideration the ethics and values.

0451- 545: ADVANCED PLANT BREEDING
CR: 3

Importance, basics and updated biological concepts of plant breeding science. Essential requirements and tools. Major objectives and examples of classical breeding achievements. Developed molecular approaches and their applications in

modern plant breeding . Emergency of recent topics associated with methodologies, economics, risks and constraints of new breeding strategies.

0451-547: ADVANCED PLANT TAXONOMY
CR: 3

Characters, taxa and species. Taxa and species concepts. The process of classification. Different sources for taxonomic information extracted from cytotaxonomy, chemotaxonomy, immunotaxonomy, and molecular biology. Identification and Classification using molecular methods.

0451-556: ADVANCED PLANT ECOLOGY
CR: 3

Major bio-mass of the world. Plant adaptations to different habitats. Interaction among plants and between plants and their physical environment. Properties of plant populations. Landscape ecology. Factors influencing the structure of plant communities. Ecology of desert ecosystems. Desert of Kuwait, habitat loss, biodiversity and conservation. Soils of Kuwait.

0451-565: STRESS ECOPHYSIOLOGY
CR: 3

Importance, definitions and types of stresses. Plant cell water relations. Regulation of cell growth under stress. Water deficits and the adjustment of photosynthetic carbon metabolism.

Osmoregulation and stress hormones. Molecular bases of tolerance to abiotic stress. Research in stress ecophysiology and its link to modern improvements in physiology research techniques.

0451-571: PLANT GROWTH AND DEVELOPMENT
CR: 3

Physiology of growth and development of the different parts of the plant. The structure and metabolism of plant hormones. Integration of hormone signaling and floral induction.

0451-573: PHOTOBIOLOGY
CR: 3

Study of the interaction of light with plants. Physiology of photobiological processes. Nature of pigments and receptors involved. Environmental factors affecting photosynthesis.

0451-582: PLANT DISEASE MANAGEMENT
CR: 3

Disease management as (a) an integral component of plant production and growth, and (b) a logical integration of pathogen biology with modern management technologies.

2000-597 to 599: THESIS
CR: 9

MASTER OF SCIENCE MICROBIOLOGY

INTRODUCTION

The Department of Biological Sciences (College of Science) offers a Master of Science Program in **Microbiology**. Only full-time students are admitted to this program.

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

The program requirements are:

31 TOTAL COURSE CREDITS

10 COMPULSORY (credits in parenthesis)

0480-385	Statistical methods in Research	(3)
0451-501	Research Techniques	(3)
0451-502	Seminar	(1)
0452-551	Microbial Taxonomy	(3)

12 ELECTIVES* (3 credits each)

0451-574	Enzymology
0452-511	Plant Virology
0452-513	Plant Pathogen Interaction
0452-515	Biology of Actinomycetes
0452-521	Marine Microbiology
0452-523	The Biology of Photosynthetic Bacteria
0452-541	Aspects of Biotechnology
0452-561	Stress Tolerant Micro-organisms
0452-562	Petroleum Microbiology
0452-571	Biology of yeast
0452-581	Advanced Immunology

*The graduate students will be allowed to take 6 credit hour courses from different disciplines of the Department of Biological Sciences. **The student can only take these courses with the approval of the thesis supervisor.**

The graduate students in the Department of Biological Sciences will be allowed to take three credit hour course/s in Medical/Science faculty **with the approval of thesis supervisor.**

9 COMPULSORY

2000-597 to 599 Thesis

COURSE DESCRIPTION

0452-511: PLANT VIROLOGY

CR: 3

Nomenclature and classification; infection process; resistance to infection; effect of virus infection on plants; effects of virus infection on the host metabolism; Virus-vector interaction; composition and structure of virus particles; Ecology of viruses; plant pathogens confused with viruses; sub-viral pathogens; Control of viral diseases; Economically important viral diseases.

0452-513: PLANT PATHOGEN INTERACTION

CR: 3

Lectures are confined to diseases caused by fungi and bacteria and will deal with the following topics.

Concepts and definitions: Plant diseases, pathogens and parasites, pathogenicity and disease reaction types, definitions and problems of terminology; Interaction between pathogens and other organisms: Initial stages of pathogenesis, attraction of pathogens to plant contact and penetration, colonization of host plants; Mechanisms of attack: cell wall degrading enzymes, toxin in plant diseases; Growth regulating substances; Responses of host plants to infection: pathological alterations in structure, function and in host metabolism; Mechanisms of disease resistance: all types of disease resistance will be discussed in this section.

The practical course includes: Inoculation of plants by pathogens, penetration as well as disease development in both a susceptible and a resistant cultivator; Methods of production of enzymes, toxins and growth regulators by different plant pathogens, The chemical analysis and characterization of these factors and their role in disease development. Investigation of disease

resistance using advanced techniques such as electron microscopy, extraction, chromatography etc.

0452-515: BIOLOGY OF ACTINOMYCETES

CR: 3

Isolation from soil by selective media. Cultivation on solid and liquid media. Primary-secondary metabolism, antibiotics. Developmental biology, followed by biochemical and morphological methods. Auto regulatory factors (hormones). Degradation of organic materials - chitin, keratin, organic soil component, mineral oil. Regulating mechanisms. Genetics. Industrial applications.

0452-521: MARINE MICROBIOLOGY

CR: 3

The marine environment. The benthic and planktonic microflora: Sampling, counting and biomass determination; responses to environmental variations, role in oceanic productivity and chemical transformations with reference to fouling problems, symbiotic associations with higher marine organisms, role in and control of pollution. In the practical course the student will be asked to isolate and characterize predominant phytoplankton from the Arabian Gulf. The effect of environmental variables on growth of individual isolates will be investigated.

0452-523: THE BIOLOGY OF PHOTOSYNTHETIC BACTERIA

CR: 3

Classification of cyanobacteria, purple and green bacteria; Cell structure and composition; Oxygenic and anoxygenic photosynthesis; Photosphorylation; Effect of light irradiance and quality on photosynthesis, pigment composition and growth; Carbon metabolism in cyanobacteria and the assimilation of Carbon Heterophic growth and

metabolism in cyanobacteria; Nitrogen fixation: mechanism, regulation of nitrogenase biosynthesis and activity. Hydrogenase-nitrogenase interrelationship; Interaction of cyanobacteria with heterotrophic bacteria.

The practical course includes: Isolation and identification of photosynthetic bacteria. Effect of light on photosystem II, I and NADP photoreduction. Enzyme assays such as glycolate dehydrogenase I oxidase, acetate dehydrogenase, Malate dehydrogenase. Nitrogen fixation experiments using acetylene reduction method.

0452-541: ASPECTS OF BIOTECHNOLOGY
CR: 3

1. Genetic Engineering:

Structure of DNA, topology of DNA, restriction enzymes (enzymes used in bioengineering), plasmids (PBR322, PUC8, PUC9); cloning with Plasmids and M13, cloning strategies, expression of cloned genes, sequencing (chemical & enzymatic); Split genes. The genetic element that control gene expression.

2. Plant Cell Structure

History of the technique; description of the technique: callus cultures, suspension cultures, protoplast cultures, green and photosynthetic cultures; The technique as a tool in basic studies (Cytology and genetics, physiology and biochemistry, genetic engineering); Production of valuable metabolites; Agricultural applications: vegetation propagation, programming, generation of stress-tolerant plants.

In the practical part (open laboratory) each student will be provided with seeds of a particular plant. He/She will be asked to establish callus and suspension cultures for this plant under the supervision of the lecturer.

0452-551: MICROBIAL TAXONOMY
CR: 3

1. Bacteria: (lectures only)

Origin and evolution of prokaryotes: Chemical, biochemical and phylogenetics evolution with reference to paleomicrobiology and origin of eukaryotes; Problems related to bacterial taxonomy: What is a bacterial species? Variability; Approaches to bacterial taxonomy: Classical, numerical, biochemical and genetic taxonomy; Nomenclature and classification of bacteria:

artificial and phylogenetic keys; description of the major bacterial parts as presented in Bergey's Manual. Emphasis on phylogenetic relationships; Problems related to taxonomy of cyanobacteria.

2. Fungi (Theoretical and Practical)

Historical aspects of microbial taxonomy: Fungal taxonomy and its links with botanical nomenclature and its application in fungal systematic; Introduction to international code of binomenclature; Introduction to world herbaria and culture collections: Preservation procedures for dried specimens; herbarium organization, Presentation procedures for living cultures, freeze-drying, liquid nitrogen storage agar slants, under mineral oil. Taxonomy of anamorphic fungi, taxonomy of telomorphic fungi.

This practical session in the taxonomy of fungi will be in the form of open laboratory sessions for identification of taxa using standard and specific keys. An introduction to technology of preservation and maintenance of cultures will be included too.

0452-561: STRESS TOLERANT MICRO-ORGANISMS
CR: 3

Review of the naturally occurring extreme ecological environments and niches which support microbial life; Review of man-made environments and conditions. Influence of industrial activity and pollution on the environment; Taxonomic survey of the stress-tolerant and obligate microbes; relationship with the Archaea, Bacteria and Eukarya and the role of natural selection in determining the composition of populations in the extreme environments; Membrane composition and function; Proteins and ribosomes; Stress induced biochemical activity in tolerant and obligate organisms; Interactions of microbes with unconventional or complex nutrient sources; hydrocarbons and heavy metals.

0452-562: PETROLEUM MICROBIOLOGY
CR: 3

Introduction: Microorganisms in genesis of petroleum, application of microorganisms in petroleum prospecting, Introductory petroleum chemistry; Microbially enhanced oil recovery. Microorganisms in deterioration of crude oil production systems, Microorganisms in oil reservoirs; anaerobic corrosion in petroleum

systems; Remediation: preventive and combative measures against microbial deterioration of crude oil systems, Petroleum pollution and role of microorganisms in remediation. Lab: classes will be in the form of mini projects to cover topics in petroleum microbiology.

0452-571: BIOLOGY OF YEAST

CR: 3

The practicals will be in the form of open laboratory and will cover the topics raised in the lectures. The lectures cover: isolation and identification of yeasts; physiology and growth; sugar transport, proteinase production, Polarographic measurements of oxygen uptake; influence of fundamental characteristics of yeast: growth form, ultra structure, taxonomy; biochemistry of yeast: Structure and composition of yeast cell membranes and walls, intermediary metabolism, bioenergetics, Biosynthesis and degradation of molecules; Formal genetics: yeast life cycle, mating type, mapping chromosomes, mating type switching, recombination and gene mapping; Molecular biology & genetics: Yeast plasmids - 2um and related ones. Killer plasmids in *Saccharomyces* & other yeast using autonomously replicating or integrating vectors. Expression of

cloned genes. Protoplast formation, regeneration & fusion; Yeast biotechnology; Pathogenic yeast; Food spoilage. antifungal; protoplast preparation; isolation of petite mutants; adhesion of yeast to host tissues.

0452-581: ADVANCED IMMUNOLOGY

CR: 3

Basic concepts. Innate immune mechanisms to infection: Cellular mechanisms Humoral mechanisms. Acquired cell-mediated immune mechanisms to intracellular infections: The cytotoxic T lymphocyte population (CTL), The helper T lymphocyte population (TH). Acquired humoral immune mechanisms to extracellular infections. Molecular aspects of immune recognition and regulation. Immune mechanisms to viral-induced tumors. Failures of immune mechanisms to infection: Envasive strategies employed by infectious pathogens, Acquired immune deficiency syndrome (AIDS). Manipulation of the immune response to fight infection.

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE GEOLOGY

INTRODUCTION

The Department of Earth and Environmental Sciences (College of Science) offers a Master of Science program in **Geology**. Both part-time and full-time students are admitted to this program. The program is designed to gain expertise in specialized fields in geology and to prepare graduates for further academic study or career development. Faculty research covers a wide range of fields in Geology and Geophysics with particular reference to environmental aspects.

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

The program requirements are:

30 TOTAL COURSE CREDITS

10 COMPULSORY (credits in parenthesis)

0460-503	Geology of the Arabian Gulf	(2)
0460-504	Interpretation of Geological Maps	(1)
0460-508	Computer Studies and Data Analysis in Geology	(3)
0460-509	Analytical Techniques	(2)
0460-590	Graduate Seminar	(2)

11 ELECTIVES* (credits in parenthesis)

0460-502	Graduate Field Studies	(2)
0460-506	Advanced Petrographic techniques	(2)
0460-511	Igneous Petrology	(3)
0460-515	Metalliferous Deposits	(3)
0460-521	Metamorphic Petrology	(3)
0460-525	Nonmetalliferous Deposits	(3)
0460-531	Micropaleontology	(3)
0460-533	Concepts in Paleontology	(3)
0460-535	Carbonate Sediments and Evaporates	(3)
0460-537	Clastic Sediments	(3)
0460-539	Advanced Stratigraphy	(3)
0460-541	Advanced Marine Geology	(3)
0460-553	Hydrogeology	(3)
0460-554	Structural Geology	(3)

0460-555	Geomorphology	(3)
0460-556	Petroleum Exploration Methods	(3)
0460-558	Seismic Stratigraphy	(1)
0460-559	Engineering Geology	(3)
0460-560	Advanced Mineralogy	(3)
0460-561	Remote Sensing	(3)
0460-562	Environmental Geology	(3)
0460-563	Geophysics	(3)
0460-564	Geographic Information System (GIS)	(3)
0460-565	Advanced Seismology	(3)
0460-566	Advanced Geophysics for Engineers	(3)

*Students may substitute up to 6 credit hours from the upper undergraduate elective courses in Geology (400-level) with the approval of the Program Committee.

9 COMPULSORY

2000-597 to 599 Thesis (Thesis Option Only)

COURSE DESCRIPTION

0460-502: GRADUATE FIELD STUDIES
CR: 2

The course involves field investigation and writing a report on the geology of an area outside Kuwait. New areas may be selected every year. Emphasis will be on synthesis of the geology of an area or a region.

0460-503: GEOLOGY OF THE ARABIAN GULF
CR: 2

General survey of the Gulf. Topography, Geomorphology settings and provinces. Lithological sequences of the Precambrian and Phanerozoic sedimentary and volcanic rocks. Generalizations of intrusive rocks. Geochronology and tectonic evolution since the Proterozoic. Deformation episodes. Recent sedimentary basins. Mineral deposits and metallogenesis.

0460-504: INTERPRETATION OF GEOLOGICAL MAPS
CR: 1

Types of information recorded on geological maps. Interpretation of standard geological maps in terms of lithology, stratigraphy, structure, tectonic

setting, geomorphology, economic geology and geological history. Examples of more special maps

(e.g. structural, geophysical, geochemical) and their interpretation.

0460-506: ADVANCED PETROGRAPHIC TECHNIQUES
CR: 2

This integrative study of igneous, metamorphic and sedimentary rocks mainly uses transmitted light microscopes, but includes some applications of reflected light optics. The emphasis is on the description and interpretation of textural features but also includes some identificatory methods. The course is almost entirely practical.

0460-508: COMPUTER STUDIES AND DATA ANALYSIS IN GEOLOGY
CR: 3

A survey of the most commonly used statistical and numerical analytical methods in geology with computer applications using software packages such as STATGRAF, MATHCAD and ROCKWARE. It is intended to teach data summarization, analysis and pattern recognition

techniques as a research tool for geologists, rather than a rigorous mathematical treatment.

0460-509: ANALYTICAL TECHNIQUES

CR: 2

Characterization of geological materials using modern and state-of-the-art techniques. The course is divided into three categories and students should select two categories that are relevant to their field of specialization. The categories are: Geophysical methods, Geochemical methods, and Image analysis and GIS.

0460-511: IGNEOUS PETROLOGY

CR: 3

Occurrence, origin and crystallization of igneous rocks and interpretation of their composition, texture, and spatial distribution. Processes of formation in relation to field and experimental data (with special emphasis on interpretation of phase diagrams). Theory and experimental evidence for equilibrium. Physiochemical state of liquid-solid interactions in silicate melts. Medium of emplacement and structural setting. Laboratory investigation of selected rock suites.

0460-515: METALLIFEROUS DEPOSITS

CR: 3

Geologic characteristics, distribution and classification of metallic deposits and their economic features. Magmatic, metamorphic and hydrothermal processes leading to concentrations of the principal metals, including emplacement and wall rock alteration. Type of mineralization and genesis. exploration methods. Laboratory use of reflected and transmitted light microscopy and study of suites from known districts.

0460-521: METAMORPHIC PETROLOGY

CR: 3

Occurrence, characteristics and origin of metamorphic rocks. Role of fluid phases during re crystallization. Interpretation of mineral assemblages and textures in terms of T, P and chemical potential (e.g. graphic analysis, reaction sequence, Gibbs-free energy). Petrogenesis of mineral assemblages, and the metamorphic facies concept. Tectonic setting of metamorphism and associated structural deformation. Laboratory investigation of selected rock suites.

0460-525: NONMETALLIFEROUS DEPOSITS

CR: 3

Origin, distribution and classification of nonmetallic deposits of industrial minerals and rocks (including coal). Emphasis on surface and sedimentary mechanisms such as alluvial, weathering and secondary enrichment processes. Methods of exploration and economic characteristics. Laboratory work involves study of groups of non-metallic minerals.

0460-531: MICROPALaeONTOLOGY

CR: 3

Importance and applications of microfossils in biostratigraphy, paleoecology and paleoclimatology and their role in solving geological problems. Review of the different groups of microfossils, with emphasis on their ecology, stratigraphic value, evolution and hard-part morphology and its relationships to environment. Laboratory and workshop methods for studying microfossils, and development of these methods.

0460-533: CONCEPTS IN PALEONTOLOGY

CR: 3

A seminar series of lectures and discussions on the development of the science of paleontology. Preservation and the fossil record. Species and population concept. Community concept, its reality, recognition and provinces. Ontogenetic variation, evolution, extinction, origin of life, and life in the Precambrian. Paleontology in relation to biostratigraphy, paleoecology, evolution, paleoclimatology and biostratigraphy.

0460-535: CARBONATE SEDIMENTS AND EVAPORATES

CR: 3

Skeletal and non-skeletal components of carbonate sediments and their mineralogical stability in marine environments. Recognition of suitable marine environments for formation of the major carbonate particles type (e.g. oolites, pisolites, stromatolites, peloids, grapestones and micrites). Diagenetic alteration by heat and pressure. Factors controlling deposition and formation of Recent dolomite. Element distribution in carbonates and its relationships to activity of organisms. Carbonate cements. Sabkhas and evaporate

generation. Thermodynamic treatment of the carbonate and evaporite systems. Techniques used in carbonate and evaporite mineralogy (e.g. petrographic, staining, XRD and SEM, AA).

0460-537: CLASTIC SEDIMENTS

CR: 3

Mineralogy of clastic rocks. Petrographic examination of sandstones and arenites and its implication to paleogeography and depositional tectonic environments. Argillitic sediments and methods used for their analysis. Processes and characteristics of different sedimentary regimes and interrelationships among fluvial, deltaic, strand plain, lagoon, tidal flat, shelf and slope depositional environments. Application of the principles of facies analysis. Brief treatment of the tectonic framework of clastic sedimentation.

0460-539: ADVANCED STRATIGRAPHY

CR: 3

Scope of stratigraphy. Analysis and classification of sedimentary basins (architecture, geometry and tectonic evolution). Basis of well-log analysis. Advanced methods in stratigraphic analysis with particular emphasis on statistical methods (cluster and trendsurface analysis and other multivariate techniques). Magnetic and seismic stratigraphy. Data collection, reduction and interpretation. Case studies from Kuwait and the Arabian Gulf Region.

0460-541: ADVANCED MARINE GEOLOGY

CR: 3

A comprehensive treatment of the origin and development of major structural features of the ocean basins and continental margins. Methods used in data acquisition and interpretation of sedimentary and volcanic processes on the ocean bottom. Structure, stratigraphy and composition of the ocean floor as revealed by geophysical techniques. Study of geologic time by review of case studies from the Mesozoic and Cenozoic geologic record. Introduction to basic shipboard techniques used by geologic, physical, chemical and biological oceanographers.

0460-553: HYDROGEOLOGY

CR: 3

Aspects of the systems approach to hydrology. Ground water movement, well hydraulics, aquifer

and well tests. Saline water encroachment. Water chemistry. Groundwater exploration. Hydrological data presentation. Model studies and numerical analysis of groundwater. Basin-wide groundwater development. Basic patterns of water resources management.

0460-554: STRUCTURAL GEOLOGY

CR: 3 PR: 0460-504

Stress and Strain. Ductile deformation processes. Brittle failure of rocks. Folds and their associated foliations and lineations. Normal and growth faults. Continental rifts: detachment and planar fault models, half grabens and transfer zones. Thrust faults: ramps, thrust duplexes, thrust-related folds. Wrenching: parallel, divergent, and convergent wrenching; wrenching mechanisms; 2nd order wrench structures, pull-apart and push-up structures; flower structures. Determining stress orientations using meso-and macrostructures. Diapiric structures and salt tectonics.

0460-555: GEOMORPHOLOGY

CR: 3

Advanced treatment of processes producing landforms. An emphasis will be on fundamental mathematical and dynamic approaches in solving problems in fluvial processes. Aspects of coastal morphology. Applications are designed to stimulate the student's understanding of local problems directly linked to desertification and coastal development.

0460-556: PETROLEUM EXPLORATION METHODS

CR: 3

Review of origin. Migration and accumulation of petroleum Geochemical methods in oil discovery, well logs and formation evaluation, dip meter logs, geophysical prospection, seismic stratigraphy. Basin evaluation.

0460-558: SEISMIC STRATIGRAPHY

CR: 1

Review of the principles of seismic exploration procedures. Relation of seismic reflections to significant geological features; seismic facies; stratigraphic interpretation of seismic facies; recognition of unconformities; qualitative and quantitative seismic correlation.

0460-559: ENGINEERING GEOLOGY

CR: 3

Surface processes. Mechanical properties of soils and rocks. Engineering classification of rocks. Data collection and presentation; field methods and laboratory methods. Engineering geological maps. Applications to foundations, dams, tunnels, highway and coastal constructions. earthquake risk and land slides. Case studies.

460-560: ADVANCED MINERALOGY

CR: 3

This course is an introduction to mineralogical techniques and interpretation of mineralogical determinations. Methods employed include X-rays (power and single-crystal methods), optical measurements, and DTA. Mineral groups are selected for study as being appropriate to the fields of specialisation of the students. The course is largely practical and a large part of the assessment is based upon individual practical work.

0460-561: REMOTE SENSING

CR: 3

Electromagnetic radiation and its interaction with earth surface features. current land observation satellites and remote sensing systems. Multispectral, hyperspectral, thermal and microwave scanning. Data acquisition, correcting, registration and display. Problems of scale, resolution and accuracy in assessment. Current applications in natural resource and hazard mapping.

0460-562: ENVIRONMENTAL GEOLOGY

CR: 3

Interaction between geological processes and natural/human environment. resource (soil, water, mineral) depletion, pollution, conservation and sustainability. Hazard (seismic, land-slide/subsidence, volcanic, coastal) assessment, prediction and mitigation. Modern methods (GIS, Remote Sensing, Geo-statistics) of data integration, environmental mapping and land-use planning.

0460-563: GEOPHYSICS

CR: 3

Origin of the solar system. Earth's internal structure and gravity field, the concept of isostasy.

Geomagnetism, palaeomagnetism and continental drift; marine magnetic anomalies and sea-floor spreading. Earthquake seismology, the propagation of seismic waves; crystal structure, earthquake source mechanisms. Continental and oceanic heat flow; cooling of the lithosphere. Global geophysics from space.

0460-564: GEOGRAPHIC INFORMATION SYSTEM (GIS)

CR: 3

Components of Geographic Information Systems and basic requirements. Spatial data models, structures and axioms. Database structures and storage. Spatial data input, verification and output. Data interpolation and surface mapping. analysis of continuous fields using filters, derivatives, clumping. Data error analysis and quality control. Current applications, issues and trends in GIS.

0460-565: ADVANCED SEISMOLOGY

CR: 3

An advanced study to the nature of earthquake motion, seismograph theory, seismic waves at different distances. Locating earthquakes, foreshocks and aftershocks and earthquake swarms, geography and distribution of shallow and deep focus earthquake with tectonic associations. Reservoir-induced earthquakes. Intensity of earthquake effects, isoseismal curves and accelerations. source mechanism estimation. Earthquake risk and protective measure. seismicity of the Arabian plate with emphasis on Kuwait.

0460-566: ADVANCED GEOPHYSICS FOR ENGINEERING

CR: 3

Advanced studies on the theory and practice of geophysical methods in exploration for energy, minerals, groundwater and engineering applications. These will include seismic reflections, seismic refraction, electrical, electromagnetic, gravity and radio-metric methods of exploration, including the planning and conduct of field surveys for general and particular applications, and the theory and practice of the data processing and interpretation of geophysical results in terms of geological problems, conditions and occurrences.

0460-590: GRADUATE SEMINAR

CR: 2 PR: Consent of

Instructor & Graduate Committee

Student selects a topic not related to his thesis thoroughly researches the subject, writes a detailed

paper, and presents a seminar on the subject. All faculty members will participate in evaluating the seminar.

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE BIOCHEMISTRY

INTRODUCTION

The Department of Biological Sciences (College of Science) offers a Master of Science program in **Biochemistry**. Full and Part-time Students are admitted to this program. Research requirements include either thesis or non-thesis options. The program is designed to allow students to expand their general exposure to Biochemistry and to deepen their expertise in a particular area of Biochemistry together with other fields of sciences related to it. With these objectives in mind, students enroll in both general and specialized courses in Biochemistry. Research for the M.Sc. degree is possible in any of the areas in which graduate faculty members have active research programs. These include the Biochemistry of Nucleic Acids, Marine Biochemistry, Natural Products Chemistry, Nutritional Biochemistry, Lipid Biochemistry, Trace Metal Metabolism, and Protein Structure Determination, Cancer research and medical biochemistry.

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

The program requirements are (non-thesis option in parenthesis):

30 (33) TOTAL COURSE CREDITS

7 (10) COMPULSORY (credits in parenthesis)

0470-511	Advanced Biochemistry I	(3)
0470-532	Advanced Biochemistry II	(3)
0470-554	Seminar	(1)
0470-593	Project (for non-thesis option only)	(3)

4-6 PRACTICAL ELECTIVE COURSES (2 credits each)

0470-521	Modern Techniques I
0470-522	Modern Techniques II
0470-523	Modern Techniques III

8-10 (17-19) ELECTIVES* (credits in parenthesis)

0470-542	Natural Products	(2)
0470-543	Nutrition	(2)

0470-544	Proteins/Peptides	(2)
0470-545	Clinical Biochemistry	(2)
0470-546	Enzymes	(2)
0470-547	Molecular Biology	(2)
0470-549	Photosynthesis	(2)
0470-550	Mycotoxins in Environment and Cancer	(2)
0470-552	Biochemical Pharmacology	(2)
0470-553	Biochemical Endocrinology	(2)
0470-555	Environmental Science	(2)
0470-556	Radiation Biochemistry	(2)
0480-385	Statistical Methods in Research	(3)

*The graduate students will be allowed to take 6 credit hour courses from different disciplines of the Department of Biological Sciences. **The student can only take these courses with the approval of the thesis supervisor.**

In addition to the (6) credit hour courses the graduate students in the Department of Biological Sciences will be allowed to take three credit hour course/s in Medical/Science faculty **with the approval of thesis supervisor.**

9 COMPULSORY

2000-597 to 599 Thesis (Thesis Option Only)

COURSE DESCRIPTION

0470-511: ADVANCED BIOCHEMISTRY I

CR: 3 PR:0470-472

Bioenergetics; role and control of macromolecular structures in biological system.

0470-521: MODERN TECHNIQUES I

CR: 2 PR:0470-332 & 0470 - 472

Spectrophotometry: Spectroscopic study as applied to the elucidation of molecular structures is given in detail. A comprehensive theoretical description of infrared, mass spectrometry and proton/carbon NMR is introduced. This is followed by interpretation of actual spectra of known compounds. A number of problems are dealt with to enable the students to deal with spectral data of unknown compounds.

0470-522: MODERN TECHNIQUES II

CR: 2 PR:0470-521

Separation methods: Separation techniques such as various analytical and preparative chromatographic

methods, size exclusion chromatography, gas chromatography, high performance liquid chromatography, gas filtration. Theoretical description of these separation methods is followed by a practical demonstration of the respective techniques in the isolation of various types of molecules.

0470-523: MODERN TECHNIQUES III

CR: 2 PR:0470-521

Radioisotopic methods: The course deals with the use and possible application of isotopes in biology: (a) and their use to study the fate of a given compound in an organism or biological process; (b) as internal standards for measuring the efficiency of extraction of compounds from biological material and (c) in the determination of extremely low amounts of biologically important compounds by radioimmunological assay. A number of problems are dealt with, to show how to calculate

the decay rates, carrier dilution double label analyses and biological half life.

0470-532: ADVANCED BIOCHEMISTRY II
CR: 3 PR:0470-511

Biochemistry of cellular organelles; regulation of metabolism under different physiological conditions and in specific tissues.

0470-542: NATURAL PRODUCTS
CR: 2 PR:0470-367

Biosynthetic pathways of secondary metabolites elaborated by microbes and higher plants. A detailed discussion of major biosynthetic pathways such as acetate/malonate, shikimate and isopropanoid pathways is introduced. Biosynthesis, biological activity and ecological significance of various classes of natural products are given. Most of these classes of secondary metabolites are considered according to the basic 'building blocks' from which they are derived.

0470-543: NUTRITION
CR: 2 PR:0470-464

Recent advances in the mode of action of vitamins and minerals; nutritional requirements of various developmental stages; in normal and abnormal conditions; nutritional interaction with food toxicants and environmental contaminants.

0470-544: PROTEINS/PEPTIDES
CR: 2 PR:0470-413

Amino acids and their metabolic and structural relationships. Peptide specificities, protein structure, protein function, protein's structure-function relationships. Biochemical basis of proteins as catalysts. Activation and inhibition of enzymes. Proteins as control of metabolism. Examples of conjugated proteins, nucleoproteins, membrane proteins and fibrous proteins.

0470-545: CLINICAL BIOCHEMISTRY
CR: 2 PR:0470-422

Disturbances in metabolism, endocrine glands, blood coagulation, and immune response. The clinical significance of these disturbances, and the chemical tests for diagnosis.

0470-546: ENZYMES
CR: 2 PR:0470-332

Mechanism of action and catalysis of some enzymes. Kinetics of unireactant and bireactant systems.

0470-547: MOLECULAR BIOLOGY
CR: 2 PR:0470-472

Current state of knowledge of the rapidly expanding science of genetic engineering.

0470-549: PHOTOSYNTHESIS
CR: 2 PR: Approval of the Department

Introduction to the photosynthetic process, light as the driving force of photosynthesis, light harvesting and energy capture in photosynthesis, architecture of the photosynthetic apparatus, electron and proton transport, synthesis of ATP: photophosphorylation and chemistry of photosynthesis.

0470-550: MYCOTOXINS IN ENVIRONMENT AND CANCER
CR: 2

Biochemistry of microorganism together with biosynthesis and biochemical effects on living systems. Methods of control, decontamination and analysis in agricultural and animal products are discussed. Environmental aspects and toxicology of cancerous mycotoxins .

0470-552: BIOCHEMICAL PHARMACOLOGY
CR: 2 PR: Approval of the Department

Introduction to pharmacology. Clinical use of drugs, mechanisms of drug action, administration and absorption of drugs, distribution of drugs to tissues, quantitative aspects of drug action, termination of drug action, drug metabolism, drug toxicity, aspects of drug abuse and dependence, development and evaluation of new drugs.

0470-553: BIOCHEMICAL ENDOCRINOLOGY
CR: 2 PR: Approval of the Department

Mechanisms of hormone secretion, action and response, prostaglandins and cyclic nucleotides, hormones and the brain, interaction of the

hypothalamus and pituitary glands in hormonal regulation, coordinated control of fuel metabolism by hormones, steroid hormones, other hormones and their effects.

0470-555: ENVIRONMENTAL SCIENCE
CR: 2

Basic principles of ecology as the foundation upon which all environmental problem-solving is based. Another purpose is to illuminate the world's most important environmental problems and to describe the pros and cons of possible solution to these problems.

0470-556: RADIATION BIOCHEMISTRY
CR: 2

Late effects of ionizing radiation in organized living systems, in general and the human beings in particular.

0470-554: SEMINAR

CR: 1 PR:0470-511

The student presents a review of an advanced topic in biochemistry to the department, after detailed library search.

0470-593: PROJECT

CR: 3

2000-597 to 599: THESIS

CR: 9

MASTER OF SCIENCE STATISTICS & OPERATIONS RESEARCH

INTRODUCTION

The Department of Statistics and Operations Research (College of Science) offers a Master of Science program in **Statistics and Operations Research**. Both part-time and full-time students are admitted to this program. Research requirements include both thesis and non-thesis options. Current research interests of the faculty include: Non-Parametric Statistics, Linear Models, Stochastic Processes, Probability Theory, Distribution Theory, Multivariate analysis, Demography, Quality Control, Sampling, Simulation, Queuing Theory, Inventory Models, and Mathematical Programming.

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

The program requirements are (non-thesis option in parenthesis):

31 (34) TOTAL COURSE CREDITS

1 SEMINAR (1 credit each)

- 0480-509 Seminar in Probability Theory
- 0480-529 Seminar in Statistics
- 0480-569 Seminar in Operations Research

9 (12) COMPULSORY (3 credits each)

- 0480-501 Probability Theory
- 0480-502 Theory of Statistics I
- 0480-550 Stochastic Processes
- 0480-593 Project (non-thesis option only).

6(12) ELECTIVES (3 credits each)

- 0480-503 Theory of Statistics II
- 0480-504 Multivariate Statistical Analysis
- 0480-505 Mathematical Statistics
- 0480-506 Topics in Probability Theory and Stochastic Processes
- 0480-510 Non-Parametric Statistics

- 0480-511 Bayesian Analysis
- 0480-512 Statistical Theory of Reliability
- 0480-513 Topics in Statistics
- 0480-520 Applied Statistics
- 0480-521 Time Series Analysis
- 0480-522 Linear Statistical Models I
- 0480-523 Linear Statistical Models II
- 0480-551 General Systems Theory
- 0480-552 Optimization of Continuous System
- 0480-553 Optimization of Discrete Systems
- 0480-554 Queues and Inventories
- 0480-560 Modeling of Systems
- 0480-561 Operations Research in Public Sectors
- 0480-562 Operations Research Project
- 0480-563 Simulation
- 0480-564 Dynamic Programming
- 0480-565 Topics in Operations Research

- 6 (9)** The remaining credit hours may be elected from any 500 level graduate courses offered by the Department of Statistics and Operations Research or the Department of Mathematics. Students may also substitute up to 6 credit hours from the elective undergraduate statistics or mathematics courses (400-level) with the approval of the Program Committee.

9 COMPULSORY

2000-597 to 599 Thesis (Thesis Option Only)

COURSE DESCRIPTION

0480-501: PROBABILITY THEORY

CR: 3

{Pre 1989/1990 was offered as 0410-540}

Measure-theoretic probability, random variables, univariate and multivariate distribution functions, expectation, characteristic functions, independence, the zero-one-law, the continuity theorem, modes of convergence. Sums of independent random variables, laws of large numbers, central limit theorems, conditional expectation.

0480-502: THEORY OF STATISTICS I

CR: 3 PR: 0480-501

{Pre 1989/1990 was offered as 0410-541}

Criteria and methods of estimation: minimum variance unbiased estimators, properties. General

Procedures: Bayes estimation, minimax estimation, fiducial probability, principle of invariance estimation of parameters, maximum likelihood estimators, method of scoring, hypotheses testing, non parametric estimation.

0480-503: THEORY OF STATISTICS II

CR: 3 PR: 0480-502

{Pre 1989/1990 was offered as 0410-542}

Asymptotic theory, Cramer-Rao type inequalities, asymptotic properties of maximum likelihood estimate, sequential analysis, estimation and hypothesis testing, decision theory and problem of identification.

0480-504: MULTIVARIATE STATISTICAL ANALYSIS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-543}

The multivariate normal, inferences about mean and covarianced matrix, Wishart distribution, Hotelling T-square, multivariate analysis of variance, classification techniques, principal components, factor analysis.

0480-505: MATHEMATICAL STATISTICS

CR: 3 PR: 0480-502

{Pre 1989/1990 was offered as 0410-545}

General decision problem, concepts of loss, risk and utility, minimax and Bayes procedures, invariance principle, monotone likelihood ratios and exponential families, optimality properties.

0480-506: TOPICS IN PROBABILITY THEORY AND STOCHASTIC PROCESSES

CR: 3

{Pre 1989/1990 was offered as 0410-556}

Special topics not covered in other courses.

May be repeated for credit under different subtitles.

0480-509: SEMINAR IN PROBABILITY THEORY

CR: 1

{Pre 1989/1990 was offered as 0410-559}

0480-510: NON-PARAMETRIC STATISTICS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-547}

Order statistics, tests based on runs, goodness of fit tests, the signed test and signed rank test, the general two sample problem, linear rank statistics and the general two sample problem, linear rank tests for the location and scale parameters.

0480-511: BAYESIAN ANALYSIS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-551}

Theories of probability: comparative, subjective, frequentist and quantitative probability. Decision theory: loss, utility and decision functions, no data problems. Distributions: prior, likelihood, posterior, fiducial and predictive. Methods of constructing prior distributions: personal, non-informative, Jeffry's prior, conjugate prior and maximum posterior distributions. Bayesian-statistical inference: point and interval estimation, testing, non-parametric procedures and analysis of contingency tables. Robustness of Bayes methods.

0480-512: STATISTICAL THEORY OF RELIABILITY

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-552}

Structural properties of coherent Systems. Reliability of coherent systems. Parametric families of distributions of direct importance in reliability theory. Classes of life distributions based on notions of aging. Concepts helpful in the study of maintenance policies. Implementing coherent structure theory for complex systems.

0480-513: TOPICS IN STATISTICS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-557}

Special topics not covered in other courses.

May be repeated for credit under different subtitles.

0480-520: APPLIED STATISTICS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-546}

Planning collection of data, sample selection, estimation in sample surveys, balance of cost and error, orthogonal and non-orthogonal designs, factor experiments in both complete and incomplete replicates, groups of experiments.

0480-521: TIME SERIES ANALYSIS

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-548}

Stationary and non-stationary models, auto-covariance and auto correlation functions, spectral density, linear models, identification, estimation and forecasting, estimation of spectral densities, analysis of time series data.

0480-522: LINEAR STATISTICAL MODELS I

CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-549}

Distribution of quadratic forms, non-central t, chi-square, non-normal cases, regression models, polynomial and trigonometric models.

0480-523: LINEAR STATISTICAL MODELS II

CR: 3PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-550}

Experimental design models, one-factor and two-factors, incomplete block models and tests for interaction, components-of-variance models.

0480-529: SEMINAR IN STATISTICS
CR: 1

{Pre 1989/1990 was offered as 0410-558}

0480-550: STOCHASTIC PROCESSES
CR: 3 PR: Consent of the Department
{Pre 1989/1990 was offered as 0410-544}

Markov chains, random walk, run problems, birth and death processes, Processes with independent increments, Poisson and Gaussian Processes, applications, models in science, engineering and social sciences.

0480-551: GENERAL SYSTEMS THEORY
CR: 3

{Pre 1989/1990 was offered as 0410-584}

Definition and classification of systems, goal seeking behaviour and memory characteristics of systems, methods of systems description, interdependence analysis, entropic content of systems and the law of requisite variety and systems design and analysis.

0480-552: OPTIMIZATION OF CONTINUOUS SYSTEMS
CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-586}

The optimization problem, the simplex method for linearizable models, duality in optimization, quadratic and convex mathematical programming, dynamic linear models, Markovian decision processes.

0480-553: OPTIMIZATION OF DISCRETE SYSTEMS
CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-587}

Integer programming and combinatorial models, network models, dynamic programming and sequential analysis.

0480-554: QUEUES AND INVENTORIES
CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-588}

Persuasiveness of waiting lines and inventories, structure and analysis of queues and inventories, optimal control of waiting lines and inventories.

0480-560: MODELING OF SYSTEMS
CR: 3 PR: Consent of the Department

{Pre 1989/1990 was offered as 0410-585}

The need for and pitfalls of modeling, the decision-making context, responsibility for and objectives of decisions, structure and analysis of decisions, modeling of decision-making situations, non-linear

dynamic stochastic models and their approximation, problems of model validation.

0480-561: OPERATIONS RESEARCH IN PUBLIC SECTORS
CR: 3

{Pre 1989/1990 was offered as 0410-589}

Modeling the operations of public sectors and the problem of measures of performance, control, and implementations, paradigm examples from health-care, education, and municipalities.

0480-562: OPERATIONS RESEARCH PROJECT
CR: 3

{Pre 1989/1990 was offered as 0410-590}

Phases of the operations research study. The student with the instructor identify a real-life significant problem and conduct on it a full operations research study.

0480-563: SIMULATION
CR: 3

{Pre 1989/1990 was offered as 0410-591}

The need for computer simulation of processes, building a simulation model generating phenomena, design of simulation experiments, application of simulation, computer languages.

0480-564: DYNAMIC PROGRAMMING
CR: 3

{Pre 1989/1990 was offered as 0410-594}

Deterministic and stochastic dynamic programming: Theory and applications. Dynamic programming algorithm. Optimal route problem. Optimal discounting and nondiscounting over time with single and multi-period decision epochs. Linear programming formulations. Stochastic scheduling. Bandit processes. Network flow. Markov decision processes.

0480-565: TOPICS IN OPERATIONS RESEARCH
CR: 3

{Pre 1989/1990 was offered as 0410-596}

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

0480-569: SEMINAR IN OPERATIONS RESEARCH
CR: 1

{Pre 1989/1990 was offered as 0410-595}

0480-593: PROJECT
CR: 3

2000-597 to 599: THESIS
CR: 9

