

Faculty of

Science

Faculty of Science

Departments

Mathematics and Computer Science

Physics

Chemistry

Biological and Environmental Science

History

The Faculty of Science was established in 1976 with the department of Physics. It underwent a rapid expansion to include the departments of Mathematics, Chemistry and Biology and Environmental Science in 1978, 1988 and 1998 respectively. The postgraduate program was initiated in 1999 to respond to the marketplace growing demand for higher education, and grew from an initial number of 40 students to over 100 Master Degrees awarded up to date. Today, more than 350 students are registered in the Masters and PhD programs, conducting research projects in molecular biology, genetics, medicinal chemistry and bioremediation, group representation, solving optimal control problems using numerical optimization techniques, analytical chemistry, physical chemistry, organic and inorganic chemistry, in addition to molecular physics, radiation physics and semiconductor physics.

In 2005, the Faculty joined international institutions of higher education by adopting the Credit Hour System to simplify and advance its education scheme. Today, the Faculty continues to reinvent itself, modernizing its undergraduate and graduate programs to keep pace with the evolving technologies and emerging scientific disciplines, preparing its students for the challenges of the 21st Century.

Vision

To be recognized in the national and international scientific communities for science education, innovation and technology. To foster an environment of intellectual freedom as well as excellence in educational programs and scientific research.

Mission

The Faculty of Science is committed to sustain excellence in the creation and dissemination of knowledge by teaching, research, and scholarly publication in both basic and applied sciences. The centrality of the Faculty within the University will be strengthened by excellence of our academic programs, as well as by our strategic collaborations with all faculties across the University.

Postgraduate Programs

Offered Degrees

The Faculty of Science offers a diploma in Nuclear Physics and Radiation Protection. MSc & PhD Degrees are offered in the following specializations:

Pure Mathematics

Applied Mathematics

Computer Science

Information Technology

Physics

Chemistry

Biology

Biochemistry

Environmental Science

Postgraduate Programs

Diploma

The Diploma Degree in Radiation Protection requires the completion of 30 credit hours divided as follows:

Mandatory Courses - 24 Cr.

Practical Training - 6 Cr.

MSc Degrees

The MSc Degree requirements in all specializations consist of 36 credit hours divided (in accordance to the field of specialization) as follows:

Mandatory Courses - 18 - 24 Cr.

Elective Courses - 6 - 12 Cr.

Thesis - 6 Cr.

PhD Degrees

The PhD Degree requirements in all specializations consist of 40 credit hours divided as follows:

Courses - 18 Cr. (Mandatory and / or Elective courses depending on field of specialization)

Thesis - 22 Cr.

Department of Mathematics & Computer Science

MSc & PhD Degrees Curricula

MSc Degree in Pure Mathematics (36 credit hours)

First Semester Cr.

MATH	601	Topics in Abstract Algebra I	3
MATH	643	Algebraic Topology	3
GNSC	601	Technical Writing & Research Skills	3
		Elective (Dept)*	6
			15

Second Semester Cr.

MATH	602	Advanced Topics in Analysis	3
MATH	604	Advanced Number Theory	3
MATH	606	Research Project in Pure Mathematics	3
		Elective (Dept)*	6
			15
MATH	699	Thesis	6

*A total of 12 credits are selected from courses offered by the department (3 Cr. each).

MSc Degree in Applied Mathematics (36 credit hours)

First Semester Cr.

MATH	605	Advanced Boundary Value Problems	3
MATH	609	Advanced Fluid Dynamics	3
GNSC	601	Technical Writing & Research Skills	3
		Elective (Dept)*	6
			15

Second Semester Cr.

MATH	652	Finite Element Methods	3
MATH	614	Advanced Topics in Applied Mathematics	3
MATH	654	Research Project in Applied Mathematics	3
		Elective (Dept)*	6
			15
MATH	699	Thesis	6

*A total of 12 credits are selected from courses offered by the department (3 Cr. each).

PhD Degree in Pure / Applied Mathematics (40 credit hours)

			Cr.
Mandatory / Elective Courses			18
MATH	799	Thesis	22

MSc Degree in Computer Science (36 credit hours)**First Semester** **Cr.**

CMPS	601	Advanced Computer Graphics	3
CMPS	603	Advanced Database Management Systems	3
GNSC	601	Technical Writing & Research Skills	3
		Elective (Dept)*	6
			15

Second Semester **Cr.**

CMPS	602	Building AI Systems	3
CMPS	604	Data Warehousing & Data Mining	3
CMPS	608	Research Project in Computer Science	3
		Elective (Dept)*	6
			15
CMPS	699	Thesis	6

*A total of 12 credits are selected from courses offered by the department (3 Cr. each).

PhD Degree in Computer Science (40 credit hours)

			Cr.
Mandatory / Elective Courses			18
CMPS	799	Thesis	22

MSc Degree in Information Technology (36 credit hours)

First Semester **Cr.**

ITEC	601	Project Planning & Feasibility Analysis	3
ITEC	603	Forecasting Methods & Applications	3
GNSC	601	Technical Writing & Research Skills	3
		Elective (Dept)*	6
			15

Second Semester **Cr.**

ITEC	602	IT Strategies	3
ITEC	604	Special Topics in Information Technology	3
ITEC	606	Research Project in Information Technology	3
		Elective (Dept)*	6
			15
ITEC	699	Thesis	6

*A total of 12 credits are selected from courses offered by the department (3 Cr. each).

PhD Degree in Information Technology (40 credit hours)

			Cr.
Mandatory / Elective Courses			18
ITEC	799	Thesis	22

MSc & PhD Degrees Courses

MSc Degree

Core Courses

- Pure Mathematics -

MATH 601 - Topics in Abstract Algebra I (3 Cr. : 3 Lec)

Topics from field extensions and finite fields, Galois Theory, structure of finite groups, basic structure of ring theory.

MATH 602 - Advanced Topics in Analysis (3 Cr. : 3 Lec)

Topics from real, complex or functional analysis.

MATH 643 - Algebraic Topology (3 Cr. : 3 Lec)

Topics from: Homotopy, retracts and extendibility, the fundamental group, homotopy type, path spaces, fiber spaces, complexes, homology, topological groups.

MATH 604 - Advanced Number Theory (3 Cr. : 3 Lec)

Topics from: Algebraic and transcendental numbers, quadratic fields, quadratic forms, ideal theory in quadratic fields, continued fractions and approximations, the prime number theorem, number - theoretic functions, number - theoretic equations.

MATH 606 - Research Project in Pure Mathematics (3 Cr. : 3 Lec)

- Applied Mathematics -

MATH 605 - Advanced Boundary Value Problems (3 Cr. : 3 Lec)

Methods of solving wave equations - Methods of solving heat equations - Boundary value problems in the theory of elasticity - Perturbation method - Variational method - Eigenvalue problems - Group theoretical methods - The method of Green's function - Applied computational methods.

MATH 652 - Finite Element Methods (3 Cr. : 3 Lec)

Application of finite element method to boundary value problems in applied mathematics.

MATH 609 - Advanced Fluid Dynamics (3 Cr. : 3 Lec)

Fundamental relations for Newtonian and non Newtonian fluids - Some exact solutions for steady and unsteady flows - Approximate solutions Stokes' flow, Oseens' flow - Laminar boundary layers - Turbulent flows in pipes, turbulent boundary layers - Surface waves: Cauchy piosson wave problem, waves due to a submerged cylinder, surface disturbance of a stream - Two dimensional and cylindrical internal waves - Fundamental line and point singularities.

MATH 614 - Advanced Topics in Applied Mathematics (3 Cr. : 3 Lec)

Topics from the various fields in applied math.

MATH 654 - Research Project in Applied Mathematics (3 Cr. : 3 Lec)**Elective Courses*****MATH 607 - Advanced Numerical Analysis (3 Cr. : 3 Lec)***

Topics from: Advanced numerical and linear algebra, numerical solutions of partial differential equations, finite element analysis, numerical solution of optimization problems, approximation theory, advanced numerical and linear algebra, finite element analysis, numerical solution of optimization problems, approximation theory.

MATH 610 - Topics in Abstract Algebra II (3 Cr. : 3 Lec)

Modules, representation theory of finite groups, homological algebra, commutative ideal theory.

MATH 611 - Linear Models (3 Cr. : 3 Lec)

Management sciences approaches in organizations, including modeling and rational approaches to decision - making process are covered. Emphasizes analysis and communication, using real world applications and cases. Topics include linear programming and its extensions; Integer programming; Network problems; Decision analysis as applied to tactical and strategic business decisions. Implementation using existing software packages for management science to understand concepts and solve various managerial problems is an integrated part of this course. Development of information systems with emphasis on mathematical concerns governing such systems.

MATH 613 - Thermoelasticity (3 Cr. : 3 Lec)

Two dimensional problems - Thermoelasticity and its applications - Viscoelasticity: State of stress and strain, mechanics of stress and deformation analysis, linear viscoelastic constitute equations, linear viscoelastic stress analysis, multiple integral representation, some applications of viscoelasticity.

MATH 615 - Integral Transforms (3 Cr. : 3 Lec)

Laplace's transform - complex inversion formula for Laplace's transform, fourier mixed transforms, other transforms, using transforms for solving initial - boundary value problems of mathematical physics.

MATH 617 - Nonlinear Models (3 Cr. : 3 Lec)

Nonlinear models and nonlinear programming and related algorithms used for decision making in management information systems are emphasized. Inventory models and related methods are also addressed. Implementation using existing software packages for management science to understand concepts and solve various managerial problems is an integrated part of this course. Development of information systems with emphasis on mathematical concerns governing such systems.

MATH 618 - Advanced Quantum Mechanics (3 Cr. : 3 Lec)

Motion of a particle in a central field: The nuclear shell model. Radial wave functions and radial integrals - Spin half particles and Pauli spin matrices - Vector addition of angular momenta: Clebsch Gordan coefficients, Racah coefficients and 9 J symbols - The stationary perturbation theory, the anharmonic oscillator, the Stark effect and the Zeeman effect for the hydrogen atom - The time dependent perturbation theory - The variational method - The quantum theory of scattering - Relativistic quantum mechanics.

MATH 619 - Aerodynamics (3 Cr. : 3 Lec)

Basic thermodynamics - Fundamental equations of compressible fluids - Theory of small disturbances and theory of small perturbations - One dimensional unsteady motions. Isentropic irrotational steady two dimensional motions - Steady flows with axial symmetry: Conical flows - An introduction to transonic and hypersonic flows.

MATH 620 - Topics in Electrodynamics (3 Cr. : 3 Lec)

Electrodynamics of material media - Plane electromagnetic waves - The emission of electromagnetic waves - Wave guides - Interaction of fields and matter - Relativistic electrodynamics.

MATH 621 - Fluid Dynamics in Electromagnetic Field (3 Cr. : 3 Lec)

Fundamental equations of magnetofluid dynamics (Mfd), Mfd boundary conditions, Incompressible Mfd flows, Mfd waves, med simple waves, Mfd shock waves, stability dynamics of plasma.

MATH 622 - General Theory of Relativity (3 Cr. : 3 Lec)

Tensor calculus - Unconnected manifold - Construction of densities from tensors - General affine connection - Curvature tensor - Geodesics in affine connection - Physical interpretation of affine connection general Lorentz transformations - Dynamics of continuous media - The electromagnetic field - Geodesics of affinity.

MATH 623 - Probability & Statistics (3 Cr. : 3 Lec)

Multiple random variables: (Central limit theorem) - Operations on multiple random variables, random processes, spectral characteristics of random processes, linear system with random inputs, optimum linear systems, applications of multiple random variables.

MATH 624 - Network Optimization: Algorithms & Applications (3 Cr. : 3 Lec)

Network flow problems, their practical applications and their solution algorithms. Categories of network flow problems. Shortest path problems. Maximum flow problems. Minimum cost flows. Network Simplex algorithms. Generalized flow models. Constrained networks.

MATH 625 - Advanced Statistical Method (3 Cr. : 3 Lec)

Review of probability and probability distributions. Data description. Random samples and sampling distributions. Parameter estimation. Tests of hypotheses. Design and analysis of single - factor experiments: The analysis of variance. Design of experiments with several factors. Simple linear regression and correlation. Multiple regression. Nonparametric statistics. Introduction to statistical quality control and reliability engineering. Introduction to analyzing and forecasting time - series data. Introduction to queuing theory. Introduction to statistical decision analysis. Introduction to simulation.

MATH 626 - Forecasting Methods & Applications (3 Cr. : 3 Lec)

Principles and applications of forecasting methods in planning and managing activities in organizations. Introduction to business forecasting. Forecasting and data considerations. Simple regression analysis. Multiple regression analysis. Time series regression (decomposition methods). Moving averages and exponential smoothing. Forecasting with Box - Jenkins methodology. Artificial neural networks as forecasting tools. Combining forecasts. Implementing forecasts in organizations.

MATH 627 - Simulation (3 Cr. : 3 Lec)

Generating discrete and continuous random variables. Discrete - event simulation. Statistical analysis of simulated data. Variance reduction techniques. Statistical validation techniques. Markov chain and Monte Carlo methods. Experience with a modern discrete - event simulation package

MATH 628 - Decision Analysis (3 Cr. : 3 Lec)

The framing of decision problems. Influence diagrams. Review of probability (random events and variables, probability distribution functions, etc.). Decision Trees. Inverting Decision Trees (Baye's Law). Traditional approach to assessment of error (confidences level). Decision Analysis view of assessment (value of information, sensitivity). Multiple attribute decision objective. Mathematical treatment of risk tolerance and avoidance.

MATH 629 - Deterministic Optimization Models (3 Cr. : 3 Lec)

Mathematical modeling and the operations research approach. Formulation and classification of optimization models. Improving search. Formulation of linear programs (LPs). Simplex algorithms for solving LPs. Duality and sensitivity in linear programming. Multi - objective optimization and goal programming. Introduction to network flow models. Formulation of integer programs. Solution methods for integer programs. Unconstrained nonlinear programming. Introduction to constrained nonlinear programming and quadratic programming.

MATH 630 - Stochastic Models & Applications (3 Cr. : 3 Lec)

Poisson process, renewal theory, queuing models, reliability theory, Markov chains, Brownian motion, random walks and Martingale, stochastic order relations.

MATH 631 - Theory of Functions of Several Complex Variables (3 Cr. : 3 Lec)

Fundamental properties of holomorphic functions, reproducing kernels, integral representations, domain of holomorphy and pseudoconvexity, Weirstrass preparation theorem, complex manifolds.

MATH 632 - Linear Analysis & Applications (3 Cr. : 3 Lec)

Vector spaces, linear transformations, integration, fourier and laplace transforms, distributions and differential operators.

MATH 633 - Mathematical Logic (3 Cr. : 3 Lec)

The predicate calculus, completeness and compactness, Godel's first and second incompleteness theorems, introduction to model theory.

Math 638 - Advanced Topics in Topology (3 Cr. : 3 Lec)

Topics from point set topology, Brouwer's fixed point theorem, smooth manifolds, differentiable structures or vector bundles.

MATH 698 - Individual Study (3 Cr. : 3 Lec)

Projects including non - thesis research which are supervised on an individual basis and which fall outside the scope of formal courses.

MATH 699 - Thesis (6 Cr.)**PhD Degree*****MATH 701 - Differential Equations (3 Cr. : 3 Lec)***

Nonlinear equations, delay equations, functional equations, differential and integral inequalities.

MATH 702 - Homological Algebra (3 Cr. : 3 Lec)

Categories, products and coproducts, factors and exact factors, projective and injective modules, embedding into an injective module, flat modules - direct and inverse limits.

MATH 703 - Universal Algebra (3 Cr. : 3 Lec)

Algebras and relational systems, partially ordered sets (posets), ideals and semilattices, subalgebra, congruence relations - homomorphism and isomorphism theorems, partial algebras, congruence lattices, direct products - free algebras.

MATH 704 - Radical Theory (3 Cr. : 3 Lec)

General theory of radicals - radical of associative rings, some special radicals, torsion theory of modules, radical theory in other categories.

MATH 705 - Numerical Linear Algebra (3 Cr. : 3 Lec)

Solving systems of algebraic equations, solving Least squares problems, solving Eigen value problems.

MATH 706 - Topics in Functional Analysis (3 Cr. : 3 Lec)

Weak topology, continuity, integration and differentiation, Banach algebra.

MATH 707 - Topics in Fractional Calculus (3 Cr. : 3 Lec)

Abstract differential and integral equations of fractional orders, functional differential and integral equations of fractional orders, applications.

MATH 708 - Optimal Control (3 Cr. : 3 Lec)

Systems in control theory, discrete and continuous time systems, reachability and controllability, feedback stabilization, linear quadratic control, Kalman filtering, controller synthesis, Pontryagin maximum principle.

MATH 709 - Numerical Optimization (3 Cr. : 3 Lec)

Unconstrained optimization: Optimality conditions, Newton's method, globalization using line search and trust region methods, steepest descent method, Quasi - Newton methods, truncated Newton methods, nonlinear least - squares. Constrained optimization: Optimality conditions, feasible - point methods, penalty and barrier methods, interior - point methods.

MATH 710 - Applied Math Logic (3 Cr. : 3 Lec)

Models of axiomatic systems, selected topics of proof theory applying techniques of mathematical logic to other areas of mathematics and science.

MATH 711 - Advanced Quantum Mechanics (3 Cr. : 3 Lec)

Symmetry in quantum mechanics, relativistic quantum mechanics, quantum electro dynamics, quantum chromo dynamics.

MATH 712 - Advanced Nuclear Quantum Mechanics (3 Cr. : 3 Lec)

Theory of nuclear structure, models of non deformed nuclei, models of deformed nuclei, Schroedinger fluid.

MATH 713 - Advanced Applications of Group Theory in Quantum Mechanics (3 Cr. : 3 Lec)

Linear groups in n - Dimensional Space, Irreducible tensors, Decomposition of representations of $SU(n)$ into representations of $R(3)$ Groups, atomic spectra, seniority of atomic spectra - Nuclear spectra, in jj - and $L - S$ coupling - LS - Coupling shell model and jj - Coupling shell model - Little groups - Ray representations.

MATH 714 - Advanced Fluid Mechanics (3 Cr. : 3 Lec)

Advanced problems of Navier, stokes equations - Multi, layered regions of fluids, hydrodynamic instability, turbulence, advanced problems of wave motions.

MATH 715 - Non Newtonian Fluids (3 Cr. : 3 Lec)

Non - Newtonian power, law fluids, peristaltic flow of non, Newtonian fluid, advanced problems of micro polar fluids, anisotropic fluids.

MATH 716 - Advanced Aerodynamics (3 Cr. : 3 Lec)

Aerofoil, propellers, wind tunnel corrections, shock waves, simple flight problems, moments - stability.

MATH 717 - Advanced Thermoelasticity Theory (3 Cr. : 3 Lec)

Advanced topics such as uniqueness and existence theorems in generalized thermoelasticity theory, variational principles and reciprocity theorems, fundamental solutions, state space formulation.

MATH 718 - Advanced Topics in the Theory of Elasticity (3 Cr. : 3 Lec)

Functionally graded materials, solids with internal friction, interaction of electromagnetic fields with elastic and thermoelastic solids.

MATH 719 - Advanced Methods of Applied Math (3 Cr. : 3 Lec)

Advanced methods in integral equations, dual integral equations, Weiner, Hopf technique, distribution theory and its applications, Green's functions for boundary value problems, advanced direct and variational methods, vibrations and waves in applied mathematics.

MATH 720 - Field Theory (3 Cr. : 3 Lec)

Interaction of fields and matter - The emission of electromagnetic waves - Wave guides - Physical interpretation of affine connection, General Lorentz transformations and dynamics of continuous media in space and structure.

MATH 721 - Measure Theory & Advanced Probability (3 Cr. : 3 Lec)

Measurable spaces, Lebesgue - Stieltjes measure, integration in probability spaces, product measures, absolute continuity of measures, Lindeberg - Feller theorem, Jensen's inequality and applications, Borel - Cantelli lemmas, infinitely divisible laws. Martingales, almost sure convergence for martingales, uniform integrability.

MATH 722 - Advanced Topics in Time Series Analysis (3 Cr. : 3 Lec)

Extensions of theory and methods to multiple time series including vector AR models, ARCH and GARCH models, state space modeling and Kalman recursions, estimation techniques, model - building and diagnostics. Use of models for forecasting, analysis and control, cross correlations and bivariate spectral analysis.

MATHS 723 - Advanced Computations in Statistics (3 Cr. : 3 Lec)

Linear and nonlinear least squares and regression computations, computations associated with maximum likelihood estimation problems, applications of Monte Carlo methods in statistics research, computer intensive applications including the bootstrap, evaluation of multiple integrals, EM algorithm, etc... Assignments will include applications of these methods using the S+ or SAS or Matlab programming language.

MATH 724 - Statistical Linear & Non Linear Models (3 Cr. : 3 Lec)

The Gauss - Markov model is introduced. Topics include estimability, parameter estimation, analysis of variance, hypothesis testing, restricted models, reparameterization, and fixed, mixed and random effects models. Topics include fixed - effects nonlinear regression models, nonlinear least squares, computational methods and practical matters, growth models, and compartmental models. Nonlinear mixed - effects models are discussed, including model interpretation, estimation and inference. Topics include hierarchical model building, estimation algorithms, analysis of deviance, and diagnostics.

MATH 725 - Advanced Statistical Inference (3 Cr. : 3 Lec)

Inference with emphasis on definition of statistical models, construction and use of likelihoods, and general estimating equations. Comparison of inference methods based on jackknife, bootstrap, and normal approximations. Rank and permutation tests and concepts from robust inference. Principles of inference including Bayesian inference.

MATH 726 - Advanced Theory of Nonparametric Statistics (3 Cr. : 3 Lec)

Order statistics in non parametric inference, distribution free confidence intervals for quartiles, distribution free tolerance intervals, distribution free prediction intervals.

MATH 727 - Topics in Operations Research (3 Cr. : 3 Lec)

Probabilistic activity networks, critical evaluation and extension of the PERT model inventory theory, deterministic and stochastic models. Nonlinear programming, quadratic and stochastic programming, computer software.

MATH 730 - Introduction to K - Theory (3 Cr. : 3 Lec)

K - theory groups for compact spaces. Long exact sequences, index theory and the Pimsner - Voiculescu theorem.

MATH 731 - Lie Theory (3 Cr. : 3 Lec)

Lie groups, lie algebras, exponential mappings, subgroups, subalgebras, simply connected groups, adjoint representations, infinitesimal theory.

MATH 732 - Representation Theory (3 Cr. : 3 Lec)

Symmetric group, matrix representations, group algebra, reducibility, group characters, tensor products, representation of symmetric group, Young's natural representation, Hook formula, symmetric functions.

MATH 797 - Research Seminar (3 Cr. : 3 Lec)

Preparation and presentation of 2 or 3 seminars on specialized topics

MATH 798 - Special Topics (3 Cr. : 3 Lec)

Topics vary according to student needs and available staff.

MATH 799 - Thesis (22 Cr.)**MSc Degree in Computer Science****Core Courses*****CMPS 601 - Advanced Computer Graphics (3 Cr. : 3 Lec : 2 Lab)***

Advanced topics in computer graphics, with focus on learning recent methods in rendering, modeling, and animation. Appropriate for students who have taken 425 or equivalent and would like further exposure to computer graphics.

CMPS 602 - Building AI Systems (3 Cr. : 3 Lec : 2 Lab)

Intensive study of a major subfield such as neural networks, expert systems, machine learning / tutoring, natural language processing, pattern recognition, robotics or others.

CMPS 603 - Advanced Database Management Systems (3 Cr. : 3 Lec : 2 Lab)

In - depth investigation of intelligent database management systems in support of business decision making, investigation of all aspects of data modeling, database design, and implementation of relational, object - oriented and semantic. Databases, data warehouse and data mining and issues surrounding choice, design, and use of such technologies.

CMPS 604 - Data Warehousing & Data Mining (3 Cr. : 3 Lec : 2 Lab)

Topics covered include data validation / cleansing / exploration to improve business information quality, data preparation for data mining, finding rules in data and discover product and customer clusters. Special emphasis is placed on data warehousing and data mining integration.

CMPS 608 - Research Project in Computer Science (3Cr. : 3 Lec : 2 Lab)**Elective Courses*****CMPS 605 - Computer Network Administration (3 Cr. : 3 Lec : 2 Lab)***

Presentation of current and emerging telecommunications services and networking technologies with emphasis on their strengths, limitations, and business applications. Commonly used network media, operating systems, LAN and WAN technologies, internetworking approaches and media will be presented.

CMPS 606 - Hardware & Software Interface Design (3 Cr. : 3 Lec : 2 Lab)

Introduction and review of instruction set and assembly language programming, instruction execution cycle and timing. Memory devices, SRAM, DRAM, flash memory, and SDRAM controller. Buses, access arbitration, timing, and protocols. Interrupts and DMA. Timers and counters. Serial communication: UART, SPI, and I2C. Parallel I / O interface and signal handshaking. Keyboards, LCD, VGA interfaces. Transducers and sensors, touch panel, A/D - D/A converters. System board - level design and system booting. Introduction of testing and JTAG port.

CMPS 607 - Advanced Computer Architecture (3 Cr. : 3 Lec : 2 Lab)

Architectures of modern computing systems, techniques for high - speed computation: Pipelining, vector processing, array processors. General purpose parallel architectures: SIMD, MIMD and data flow systems and their memory organizations and processor communication.

CMPS 609 - Data Visualization (3 Cr. : 3 Lec : 2 Lab)

A course on techniques in visualizing scientific and other types of data. Topics include a review of computer graphics fundamentals, 2D and 3D data types, differential operators and metric spaces, visualization for 2D and 3D data sets and methods of computational science.

CMPS 610 - Special Topics in Computer Science (3 Cr. : 3 Lec : 2 Lab)

A course whose topics may vary each semester and are excepted to be in areas of active research.

CMPS 611 - Advanced Software Engineering (3 Cr. : 3 Lec : 2 Lab)

Use of recent mathematical relations theory in specification, design, and validation of software engineering products, with particular emphasis on applying these new methods in the design of knowledge - based systems.

CMPS 612 - Complexity Theory (3 Cr. : 3 Lec : 2 Lab)

A course that discusses complexity classes of algorithms, especially those arising from time and space analysis of bounded computations. Topics include sequential, deterministic, parallel, and non - deterministic models of computation, and the hierarchy of complexity classes.

CMPS 613 - Parallel Computing (3 Cr. : 3 Lec : 2 Lab)

A course that discusses the design, analysis, and implementation of algorithms for parallel computers. Topics include selection, merging, sorting, searching, matrix processing and complexity of parallel computations.

CMPS 614 - Advanced Operating Systems (3 Cr. : 3 Lec : 2 Lab)

Survey of operating systems covering: Early systems, virtual memory, protection, synchronization, process management, scheduling, input / output, file systems, virtual machines, performance analysis, software engineering, user interfaces, distributed systems, networks, current operating systems, case studies.

CMPS 615 - Scientific Programming Methods (3 Cr. : 3 Lec : 2 Lab)

Advanced programming (control statements - functions - subroutines - I / O files), applications on mathematical physics problems, excursion on the available ready packages, operating systems.

CMPS 698 - Special Topics (3 Cr. : 3 Lec : 2 Lab)

Topics vary according to student needs and available staff.

CMPS 699 - Thesis (6 Cr.)**PhD Degree in Computer Science*****CMPS 701 - Advanced Digital Signal Processing (3 Cr. : 3 Lec)***

DSP embedded systems, specialized processor vs. regular processors for DSP applications, binary number representation, fixed - point and floating - point DSP architectures, Q - format for data representation, bit allocation and arithmetic, portability of arithmetic expressions: Floating point vs. fixed point. Applications to signal parameter estimation, signal generation, filtering, signal correlation, spectral estimation (FFT).

CMPS 702 - Quantum Circuits & Algorithms (3 Cr. : 3 Lec)

Oracle implementation. Deutsch - Jozsa algorithm. Shor's algorithm. Quantum fourier transform. Amplitude amplification, phase estimation. Grover quantum search algorithm, quantum Boolean circuits. Toffoli gate, circuit topologies and optimization.

CMPS 703 - Emerging Topics in AI (3 Cr. : 3 Lec)

Theories of intelligent agents. Agent architectures, knowledge representation, communication, cooperation, and negotiation among multiple agents, planning and learning; Issues in designing agents with a physical body; Dealing with sensors and actuators, world modeling.

CMPS 704 - Advanced Topics in Knowledge Representation & Non - Monotonic Reasoning (3 Cr. : 3 Lec)

Families of nonmonotonic logics (Circumscription, default logic, autoepistemic logic). The Well founded semantics, stable model semantics, the state - of - the - art answer set programming paradigm, planning, diagnosis and model checking. Answer set programming.

CMPS 705 - Database Bioinformatics (3 Cr. : 3 Lec)

DBMS support for biological databases, data models. Searching integrated public domain databases, queries / analyses, DBMS extensions, emerging applications.

CMPS 706 - Data Mining & Knowledge Discovery (3 Cr. : 3 Lec)

Data, information, knowledge, SEMMA, statistical data mining, machine learning, predictive modeling, variable selection, neural networks, decision trees, cluster analysis. Evaluation of data mining: Confusion matrix, ROC graph, cumulative Gains chart and lift, data cubes and summarization, itemsets: Support Measures, apriori itemset generation, share measures, support and share measures, apriori program, dynamic itemset. Mining the data stream, temporal data mining, web data mining, knowledge application and management, data and knowledge visualization - text mining, web mining.

CMPS 711 - Contemporary Computer Architectures (3 Cr. : 3 Lec)

Contemporary computer organizations and operations; Parallel systems: Pipelines, array, multiprocessors; Shared memory and message passing architectures; Data flow architectures.

CMPS 712 - Introduction to Computational Linguistics (3 Cr. : 3 Lec)

Computational approaches to linguistics, covering natural language parsing, meaning representation and inference, and natural language generation.

CMPS 709 - Computer Systems Performance Evaluation (3 Cr. : 3 Lec)

Theory and practice of computer system performance evaluation, measurement, simulation, and analytical techniques with strong emphasis on analytical modeling.

CMPS 710 - Machine Intelligence & Heuristic Programming (3 Cr. : 3 Lec)

Methods for making machines behave intelligently, problem solving, theorem proving, game playing, question answering, learning induction, specialized languages and data structures.

CMPS 797 - Research Seminar (3 Cr. : 3 Lec)

Preparation and presentation of 2 or 3 seminars on specialized topics.

CMPS 798 - SPECIAL TOPICS (3 Cr. : 3 Lec)

Topics vary according to student needs and available staff.

CMPS 799 - THESIS (22 Cr.)**MSc Degree in Information Technology****Core Courses*****ITEC 601 - Project Planning & Feasibility Analysis (3 Cr. : 3 Lec)***

Assimilation of client needs. Market assessment studies. Impacts of laws and regulations on the facility program. Surveys of project area infrastructure conditions. Investigation of site conditions. Project scope validation. Project cost and revenues estimation. Project life - cycle analysis. Financial planning. Financial feasibility framework design and analysis.

ITEC 602 - IT Strategies (3 Cr. : 3 Lec)

Strategic planning for information systems, methodologies for strategy formulation, risk portfolios, applications master plan, developing E-business vision, integration challenges, enterprise commerce management, outsourcing, and public key infrastructure.

ITEC 603 - Forecasting Methods & Applications (3 Cr. : 3 Lec)

Principles and applications of forecasting methods in planning and managing activities in organizations. Forecasting and data considerations. Simple regression analysis. Multiple regression analysis. Time series regression (decomposition methods) moving averages and exponential smoothing. Forecasting with Box-Jenkins methodology. Artificial neural networks as forecasting tools. Combining forecasts. Implementing forecasts in organizations.

ITEC 604 - Special Topics in Information Technology (3 Cr. : 3 Lec)

A course on selected topics which change according to the interests of the instructors or students. Topics will be chosen from state-of-art innovations in software and computer technology systems.

ITEC 606 - Research Project in Information Technology (3 Cr. : 3 Lec)**Elective Courses*****ITEC 605 - Information Security & Assurance (3 Cr. : 3 Lec)***

This course covers theoretical, conceptual, and methodological foundations of information security and assurance.

ITEC 607 - IS Social & Intellectual Aspects (3 Cr. : 3 Lec)

The limitation and differences imposed on IT due to social and intellectual traits and capabilities of people (and hence organizations) involved in the process.

ITEC 608 - Software Verification & Testing (3 Cr. : 3 Lec)

Role of verification, testing and quality assurance. Formal verification techniques. Proving correctness and conformity of system behavior to systems requirement specification (SRS). Nature and limitations of testing. Nature of hardware and software faults. Formal models of testing. Test environments. Test case generation. Test results analysis. Test standards and documentation. The course includes a project that will develop techniques and strategies for applying formal verification and testing techniques to a problem of industrial size and interest.

ITEC 609 - Supply Chain Management (3 Cr. : 3 Lec)

Logistics, warehousing, and inventory control, bullwhip effect, vendor inventory management, distribution networks, alliances and outsourcing strategies, information systems and decision support for SCM.

ITEC 610 - Expert Decisions Support Systems (3 Cr. : 3 Lec)

Understanding and utilizing the concepts of decision support systems (DSS) to support managerial decision - making, DSS components, DSS technology levels, managerial cognitive styles, DSS development. Applications of decision support systems, executive information technologies and expert systems in a business environment.

ITEC 611 - Database Management & Administration (3 Cr. : 3 Lec)

Introduces advanced topics in database management systems that are fundamental to effective administration of enterprise information systems.

ITEC 612 - Data Analysis & Modeling (3 Cr. : 3 Lec)

Learning advanced tools for data acquisition organization and analysis using multivariate statistical packages, OLAP, and other tools. Real data projects will be carried and result presentations will be conducted.

ITEC 613 - Manufacturing Systems & Facilities Planning (3 Cr. : 3 Lec)

Assembly lines. Transfer lines. Flexible manufacturing systems. Group technology. Facility layout. Material handling systems. Warehousing storage and retrieval systems. Introduction to general - purpose queuing and simulation models.

ITEC 614 - Human Factors Information Systems (3 Cr. : 3 Lec)

Designing for human performance effectiveness and productivity. Introducing human factors and ergonomics. Design and evaluation methods. Perception - vision and hearing. Cognition. Displays and controls. Work - space design. Biomechanics of work. Stress and workload. Safety and human error. Human - computer interaction.

ITEC 615 - Human - Computer Interaction (3 Cr. : 3 Lec)

Users, models of users, developing the models, technology for creating interfaces; Examples of good research and implications for Human - Computer Interface (HCI) design.

ITEC 616 - Production - Inventory Planning & Control (3 Cr. : 3 Lec)

Introduction to supply chain management and its key issues. Logistics, network configuration. Inventory management. Distribution strategies and strategic alliances. The value of information in supply chains. Information technology and decision support systems for supply chain management.

ITEC 617 - Queuing Theory (3 Cr. : 3 Lec)

A course that covers Poisson counting and renewal processes; Markov chains and decision theory, branching processes, birth death processes, and semi - Markov processes, simple Markovian queues, networks of queues, general single and multiple - server queues, bounds and approximations.

ITEC 618 - Network Management & Security (3 Cr. : 3 Lec)

Essential skills and knowledge for effectively utilizing networks and internet technologies to facilitate, manage and secure data communications and applications.

ITEC 619 - Web & Internet Information Retrieval (3 Cr. : 3 Lec)

The course addresses aspects of searching, retrieving and modeling the Web / Internet as information repositories using mathematical and probabilistic treatments.

ITEC 620 - Crisis, Disaster & Risk Management (3 Cr. : 3 Lec)

This course examines the fundamental elements of crisis, disaster, risk and emergency management.

ITEC 698 - Special Topics (3 Cr. : 3 Lec : 2 Lab)

Topics vary according to student needs and available staff.

ITEC 699 - Thesis (6 Cr.)**PhD Degree in Information Technology*****ITEC 701 - Data & Information System (3 Cr. : 3 Lec)***

This course provides an overview of key topics in designing, building and managing information systems (IS) that incorporate database management systems (DBMS) as their foundation, topics include: Fundamentals of DBMS technology and their application in IS development, mastering technology issues based on data / information as a valuable business resource, new IS business uses enabled by advances that build upon the core DBMS technology, information systems development life cycle, techniques for researching system requirements, analyzing and modeling organizational processes and data; Development and implementation of information systems in organizations. The course also provides hands - on experience in the analysis and design of a system and developing a database application using a state - of - the - art DBMS.

ITEC 702 - Enterprise & Systems Integration (3 Cr. : 3 Lec)

This course addresses the issues and solutions involved in internal coordination and external customer focus through integrated processes, using an enterprise approach to information technologies. The two primary approaches to integration, namely, ERP systems and enterprise application / data integration will be covered, with emphasis on the business and technical principles of each approach, as well as their pros and cons. The role of business intelligence systems in enterprise integration will be considered. Using class projects, the insights gained will be applied to real situations.

ITEC 703 - Models & Technologies (3 Cr. : 3 Lec)

This course provides both the strategic and technical essentials of what a manager needs to know in order to manage and lead an electronic commerce (EC) initiative. Topics include: EC business models, economics of information goods, virtual value chain, impact of EC on organizational strategy and industry structure, in - depth assessment of successful EC strategies, and emerging issues related to electronic communities and virtual organizations as well as web site design. Issues of design of E - Commerce applications will be considered, including hardware, software and network issues; Usability; Software tools; Web analytics; and team dynamics. The course also includes producing a business plan, a requirements definition document, and several case studies.

ITEC 704 - Theory of Information & Network Management (3 Cr. : 3 Lec)

This course introduces the theoretical foundations of information, with applications in communication, signal processing, machine learning, and pattern recognition. It also provides the students with a comprehensive understanding of the fundamental issues and concepts of network security and security management, and the mainstream network security technologies and protocols that are widely used in the real world.

ITEC 705 - Contemporary Issues in Information Systems Development (3 Cr. : 3 Lec)

Globalization revisited, fast growth of information and communication technologies, the growing importance of knowledge - based industries, changing impact of international rules and regulations concerned with quality standards, environmental constraints, trading generally, etc... Productivity and competitiveness revisited framework, factors, and changing conditions: National level, branch level, and firm level. Privatization and participation of the private sector, clustering and networking of firms, business development services and incubators, technology and industry parks.

ITEC 706 - Intelligent Agents & Distributed Decision Making (3 Cr. : 3 Lec)

Distributed decision making theories and agent - based technologies, models and systems with applications in command and control, emergency and resource management.

ITEC 707 - Data Mining I (3 Cr. : 3 Lec)

This course introduces data mining and statistical / machine learning, and their applications in information retrieval, database management, and image analysis.

ITEC 708 - Computer - Supported Cooperative Work (3 Cr. : 3 Lec)

Introduces theories, empirical findings, evaluation methods, and design frameworks in computer - supported cooperative work.

ITEC 709 - Introduction to Multisensor Data Fusion (3 Cr. : 3 Lec)

Understanding the concepts, techniques, and issues surrounding the fusion of information from multiple sensors and sources of data.

ITEC 797 - Research Seminar (3 Cr. : 3 Lec)

Seminars provide opportunities for students to pursue directed study readings and preliminary research relevant to their concentration where existing courses do not offer the required subject matter. Tutorials include a presentation of a report on the work.

ITEC 798 - Special Topics (3 Cr. : 3 Lec)

Formal courses given on a topical or special interest subject which may be offered infrequently.

ITEC 799 - Thesis (22 Cr.)

Department of Physics

Diploma in Radiation Protection (30 credit hours)

First Semester Cr.

PHYS	501	Review of Fundamentals	3
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PHYS	503	Quantities & Measurements	2
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PHYS	505	Biological Effects of Ionizing Radiation	1
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PHYS	507	Principles of Radiation Protection & the International Framework	2
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PHYS	511	Assessment of External & Internal Exposures	3
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PHYS	513	Protection against Occupational Exposure	4
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Second Semester Cr.

PHYS	502	Practical Training	6
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PHYS	504	Exposure of the Public due to Practices	3
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PHYS	506	Intervention in Situation of Chronic & Emergency Exposure	3
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PHYS	508	Medical Exposures in Diagnostic Radiology, Radiotherapy & Nuclear Medicine	3
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Diploma Courses

PHYS 501 - Review of Fundamentals (3 Cr. : 3 Lec)

Basic nuclear physics, radioactivity, nuclear reactions, basic mathematics, statistics, charged particle radiation, uncharged radiation, natural radiation, human made radioactive sources, radiation generators.

PHYS 502 - Practical Training (6 Cr. : 0 Lec : 12 Lab)

Induction training for new comers, specific safe working procedures, refresher training, communication skills. General considerations on persons to be trained and types of training, building a structured learning session to meet objectives, how to teach involving the group, course design, course evaluation.

PHYS 503 - Quantities & Measurements (2 Cr. : 2 Lec)

Radiometric quantities and interaction coefficients, dosimetric and radiation protection quantities, dosimetric calculations, detectors, measurement techniques.

PHYS 504 - Exposure of the Public due to Practices (3 Cr. : 3 Lec)

Natural sources of exposure, human made sources of exposure, responsibilities, safe transport, radioactive waste management, environmental assessment, environmental monitoring, consumer products.

PHYS 505 - Biological Effects of Ionizing Radiation (1 Cr. : 1 Lec)

Basic radiation chemistry, effects of radiation on cells, effects of whole body irradiation, effects of partial body irradiation, stochastic effects, radiation effects, epidemiological studies, radiation detriment.

PHYS 506 - Intervention in Situation of Chronic & Emergency Exposure (3 Cr. : 3 Lec)

Principles of intervention, emergency response, emergency preparedness, implementation of emergency response plans, assessment of radiological emergency, assessment of nuclear emergency, emergency monitoring overview, field radiation and contamination monitoring, radiation protection of monitoring teams, basic data evaluation, medical management, communication with the public, international cooperation.

PHYS 507 - Principles of Radiation Protection & the International Framework (2 Cr. : 2 Lec)

Conceptual framework: The ICRP Basic Framework (types of exposure, control of radiation sources), optimization of protection with examples, individual dose limits, dose and risk constraints, system of protection for intervention, assessment of the effectiveness of the system of protection. The role of international organizations in radiation protection. Safety culture of staff at all levels: Priority to safety, policies, procedures, responsibilities, the lines of authority for making decisions, organizational arrangements, communication lines, safety culture indicators, examples of safety culture.

PHYS 508 - Medical Exposures in Diagnostic Radiology, Radiotherapy & Nuclear Medicine (3 Cr. : 3 Lec)

General principles, justification of medical exposures, design considerations for equipment, determination of a dose to the patient, operational considerations, guidance levels for the patients, comprehensive specific quality assurance program, calibration of sources and equipment, records, accidental medical exposures.

PHYS 511 - Assessment of External & Internal Exposures (3 Cr. : 3 Lec)

Assessment of occupational exposure due to external sources of radiation: Dosimetric quantities, the monitoring programs for individual dose assessment, monitoring program for the work place, interpretation of measurements, calibration, quality assurance. Assessment of occupational exposure due to intake of radionuclides: Modes of intake, monitoring program, biokinetic models used by ICRP, calculation of committed effective dose, calibration, quality assurance.

PHYS 513 - Protection against Occupational Exposure (4 Cr. : 4 Lec)

Radiation protection program, technical aspects of radiation protection against sealed and unsealed sources, safety and security of sources, features of facility design, personal protection, classification of areas, optimization of radiation protection, quality assurance, monitoring, health surveillance, potential exposures, industrial radiography, industrial irradiators and accelerators, nucleonic gauges, radiotracers, well logging, radioisotope production plants, diagnostic radiology, nuclear medicine, radiotherapy, nuclear installations, mining and processing of raw materials.

MSc & PhD Curricula

MSc Degree in Physics (36 credit hours)

First Semester				Cr.
PHYS	601	Advanced Quantum Physics		3
PHYS	603	Advanced Nuclear Physics		3
PHYS	607	Condensed Matter Physics		2
		Elective ¹		7
				15

Second Semester Cr.

PHYS	602	Advanced Molecular Physics	3
PHYS	604	Materials Science	2
PHYS	698	Independent Studies	2
		Elective ¹	8
			15
PHYS	699	Thesis	6

¹Selected from courses offered by the department.

PhD Degree in Physics (40 credit hours)

			Cr.
Mandatory / Elective Courses			18
PHYS	799	Thesis	22

MSc & PhD Degrees Courses

MSc Degree

PHYS 601 - Advanced Quantum Physics (3 Cr. : 3 Lec)

Many electron wave functions: Antisymmetry and the Slater method, configuration interaction, fock space. Spin and permutation Symmetry: Spin eigen function, permutation symmetry and its applications. The electron distribution: Electron density functions, density matrices, transition densities, spin density. Self consistent field theory: Hartree - Fock theory, restricted and unrestricted Hartree - Fock theory, an open shell system, state of given spin. Multiconfiguration SCF theory: The optimization problem, orbital variation, gradient method, variation of all parameters. Perturbation theory: The cluster development, the link cluster, generalization.

PHYS 602 - Advanced Molecular Physics (3 Cr. : 3 Lec)

Spectra in the visible, ultra violet, infrared and Raman regions, vibration and rotation of diatomic molecule, wave function, potential energy function, selection rule and Matrix elements in the Raman and infrared transitions, electronic states and electronics transitions, vibrational and rotational structure, intensities in electronic bands, the Franck - Condon principle, Hund's cases a, b, c, and d. Theory of symmetry: Point group, representation of group, continuous group and finite point groups. Polyatomic molecules: Vibration - rotation, classification of molecular terms, electronic states and dissociation.

PHYS 603 - Advanced Nuclear Physics (3 Cr. : 3 Lec)

Neutron losing reactions, neutron sustaining reactions, neutron cross - sections, diffusion of neutrons, the nuclear reactor, neutron multiplication factor, critical size, power control, level operation, the fast fission factor, the resonance escape probability, the thermal utilization factor, the thermal fission factor, the size shape factor (Buckling), neutron life time, neutron level of prompt neutrons.

PHYS 604 - Materials Science (2 Cr. : 2 Lec)

The materials cycle and resources, extraction and recycling, polymeric materials, processing and properties of ceramics, ionic materials, biomaterials.

PHYS 607 - Condensed Matter Physics (2 Cr. : 2 Lec)

Interatomic forces, ionic crystals, covalent crystals, hydrogen bonds, elastic constants, elastic waves in cubic crystals. Plasma optics, plasmons, electrostatic screening, polaritons and polarons, optical reflectance, excitons, Raman effect in crystals. Polarization, local field, dielectric crystals, electronic polarizability, ferroelectric crystals.

PHYS 608 - High Energy Physics (3 Cr. : 3 Lec)

The physics of nucleons and antinucleons: Low energy nucleon - nucleon interactions and nuclear forces, nucleon - nucleon interactions at high and ultrahigh energies, the structure of the nucleons, antinucleons and antinuclei. Particles and resonances: Leptons, π - mesons, strange particles, unitary symmetry of strong interactions, quarks and gluons (quantum chromodynamics).

PHYS 609 - Nanoscience & Technology (2 Cr. : 2 Lec)

Study of the physical properties of nanomaterials, the tools and techniques for nanosystems fabrication and investigation; Principles of mechanical, optical, electrical, and magnetic nanosystems.

PHYS 610 - Quantum Field Theory (3 Cr. : 3 Lec)

Canonical quantization of the neutral scalar field: Conjugate momentum, commutation relations, normal ordering, Bose symmetry, Fock space. Complex scalar field. Charge conservation. Particles and antiparticles, charge conjugation. Feynman propagator for scalar fields. Bose - Einstein distribution, propagators at finite temperature. The Dirac equation. Anti - commentators, quantization of the spinor field. Electrons and positrons. Fermi - Dirac statistics. Spin statistics connection. Quantization of the electromagnetic field in the Coulomb gauge, Feynman propagator, gauge invariance. Elements of quantum electrodynamics. Wick's theorem. Feynman rules and Feynman diagrams for spinor electrodynamics. Lowest order cross - sections for electron - electron, electron - positron and electron - photon scattering.

PHYS 611 - Fluid Mechanics (2 Cr. : 2 Lec)

Survey of principal concepts and methods of fluid dynamics. Mass conservation, momentum, and energy equations for continua. Circulation and vorticity theorems. Potential flow. Navier - Stokes equation for viscous flows. Similarity and dimensional analysis. Lubrication theory. Boundary layers and separation. Introduction to turbulence. Lift and drag. Surface tension and surface tension driven flows.

PHYS 612 - General Relativity (3 Cr. : 3 Lec)

General relativity with application to cosmology. Basic principles of relativity. Applications to orbits, gravitational radiation, and black holes. Relativistic cosmography and cosmology. The early universe, galaxy formation, and active galaxies.

PHYS 613 - Fourier Optics (2 Cr. : 2 Lec)

Fourier optics and optical processing of information. Topics include diffraction theory, optical transfer functions and holography. The Fourier Transform, Discrete Fourier Transform and Fast Fourier Transform.

PHYS 614 - Cartesian Tensors (2 Cr. : 2 Lec)

Second rank tensors, Cartesian tensor of rank three, isotropic tensors, applications of tensors to elasticity, electromagnetic theory, polarization.

PHYS 615 - Advanced Experimental Techniques in Physics (3 Cr. : 3 Lec)

Thermal analysis, molecular beam epitaxy, electron microscopy and analysis, field ion microscopy, atomic force microscopy, paramagnetic resonance, nuclear magnetic resonance, x - ray and neutron techniques.

PHYS 616 - Solar Photovoltaics (2 Cr. : 2 Lec)

Single - crystalline silicon solar cell, solar cells: Alternatives, materials, PV module, panel and array, energy storage, balance - of - system (BOS), PV system, system design, application.

PHYS 617 - Gamma Spectroscopy (2 Cr. : 2 Lec)

Interactions of radiation with matter, an introduction to the basic concepts of gamma - ray spectroscopy using NaI(Tl) or germanium detectors, efficiency calibration, energy calibration, neutron activation analysis, identification of nuclides, uranium detection in environment, calculation of radioactivity.

PHYS 618 - Biophysics & Medical Instruments (3 Cr. : 3 Lec)

Radiation measurement, radioactivity measurement, radioactive decay by alpha, beta and gamma emission, energy absorption (deposition) and absorbed dose in tissue, gamma ray and neutron interactions in tissue, radiation effects on human body and safety precautions, diagnostic x - ray images and tomography, MRI, osmosis in cells, bioelectricity, cardiographs, sound waves, hearing and hearing aids, ultrasound waves and imaging.

PHYS 619 - Critical Phenomena & Field Theory (3 Cr. : 3 Lec)

Phase transitions; Infrared behavior, Hartree Fock approximation; Large - N expansions. Field theoretical treatment of critical phenomena; Perturbative evaluations of critical exponents; Scaling laws; Universality. Renormalization group and its mathematical structure; Scaling laws; Approximation methods. Gaussian model, Ising model; Landau - Ginzburg model. Elements of conformal field theory; Fluctuations and random processes.

PHYS 620 - Scientific Programming Methods (2 Cr. : 1 Lec : 2 Lab)

Advanced programming (control statements - functions - subroutines - I / O files), applications on mathematical physics problems, excursion on the available ready packages, operating systems.

PHYS 621 - Standard Model of Elementary Particles Physics (3 Cr. : 3 Lec)

A detailed treatment of unification of the standard model of elementary particles. Yang - Mills theory for gauge groups $SU(2)$ $XU(1)$ and $SU(3)$ spontaneous symmetry breaking phenomenon, Goldstone theorem, Higgs particles, gauge invariant mechanisms for generating particle masses. Quantum chromodynamics, phenomenology, ideas from lattice gauge theory, confinement and asymptotic freedom. Grand unified theories: Basic ideas and confrontation with experiments, proton decay. Selected topics from superstring theory.

PHYS 622 - Transport Phenomena in Solids (3 Cr. : 3 Lec)

Boltzmann transport equation. Scattering mechanisms in solids. Probability and relaxation time for scattering mechanisms. Electron - acoustic phonon scattering. Electron - optical phonons scattering. Scattering by neutral and ionized impurities in semiconductors. Thermo - electric effects in solids. Phonon drag effect. Landau Fermi liquid theory, introduction to density functional theory. Local description of solids. Introduction to many - body theory.

PHYS 623 - Chaos in Physical Systems (2 Cr. : 2 Lec)

Motion in phase space, characteristics of chaotic systems, Lyapunov exponents, stability of equilibrium, strange attractors, bifurcations, discrete dynamics, applications to lasers, fluids, and other physical systems.

PHYS 624 - Hopping Conduction in Disordered Systems (3 Cr. : 3 Lec)

Principles of hopping conduction mechanisms. Mott criterion. Thermal and magnetic freeze out in semiconductors. Nearest neighbor hopping conduction (NNH) variable range hopping conduction (VRH) metal - insulator transition. Mott transition, Shklovski - Efros transition. Hopping in low dimensional systems.

PHYS 625 - Physics of the Universe I (3 Cr. : 3 Lec)

This course focuses on the nearly homogenous evolution of the universe including the standard big bang picture, inflationary cosmology, dark matter, and the possibility of present - day accelerated expansion.

PHYS 626 - Physics of the Universe II (3 Cr. : 3 Lec)

This course focuses on the late stages in the evolution of the universe, when gravity results in the growth of large - scale structure, perturbations in the cosmic microwave background, gravitational lensing and other non - linear phenomena.

PHYS 627 - Astrophysics I (3 Cr. : 3 Lec)

Celestial mechanics; Earth - Moon systems; Planets and satellites; Interplanetary medium; Origin of the solar system.

PHYS 628 - Astrophysics II (3 Cr. : 3 Lec)

Properties of sun and stars, variable stars, binary - and multiple-star systems, star clusters, interstellar medium, stellar.

PHYS 698 - Independent Studies (2 Cr. : 2 Lec)

An in - depth study of a particular topic in physics. Areas which may be included are selected by groups of students and approved by the department board.

PHYS 605 - General Relativity (3 Cr. : 3 Lec)

It is widely recognized as a theory equating gravity and the geometry of spacetime leads to a profound conceptual change in the way we regard the universe. The predictions of the theory are relevant to systems as varied as high precision measurements of the earth's gravitational field or the strongly curved space - times around black holes. In this course, we will gradually develop an understanding of the geometries which are the solutions of the Einstein equation, with an emphasis on their relevance to physical situations.

PHYS 629 - Quantum Computation & Information (3 Cr. : 3 Lec)

This course provides an overview of recent developments in quantum computation and quantum information theory. The topics include: An introduction to quantum mechanics, quantum channels, both ideal and noisy, quantum cryptography, an introduction to computational complexity, Shor's factorization algorithm, Grover's search algorithm, and proposals for the physical realization of quantum devices, such as correlated photons, ions in traps, and nuclear magnetic resonance.

PHYS 630 - Classical Electrodynamics (3 Cr. : 3 Lec)

This course introduces selected topics of classical electricity and magnetism at the graduate level including solutions to boundary conditions using Green's functions, wave equations, retarded solutions, theory of wave guides, relativistic particles and electromagnetic fields or radiation by moving charges.

PHYS 631 - Introductory Astrophysics (3 Cr. : 3 Lec)

Astrophysics is an application of physics to astronomy. This course covers all main branches of modern astrophysics and provides current understanding in astronomy based on physical explanations of observational data. Some of the basic physical tools used in astronomy are reviewed before an introduction to the physics of stars, galaxies, and the universe. Topics covered in this course include the physics of solar system objects, the structure, formation and evolution of stars and galaxies, the large scale structure of the universe and cosmology discussing the origin, evolution and fate of the universe.

PHYS 699 - Thesis (6 Cr.)

PhD Degree

PHYS 701 - Many Body Physics (3 Cr. : 3 Lec)

Weakly interacting Bose gas (ground state), collective excitations and super fluidity, breakdown of long - range order in 1D / 2D, Mott insulators of bosons, transition from super fluid to Mott insulator. Interacting fermions, random phase approximation for the ground state energy and collective modes.

PHYS 702 - Advanced Condensed Matter Physics (3 Cr. : 3 Lec)

Interacting systems. Green's functions. Second quantization. Landau theory of quasi - particles. Schroedinger and Heisenberg pictures. Many - body Green's functions. Perturbation series. Diagrammatic analysis. Applications to superconductivity. Fluctuations. Functional integration Generalized susceptibility and dielectric response. Fluctuation - dissipation theorem. Structure function.

PHYS 703 - Heavy Ion Reactions (3 Cr. : 3 Lec)

Scattering, particle transfer, resonance reactions, fission. Time - dependent Hartree - Fock, Vlasov equation. Nuclear transport equations, particle production, nuclear liquid - gas phase transition, quark - gluon plasma.

PHYS 704 - Bose - Einstein Condensation & Ultra - Cold Quantum Gases (3 Cr. : 3 Lec)

Bose and Fermi statistics. Experimental techniques (laser cooling, trapping, evaporative cooling) Nonlinear Schroedinger Equation (or Gross - Pitaevskii Equation) Thomas - Fermi Approximation. Dressed atom picture (for an atom in a field) Quasiparticles (ie, low - lying excitations).

PHYS 705 - Quantum Optics (3 Cr. : 3 Lec)

Introduction to quantum electrodynamics, quantization of electromagnetic field, ladder operators. Statistical properties of photons, coherent and squeezed states of radiation field, photon optics. Pauli Equation, atom - field interaction, semi - classical approximation to the atom - field interaction, second quantization. Radiative shift and radiative decay of atom levels, the Lamb shift. Quantum theory of laser. Resonant fluorescence, multi - photon processes. Modern topics in quantum optics.

PHYS 706 - Advanced Quantum Field Theory (3 Cr. : 3 Lec)

Path integral quantization, regularization, renormalization, non - Abelian gauge theories, spontaneous symmetry breaking.

PHYS 707 - Advanced Statistical Physics (3 Cr. : 3 Lec)

Equilibrium critical phenomena (critical exponents, scaling relations, multicritical phenomena) exact solutions. Renormalization group theory and other approximate methods, critical behavior of magnets, fluids, and surfaces.

PHYS 708 - Radiation Physics: High Resolution Gamma Spectroscopy (3 Cr. : 3 Lec)

Interaction of gamma rays with material (solid and gas): Photoelectric effect, Compton scattering and pair production. Scintillation principles, types of scintillator, scintillation mechanisms, organic molecules, fluorescence and phosphorescence, quenching, inorganic scintillators, band structure and activators. Types and properties of organic and inorganic scintillators. Light collection and photoelectron production. Photomultiplier tubes; Basic elements, photocathode, electron multiplication. Spectroscopy with scintillators. Semiconductor detectors; Types of semiconductor (silicon, germanium, cadmium telluride, cadmium zinc telluride, etc...) different types of detector geometry; Planar, coaxial. High resolution spectroscopy of X - rays and gamma rays. Properties of spectrometers including resolution, peak to total ratio (photofraction) and efficiency (total, full - energy peak, single escape and double escape).

PHYS 709 - Molecular Structure (3 Cr. : 3 Lec)

Force field method, electronic structure method, electron correlation method, basis set, density functional theory, valence bond method, relativistic method, wave function analysis, molecular properties, illustrating the concepts.

PHYS 710 - Applications of the Molecular Spectroscopy (3 Cr. : 3 Lec)

Infrared and Raman spectra, mass spectroscopy, canonical functions approach, rotational and centrifugal distortion constants, matrix elements.

PHYS 711 - Introduction to String Theory (3 Cr. : 3 Lec)

A familiarity with tensors and Einstein summation as well as a basic level of understanding of quantum mechanics is expected. Introduction to the perturbative formulation of string theories and dualities. Quantization of bosonic and superstrings, perturbative aspects of scattering amplitudes, supergravity, D - branes, T - duality and mirror symmetry. Also a brief overview of recent developments in string theory.

PHYS 712 - Quantum Electrodynamics (3 Cr. : 3 Lec)

Application of quantum field theory to the interaction of electrons and photons: Pair annihilation, Compton scattering. Bound states, renormalization theory.

PHYS 713 - Modern Atomic Optical Physics I (3 Cr. : 3 Lec)

Topics will include two - state systems, magnetic resonance, interaction of radiation with atoms, transition probabilities, spontaneous and stimulated emission, dressed atoms, trapping, laser cooling of "two - level" atoms, structure of simple atoms, fundamental symmetries, two - photon excitation, light scattering and selected experiments. The first of a two - term subject sequence that provides the foundations for contemporary research.

PHYS 714 - Modern Atomic Optical Physics II (3 Cr. : 3 Lec)

The basic concepts and theoretical tools will be introduced. Topics will include coherence phenomena, non - classical states of light and matter, atom cooling and trapping and atom optics. The second of a two - term subject sequence that provides the foundations for contemporary research.

PHYS 799 - Thesis (22 Cr.)

Department of Chemistry

MSc & PhD Degrees Curricula

MSc Degree in Chemistry (36 credit hours)

First Semester Cr.

CHEM	601	Advanced Analytical Chemistry	3
CHEM	603	Advanced Organic Chemistry	3
CHEM	621	Advanced Physical Chemistry	3
		Elective (Dept)*	6
			15

Second Semester Cr.

CHEM	642	Advanced Inorganic Chemistry	3
CHEM	604	Advanced Instrumental Analysis	3
CHEM	698	Independent Study	3
		Elective (Dept)*	6
			15
CHEM	699	Thesis	6

*A total of 12 credits are selected from courses offered by the department (3 Cr. each).

PhD Degree in Chemistry (40 credit hours)

Cr.

Mandatory / Elective Courses	18
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CHEM 799 Thesis	22
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*Selected from mandatory or elective courses depending on the major field of specialization.
 Note: the PhD students can also register in graduate courses from the MSc Degree.

MSc & PhD Degrees Courses

MSc Degree

Core Courses

CHEM 601 - Advanced Analytical Chemistry (3 Cr. : 3 Lec)

Introduction to modern chromatographic separation techniques (general description, migration rates, zone broadening, column efficiency, important relationships, applications). Gas chromatography (gas - liquid, instruments, column and stationary phases, gas - solid chromatography, applications). High - performance liquid chromatography (scope, column, instruments, partition, adsorption, ion - exchange, size - exclusion and thin layer chromatography, applications). Supercritical fluid chromatography.

CHEM 603 - Advanced Organic Chemistry (3 Cr. : 3 Lec)

Carbon - carbon bond formation, Enolates, imines and Enamines. Aldol condensations and the Robinson annulation. The Mannich reaction, Wittig and related reactions. Functional group interconversion. Electrophilic additions to carbon - carbon multiple bonds. Reduction reactions and reagents.

CHEM 604 - Advanced Instrumental Analysis (3 Cr. : 3 Lec)

Fourier Transform Infrared Spectroscopy, 1D and 2D - nuclear magnetic resonance experiments, Mass Spectrometry, high resolution MS, accurate mass measurements and isotope ratios and ultraviolet spectroscopy, applications of the Woodward - Fieser rules. Extensive application of spectral analysis for the identification of chemical structures and interpretation of data.

CHEM 621 - Advanced Physical Chemistry (3 Cr. : 3 Lec)

A more advanced treatment of a fundamental topic of current interest in physical chemistry.

CHEM 642 - Advanced Inorganic Chemistry (3 Cr. : 3 Lec)

Oxygen and sulfur compounds as ligands and their metal complexes. Dinitrogen and nitrogen compounds as ligands and their metal complexes. Metal-Metal bonds (energy diagram and configuration, examples on complexes with triple and quadruple metal - metal bonds) spectroscopy terms of transition metals and their complexes.

CHEM 698 - Independent Study (3 Cr. : 3 Lec)

Research project related to the field of interest of the students.

Elective Courses***CHEM 608 - Advanced Physical Organic Chemistry (3 Cr. : 3 Lec)***

Quantitative structure and reactivity relationship. Reagents and reactions. Kinetics and energetics of organic reactions. Investigations of reaction mechanisms. Nucleophilic substitution at a saturated, aromatic and heterocyclic carbon atom. Free radical reactions. Electrophilic substitution in aromatic systems. Carbonyl addition, linear free energy correlations. Symmetry controlled reactions. Stereochemistry of some important reactions.

CHEM 611 - Advanced Topics in Physical Chemistry (3 Cr. : 3 Lec)

Advanced topics in physical chemistry by staff members.

CHEM 613 - Advanced Topics in Organic Chemistry (3 Cr. : 3 Lec)

Advanced topics in organic chemistry by staff members.

CHEM 615 - New Synthetic Reactions & Catalysts (3 Cr. : 3 Lec)

Recent highlights of new synthetic reactions and catalysts for efficient organic synthesis. Mechanistic details as well as future possibilities will be discussed.

CHEM 618 - Advanced Physical Chemistry for Pharmacists (2 Cr. : 2 Lec)

Kinetics of simple and complex reactions. Effect of temperature on reaction rates. Determination of reaction mechanism. Chain reactions and kinetics of fast reactions. Kinetic isotope effect. Reactions in solutions. Theories of solvation. Solvent types and properties. Solvent effects on reaction rates and mechanisms.

CHEM 619 - Radiation Uses & Protection (3 Cr. : 3 Lec)

Natural and artificial radiation sources, high - energy radiations; α , β , γ and accelerated electrons. Matter - radiation interaction, dose measurements, dosimetry physical and chemical measurement techniques. Radiation chemistry of aqueous systems, radiation technology and radiation protection.

CHEM 620 - Advanced Topics in Inorganic Chemistry (3 Cr. : 3 Lec)

Advanced topics in inorganic chemistry by staff members.

CHEM 622 - Advanced Quantum Chemistry (3 Cr. : 3 Lec)

Solution of Schrodinger equation for the rigid rotator and harmonic oscillator systems. Theoretical explanation of the rotational and vibrational spectra of diatomic molecules. The rotational fine structure of a vibrational transition in diatomic molecules. The nonrigidity and anharmonicity corrections. Roothaan's equation for closed shell system. The ZDO approximation. The PPP method and other semiempirical methods. A brief introduction to ab initio methods.

CHEM 624 - Ionic Processes in Solution (3 Cr. : 3 Lec)

Ion - Solvent Interactions. Ionic solvation in mixed aqueous solvents. Selective solvation of ions in mixed solvents. Determination of selective solvation by transference number, EMF, conductivity and solubility methods. Solute - Solvent interactions. Determination of ionic solvation in non - aqueous water mixtures. Determination of apparent and partial molar volumes of ions in aqueous and non - aqueous solutions from density measurements. Absolute densities and excess volume calculations. Thermodynamics of mixed ionic/non-ionic surfactant system.

CHEM 629 - Applied Techniques in Chemistry (3 Cr. : 3 Lec)

Experimental or theoretical work carried on by the student under the supervision of staff members.

CHEM 630 - Advanced Heterocyclic Chemistry (3 Cr. : 3 Lec)

Synthesis and reactions of different types of fused heterocyclic ring.

CHEM 631 - Advanced Inorganic Reactions Mechanisms (3 Cr. : 3 Lec)

Oxidative addition, reductive elimination, insertion and elimination. Kinetics and mechanisms of reactions of transition metal complexes. Homogenous catalysis of organic reactions. Heterogeneous catalysis.

CHEM 632 - Natural Products (3 Cr. : 3 Lec)

Classification of natural products, natural products in medicine, antibiotics and carbohydrates.

CHEM 636 - Advanced Organic Synthesis (3 Cr. : 3 Lec)

Advanced synthetic methods and procedures, reagents, mechanisms and design of synthetic processes.

CHEM 637 - Advanced Chemical Kinetics (3 Cr. : 3 Lec)

Pitfalls in chemical kinetics. Determination of reaction mechanism. Analysis of non - linear Arrhenius plots. Salt effect on reaction rate and mechanism. Effect of ion - pairing on reaction rate and mechanism. Mechanism of catalytic reactions.

CHEM 640 - Solvent Effects on Reaction Rate (3 Cr. : 3 Lec)

Solute - Solvent interactions. Structure of water. Binary mixtures. Theories of solvation and selective solvation. Classification of solvents. Solvent effects on reaction rates and mechanisms.

CHEM 641 - Advanced Electrochemistry (3 Cr. : 3 Lec)

Physical principles of electrochemistry. Thermodynamics and potential, charge transfer kinetics and mass transfer. Double layer structure and adsorbed intermediates in electrode processes. Fundamentals of kinetics and mechanisms of electrode reactions. Applications and instrumentations of modern electrochemical techniques.

CHEM 644 - Advanced Topics in Analytical Chemistry (3 Cr. : 3 Lec)

Advanced topics in analytical chemistry by staff members.

CHEM 699 - Thesis (6 Cr.)**PhD Degree*****CHEM 715 - Advanced Organometallic Chemistry (3 Cr. : 3 Lec)***

π - acid ligands, carbon monoxide and metal carbonyls. Alkene, Arene and cyclopentadienyl metal complexes. Synthesis and reactivity.

CHEM 702 - Organic Synthesis & Structure (3 Cr. : 3 Lec)

A close consideration of the mechanism, applicability and limitations of the major reactions in organic synthesis. Stereochemical control in synthesis. Advanced NMR techniques for structure elucidation. H.C. Brown equation, selectivity and reactivity, vocabulary of carbonyl compounds. Linear free energy relationship, Hammett postulate.

CHEM 703 - Advanced Organic Reactions (3 Cr. : 3 Lec)

Reductions and oxidations of organic compounds, catalytic hydrogenation and dehydrogenation, metal hydride reductions and related reactions, oxidation of Cr and Mn compounds, oxidation with peracids and other peroxides, synthetic uses of silicon and boron.

CHEM 704 - Tactics of Organic Synthesis (3 Cr. : 3 Lec)

A dissection of the most important syntheses of complex natural and unnatural products. Synthesis planning and methodology. The logic of synthesis. Biogenesis. Chemistry of flavinoids.

CHEM 705 - Advanced Project in Inorganic Chemistry (3 Cr. : 3 Lec)

Theoretical and or experimental detailed study of a special topic in inorganic chemistry under the guidance of a faculty member.

CHEM 706 - Electrolytic Conductance & Ion Association (3 Cr. : 3 Lec)

The nature of electrolyte solutions. Classification of solvents. Ion - Ion Interactions. Debye - Hückel theory. Debye - Onsager equation. Fuoss - Kraus and Shedlovsky treatments. Ion pairing. Lee - Wheaton conductance equations. The effect of solvent structure on ionic mobility in aqueous solvent mixtures. Evaluation of ionic radii, transference number, Walden product of ions and ion - pair formation.

CHEM 707 - Advanced Project in Organic Chemistry (3 Cr. : 3 Lec)

Theoretical and or experimental detailed study of a special topic in organic chemistry under the guidance of a faculty member.

CHEM 708 - Heterogeneous Catalysis (3 Cr. : 3 Lec)

Investigation of the chemical structure and physical characteristics of heterogeneous catalysts, support materials, metallic catalysts, zeolites, selectivity of catalysts, diffusion into catalysts, poisoning of catalysts, reactivation of catalysts, industrial catalytically processes. Hydrogenation and oxidation catalysts and their industrial applications.

CHEM 709 - Computational Physical Chemistry (3 Cr. : 3 Lec)

Basic Transition State Theory. Variational Transition State Theory. Tunneling and Microcanonical Rate Concepts. Computational Practices using GAUSSIAN and POLYRATE Computer Programs.

CHEM 710 - Advacend Characterization Techniques (3 Cr. : 3 Lec)

Advanced electrical, optical, magnetic and ion beam characterization techniques including deep level transient spectroscopy, photo - luminescence, electron paramagnetic resonance, and Rutherford backscattering.

CHEM 711 - Advanced Project in Analytical Chemistry (3 Cr. : 3 Lec)

Theoretical and or experimental detailed study of a special topic in analytical chemistry under the guidance of a faculty member.

CHEM 712 - Advanced Project in Physical Chemistry (3 Cr. : 3 Lec)

Theoretical and or experimental detailed study of a special topic in physical chemistry under the guidance of a faculty member.

CHEM 713 - Research Seminar (3 Cr. : 3 Lec)

Preparation and presentation of seminars on specialized topics.

CHEM 799 - Thesis (22 Cr.)

Department of Biological & Environmental Science

MSc Degree in Biology / Biochemistry (36 credit hours)

Program Description

- The Master Degree requirements consist of 36 credits
- The student must register 30 course credits and 6 thesis credits
- The 30 course credits should contain 9 credits of obligatory courses and 21 credits from the list of offered courses
- To achieve a specialization in one of the programs, a student should complete a minimum of 15 credits of courses within that program with a satisfactory grade, out of the 21 required credits

Obligatory Courses

Cr.

BIOL	608	Technical Writing & Research Skills	2
BIOL	610	Research Techniques	3
BIOL	612	Current Topics Seminar	2
BIOL	664	Biostatistics	2

MSc & PhD Degrees Courses

MSc Degree

BIOL 608 - Technical Writing & Research Skills (2 Cr. : 2 Lec)

Guidelines for better technical writing: Research proposals, abstracts, citing scientific references properly. Accessing the Literature, efficient database searches, important journals in the field, reliable online resources. Anatomy of a science paper. How to give effective oral presentations. Writing a professional C.V.

BIOL 609 - Protein Structure & Function (3 Cr. : 3 Lec)

Detailed protein biochemistry with emphasis on the interrelated roles of protein structure, catalytic activity, and macromolecular interactions in biological processes. Protein modifications. Protein structure determination by X - ray crystallography, nuclear magnetic resonance spectroscopy and electron microscopy, protein structure prediction by computational methods, pathways of protein folding and prion proteins.

BIOL 610 - Research Techniques (3 Cr. : 2 Lec : 3 Lab)

A core course that provides practical experience in a variety of techniques currently employed in biological research, providing an understanding of their application and result interpretation.

BIOL 611 - Genetic Engineering (3 Cr. : 3 Lec)

Overview of genetic engineering techniques. DNA cloning, DNA libraries, identification of disease genes. Techniques used to reveal the function of genes & proteins. Transgenic plants & animals. Introduction to the applications of genetic engineering techniques in biotechnology such as bioreactor organisms and gene therapy.

BIOL 612 - Current Topics Seminar (2 Cr. : 2 Lec)

A seminar series of selected current topics offered by the faculty members of the department of Biological and Environmental Science.

BIOL 613 - Advanced Molecular Genetics (3 Cr. : 3 Lec)

Overview of complex genotype / phenotype relationships and genetic disorders. Understanding the variability of genetic background and diseases through incomplete penetrance, epigenetic and environmental factors, and gene modulators. A review of common genetic disorders. Genetic and functional mapping of disease genes and the future of genetic medicine. Recent advances in pharmacogenomics. Genetic testing and genetic counseling.

BIOL 614 - Diagnostic Microbiology (3 Cr. : 2 Lec : 2 Lab)

Phenotypic and genotypic characterization of the human pathogens. Specimen collection, transport, and processing; Lab identification methodologies for groups of clinically significant organisms; Antimicrobial susceptibility testing.

BIOL 615 - Environmental Microbiology (3 Cr. : 2 Lec : 2 Lab)

Microorganisms as a component of the environment, extreme environments, environmental biotechnology, biocontrol of microorganisms causing decay and spoilage, bioremediation of contaminated sites and industrial effluents, role of plants and microorganisms in bioremediation processes.

BIOL 616 - Advanced Molecular Biology (3 Cr. : 3 Lec)

Advanced topics in cellular molecular biology such as protein trafficking, cytoskeleton dynamics, cell locomotion, cell cycle regulation, signal transduction, cell - cell interaction. DNA repair and homologous recombination. Visualizing cells using molecular techniques.

BIOL 617 - Advanced Medical Biochemistry (3 Cr. : 3 Lec)

Overview of blood molecules, function of plasma proteins, and their relation to human diseases, jaundice types and causes, porphyria, hemoglobinopathies, blood coagulation; Bleeding disorders; Phases of blood hemostasis and clinical significance. Diabetes Mellitus: Metabolic changes and treatment. Thyroid gland: Production and function of thyroid hormones, thyroid diseases. Collagen disorders: osteogenesis imperfecta, Marfan's syndrome, rheumatoid arthritis. Review of case studies.

BIOL 618 - Biochemical Regulation & Signal Transduction (3 Cr. : 3 Lec)

A study of metabolic regulation in biochemical processes and pathways emphasizing theories of metabolic flux and enzyme regulation in the context of cellular signaling processes. Theories of metabolic flux, signal transduction pathways, fundamental regulatory mechanisms, such as allosterism, covalent protein modification, induction and protein degradation are discussed.

BIOL 619 - Advanced Biochemistry (3 Cr. : 2 Lec : 2 Lab)

Glycoconjugates: Glycolipids, glycoproteins, proteoglycans; Processing of lysosomal enzymes: Glycosylation, Man phosphorylation, man - 6 - P receptor; Phospholipases: Subtypes, formation of lipids - derived messengers, activation of protein kinase C; Protein kinase C: Subtypes, mechanism, cell function; Gangliosides in cell growth and apoptosis. Eicosanoids: Prostaglandins, prostacyclins, leukotrienes, thromboxanes, Cox - 2 inhibitors, Cox - 2 in human cancer.

BIOL 620 - Concepts in Development, Self Renewal & Repair (3 Cr. : 3 Lec)

Explore the developmental mechanisms that persist through the entire life cycle. In depth analysis of cells and tissues that undergo cell fate restriction, commitment, differentiation and yet retain the ability to renew themselves following normal wear or wounding. General developmental mechanisms that are essential for both tissue formation and self - renewal. Methods used to study stem cells in vivo, explore new frontiers of regenerative tissue biology in simple and emerging model organisms.

BIOL 621 - Topics in Human Physiology (3 Cr. : 3 Lec)

Selected contemporary topics in physiology using directed reading of current literature.

BIOL 622 - Neurobiology (3 Cr. : 3 Lec)

Detailed topics in neurobiology: Chemical and electrical synapsis; Classes of neurotransmitters; Synaptic plasticity; Neuroendocrinology: Hypothalamo - hypophyseal thyroid action and neurohormones. Neuropathology: Roles of neurohormones in bone remodeling.

BIOL 623 - Applied Microbiology (3 Cr. : 2 Lec : 2 Lab)

Microbial enzymes, alkaloids, toxins and bacteriocins. Other microbial products: Bioinsecticides, biopolymers, biosurfactants. Production and pathways. Biotransformation pathways.

BIOL 624 - Advanced Bacteriology (3 Cr. : 2 Lec : 3 Lab)

Basis of bacterial identification (numerical, phenotypic and genotypic characteristics). Detailed study of the characteristics of archaeobacteria and actinomycetes and their biological applications.

BIOL 625 - Topics in Gene Expression (3 Cr. : 3 Lec)

Covers both biochemical and genetic studies in regulatory mechanisms. RNA silencing in gene expression regulation. How gene expression signatures of tumors and disease are the new frontier in molecular medicine. The technologies that make high throughput gene expression analysis possible and how they are used in research and medical laboratories.

BIOL 626 - Biodiversity & Pollution (3 Cr. : 2 Lec : 2 Lab)

Air and atmospheric pollution; water, land and soil pollution; environmental factors affecting biodiversity; impact of loss of biodiversity; principles of environmental toxicology; hazard assessment; carcinogen risk assessment. Laboratory Topics: animal handling and tissue collection, routes of toxicants administration, markers of exposure to environmental toxicants; mechanisms of acute toxicity: hypoxia, mechanisms of metabolic (endogenous) toxicity, analysis of volatile toxic agents, analysis of non-volatile toxic agents.

BIOL 627 - Diseases & Natural Products (3 Cr. : 3 Lec)

This course is designed to introduce students to the numerous natural compounds that show promise in the treatment of diseases and the mechanism-based approaches to treatment using these compounds. In addition, the course provides information on the research designs, protocols and assays involving natural compounds.

BIOL 628 - Experimental Embryology (3 Cr. : 3 Lec)

Differentiation and morphogenesis. Homeobox genes and pattern formation. Experimental methods in studying regeneration. Blastima formation. Neural and chemical induction. From regeneration to tissue repair.

BIOL 629 - Cell Biology Techniques (3 Cr. : 2 Lec : 2 Lab)

Cells with special function: secretory, absorptive, supportive, muscular, nervous. Apoptosis, oncogenesis. Practical: this course introduces students to a variety of advanced laboratory techniques employed in the basic and applied biological research. Part of this course includes seminar presentation by the students.

BIOL 631 - Advanced Biotechnology (3 Cr. : 3 Lec)

Applications of biotechnology in medicine, Mammalian expression systems, Protein engineering, Gene transfer into mammalian cells, Applications of biotechnology in agriculture, Improved/novel uses of microbes, plants, animals, aquatic organisms. The human genome project. Regulations, patents and ethical issues, including the impact on society and the environment.

BIOL 632 - Histopathology (3 Cr. : 2 Lec : 2 Lab)

Overview practical assessment of tissues and organs with the use of the light microscope. Cellular degenerations, inflammation and neoplasia. Various organ systems and their primary disease states will then be presented. These systems include musculoskeletal, nervous, cardiovascular, pulmonary and reproductive.

BIOL 633 - Conservation & Rehabilitation in Ecology (3 Cr. : 3 Lec)

Reasons for conservation, value of wild life, ecosystem services, causes of wild life loss and impact of population growth on natural resources, establishment and maintenance of protected areas, strategies that combine economic activities and conservation over entire regions.

BIOL 634 - Soil Microbiology (3 Cr. : 2 Lec : 2 Lab)

Exploring the soil microbial community such as fungi, prokaryotes and viruses. Soil as a microbial environment. Nutrient cycles of soil microorganisms. Soil microbial interactions. Effect of soil microorganisms on environmental quality.

BIOL 635 - Marine Microbiology (3 Cr. : 2 Lec : 2 Lab)

The class explores microbes and microbial processes in marine environments. Marine microbial habitats. Methods in marine microbiology. Effect of nutrient concentrations and extreme environmental conditions. Classes of marine microorganisms. Role of microbes in marine processes. Beneficial and detrimental effects of marine microorganisms.

BIOL 636 - Tissue Culture Techniques (3 Cr. : 3 Lec)

Overview of tissue culture techniques. Isolation of primary cells. Preservation and propagation. Differences between cell lines and primary cells. Media and instrumentation. Transfection, electroporation, and transduction techniques. Marker molecules and marker genes such as GFP in tissue culture. Microscopic and macroscopic analysis. Harvesting cells. Result interpretation. Tissue culture of stem cells and embryoid bodies.

BIOL 637 - Advanced Virology (3 Cr. : 3 Lec)

Study of the pathogenesis of representative plant and animal viruses, the infection process and representative diseases of plant and man, mechanisms of genome organization and regulation of transcription and translation in the host, host response to viral infection, chemotherapeutic, immunological and genetic control strategies to viral infection.

BIOL 638 - Projects in Bioinformatics (3 Cr. : 2 Lec : 2 Lab)

Project based course investigating the rapid growth in biotechnology paralleled with the explosive growth in information technology and methods of molecular biology. Projects will include biological databases, DNA and protein sequence alignment and searching, gene identification, phylogenetic analysis, population genetics.

BIOL 639 - Population Genetics (3 Cr. : 3 Lec)

Genetic structure of populations and how it changes through time. Evolutionary pressures on populations. Human migrations and genetic origins. Low and High throughput technologies. Genetic background relationship to racial characteristics.

BIOL 664 - Biostatistics (2 Cr. : 2 Lec)

Descriptive statistics. Gaussian probability models, point / interval estimation for means / proportions. Hypothesis testing, including t, chi - square, and nonparametric tests. Simple regression / correlation. ANOVA. Health science applications using output from statistical packages. Two - way ANOVA, interactions, repeated measures, general linear models. Logistic regression for cohort and case - control studies. Loglinear models, contingency tables, poisson regression, survival data, Kaplan - Meier methods, proportional hazards models.

BIOL 699 - Thesis (6 Cr.)***BCHM 699 - Thesis (6 Cr.)***

PhD Degree

- Biology / Biochemistry (40 credit hours) -

Program Description

- The PhD Degree requirements consist of 40 credits
- The student must register 18 course credits and 22 thesis credits
- The 18 course Credits should be selected from an offered list of comprehensive courses dealing with current topics
- PhD courses are based on directed reading, literature review, instructor discussions and special projects

PhD Degree

BIOL 701 - Advanced Immunology (3 Cr. : 3 Lec)

Innate immune system (anatomical barriers, mechanical removal, and bacterial antagonism, abnormal flora. The complement system: An overview, cells involved in body defense, inflammation). Acquired Immune System (humoral immunity, cell - mediated immunity, vaccines and adjuvants, disorders of the immune response (immunosuppression, hypersensitivities, autoimmunity) tumour immunity, immunological techniques. immunotherapy.

BIOL 702 - Ecological Effects of Pollutants (3 Cr. : 3 Lec)

Oriented course examining the effects of pollutants in natural and human-dominated ecosystems. Topics include identification and qualification methods, contaminant sources and effects, predictive methods and restoration.

BIOL 703 - Cellular Pharmaco - Toxicology (3 Cr. : 3 Lec)

Principles, definitions and techniques of cell cultures, methods of cell culture in pharmacology, toxicology and their future perspectives, evaluating environmental pollution using cell cultures, cell cultures and the study of anti - cancerous drugs, cell cultures and dermo - cosmetology: Fundamental, clinical and cosmetic aspects. Scientific articles analysis in relation with the subject is performed during tutorials.

BIOL 704 - Cancer, Angiogenesis & Cell Invasion (3 Cr. : 3 Lec)

Cell proliferation, differentiation and apoptosis in the frame of tumor cell and stroma, signal transduction in cancer, cancer genetics, chromosomal alterations, gene expression signature of tumors, epigenetic modifications. Cancer metabolic alterations, invasion and metastasis, tumor angiogenesis, tumor immunology, cancer etiology and epidemiology, principles of anti - cancerous prevention and therapy.

BIOL 705 - Advanced Plant Biotechnology (3 Cr. : 3 Lec)

Recent advances in plant engineering with emphasis on the challenges and potential of important crops and plants in Lebanon and the Mediterranean basin. Cloning, gene modification, and the transformation of plant species will be discussed. Uses of transgenic plants as food, fiber and oil crops, herbicidal and insecticidal transgenic plants, and phytoremediation of pollutants. Ecological and Social impact of plant biotechnology will be addressed.

BIOL 706 - Developmental Biology & Genetics (3 Cr. : 3 Lec)

This course will explore the application of genetic tools in model systems for the analysis of developmental events. The construction of a metazoan organism involves a continuum of events, from gross patterning of the embryo and the generation of the right number of cells, to the determination of an appropriate array of cell fates, to the differentiation and coordinated morphogenesis of each tissue.

BIOL 707 - Problems in Cellular & Molecular Immunology (3 Cr. : 3 Lec)

Mechanisms of generation of variability; recognition by the T - Cell receptor; Regulation of immune recognition in the nervous system; Lymphocyte activation cascades; Immunotherapy for cancer; Viral immune - modulation; immunological memory; Cytokines in rheumatoid arthritis.

BIOL 708 - Protein Sorting & Vesicular Trafficking (3 Cr. : 3 Lec)

The current literature will be used to investigate controversies and discoveries in protein sorting and trafficking. Medical and pharmacological repercussions will be introduced, as well as the topics importance in therapeutic drug delivery and gene therapy.

BIOL 709 - Molecular Toxicology (3 Cr. : 3 Lec)

Molecular toxicology attempts to understand the mechanisms by which hazardous compounds cause their toxic effects. The course will focus on our understanding of the important tissue and cellular components involved in chemical exposure from entry to effect to exit. Topics include metabolism and mechanisms of toxins, toxicogenomics, toxin effects in individuals and groups, and tools to predict toxicology.

BIOL 710 - Seminar in Biochemistry (3 Cr. : 3 Lec)

Special topics in Biochemistry.

BIOL 711 - Bacterial Biochemistry (3 Cr. : 3 Lec)

An essential overview of bacterial metabolism including, bacteria nutrition, ATP synthesis, aerobic and anaerobic growth on various substrates, bacterial fermentation, chemolithotrophic and phototrophic metabolism, fixation of molecular nitrogen, regulation of bacterial metabolism. Discussion of the most recent discoveries and their related topics.

BIOL 720 - Functional Genomics (3 Cr. : 3 Lec)

Experimental functional genomics, computational prediction of gene function, and properties and models of complex biological systems. The course will primarily involve critical reading, discussion of current literature, and exercises in bioinformatics.

BIOL 713 - Yeasts & Technology (3 Cr. : 3 Lec)

Exploration of the world of yeast: Classification, reproduction, sporulation, hybridization, biochemical aspects. Carbon and Nitrogen containing compounds. Modifiers and Metabolism. The exploitation of yeasts by man.

BIOL 722 - Advanced Phycology (3 Cr. : 3 Lec)

Classification, description of different groups of algae. Habitat and lifecycle. Economic importance and biotechnological applications. Evolutionary relationships between different types.

BIOL 715 - Seminar in Microbiology (3 Cr. : 3 Lec)

Special topics in microbial diversity: Food microbiology and mycology, medical mycology. Viral pathogenesis, viral epidemics of the twenty first century.

BIOL 716 - Bioinformatics of Prokaryotes (3 Cr. : 3 Lec)

This course explores the theory and practice of biological database searching and analysis as pertaining to research on prokaryotic organisms such as bacteria, yeast and viruses. Information about Prokaryotes are discussed and many practical examples in a computer laboratory setting enable students to improve their data mining skills. Methods included in the course are searching the biomedical literature, sequence homology searching and multiple alignments, protein sequence motif analysis, and several genome analytical methods.

BIOL 717 - Seminar in Enzymes (3 Cr. : 3 Lec)

Advanced study in enzyme biology: Isolation, clinical importance, regulation, mechanisms, and engineering.

BIOL 798 - Directed Individual Study (3 Cr.)***BCHM 798 - Directed Individual Study (3 Cr.)******BIOL 799 - Thesis (22 Cr.)******BCHM 799 - Thesis (22 Cr.)***

MSc & PhD Degrees in Environmental Science

MSc Degree

- Environmental Science (36 credit hours) -

Program Description

- The Master Degree requirements consist of 36 credits
- The student must register 30 course credits and 6 thesis credits.
- The 30 course credits should contain 12 credits of obligatory courses and 18 credits from the list of offered courses.
- To achieve a specialization in one of the programs, a student should complete a minimum of 12 credits of courses within that program with a satisfactory grade, out of the 18 required credits

Obligatory Courses**Cr.**

BIOL	608	Technical Writing & Research Skills	2
BIOL	610	Research Techniques	3
BIOL	612	Current Topics Seminar	2
BIOL	664	Biostatistics	2
ENVI	606	Ecosystem Types	3

MSc Degree Courses***ENVI 601 - Pollution Microbiology (3 Cr. : 3 Lec)***

Microorganisms and microbiology of pollution; Important roles, direct and indirect effects of microbes in causing pollution problems; Use of microbiological indicators for quality assessment; Application of microorganisms in environmental mitigation; Field studies included. Microorganisms and microbiology of waste water; Factors affecting microbial activities on waste water treatment systems; Analysis of problems and process control for efficient operation; Field studies included.

ENVI 602 - Ecology, Conservation, & Culture (3 Cr. : 3 Lec)

This course will examine principles of ecology and conservation biology through field research in a natural setting. Students will participate in research projects emphasizing analyses of biodiversity, population demography, species interactions, or behavior. Study of interactions of organisms with their environment, including growth and regulation of populations, energetic of organisms and ecosystems, life - history evolution, and community ecology.

ENVI 603 - Groundwater Resources & Protection (3 Cr. : 3 Lec)

Review the fundamental principles of groundwater and watershed hydrology, water quality, and water contamination. Overview of the most common tools for measuring, monitoring, and assessing groundwater and surface water resources. Management, assessment, and protection of water resources.

ENVI 604 - Risk Assessment & Management (3 Cr. : 3 Lec)

Definition, scope and field of application environmental impact assessment (EIA) methodologies of EIA. Assessment of impacts. Socio - economic effects & impacts, national and international legislation of EIA. Discussion of case studies. Environment assessment and its implementation.

ENVI 605 - Biological Effects of Air Pollution (3 Cr. : 3 Lec)

Structure and function of the respiratory system and the changes that may be produced by specific air pollutants, such as ozone, SO₂ and fine particles. Air quality criteria and the economic costs of disease are discussed.

ENVI 606 - Ecosystem Types (3 Cr.)

An overview of the general principles of ecosystem, types; Survey of the different ecosystems; forest ecosystems, grassland ecosystems, freshwater ecosystems, ocean and coastal ecosystems, fragile ecosystems, and human-dominated ecosystems. Delta, Western Desert, Dunes, coastal and marine areas, Coral reefs, fresh water marches, salt water marches, fresh water swamps, fresh water lakes and mangroves.

ENVI 608 - Environmental Geochemistry (3 Cr. : 3 Lec)

This course explores the fundamental geochemical processes which affect the fate and transport of inorganic and organic pollutants in both aquatic and terrestrial environment. The course will cover both equilibrium and kinetic descriptions of the processes which affect the fate of pollutants. Link the effects of these processes on pollutant bioavailability, remediation and ecotoxicology.

ENVI 611 - Coastal Zone Management (3 Cr. : 3 Lec)

Introduction to coastal management in the context of environmental policy and natural resource management. Management of coastal land resources. Management of coastal water resources. Managing the countryside and coast, managing water quality, waste management. Analyzing issues and conflicts in coastal zone management (CZM), such as: zoning and planning, coastal and beach protection, ecosystem protection (mangroves and coral reefs), coastal pollution from land-based sources, tourism impacts, and oil and gas exploitation.

ENVI 612 - Energy & the Environment (3 Cr. : 3 Lec)

Basic concepts of energy supply, demand, production of heat and power impacts of energy use on the environment. Extensive discussion of mitigation technologies and strategies for meeting energy needs while preserving environmental quality.

ENVI 613 - Natural Hazard Assessments (3 Cr. : 3 Lec)

Description of the most hazardous geologic phenomena-earthquakes, volcanoes, and tsunamis-and their effects. A discussion of how to use existing information to assess the hazards associated with these phenomena and incorporate mitigation measures early in an integrated development study. Sources of geologic data and maps, information with which to make key decisions early in the planning process.

ENVI 615 - The Geology of Pollution (3 Cr. : 3 Lec)

The geologic aspects of pollution. Natural and unnatural (anthropogenic) sources of pollution; how do natural events such as volcanic eruptions forest fires, how dust storms pollute large portions of the world? How much of the pollution found in the world's oceans and ice sheets are natural in origin? How much of the global warming and acid rain problem is natural in origin? Chemical contamination by pollution out of the lithosphere and into the atmosphere, hydrosphere and biosphere, asbestos, radon radioactivity gas, landfills, hazardous (radioactive) waste storage; deep ocean disposal sites, salt dome storage.

ENVI 618 - Marine Pollution (3 Cr. : 3 Lec)

Introduction to coastal pollution. Oil spills and clean - up. Consequences of oil pollution. Heavy metal pollution. Marine hydrodynamics and pollutant dispersion in the marine environment. Thermal pollution.

ENVI 621 - Advanced Groundwater Hydrology (3 Cr. : 3 Lec)

An intensive study of hydrologic, geologic, and other factors controlling groundwater flow, occurrence, development, chemistry, and contamination. Groundwater flow theory and aquifer test methods are introduced. Interaction between surface and subsurface hydrologic systems are covered.

ENVI 627 - Medical Geology (3 Cr. : 3 Lec)

The most recent information on the relationship between toxic metal ions, trace elements, and their impact on the environmental and public health issues; Environmental toxicology, environmental pathology, geochemistry, geo - environmental epidemiology, extent, patterns and consequences of exposures to toxic metal ions in the general environment, biological risk assessment studies, modern trends in metal analysis and updates on the geology, toxicology and pathology of metal ion and dust exposures.

ENVI 632 - Environmental Management Systems (3 Cr. : 3 Lec)

The EMS standards - ISO 14001, the Eco - Management and Audit Scheme (EMAS) and what they mean for a business; Undertaking an initial environmental review; The core planning aspect of environmental management - regulatory & impact issues; Writing an effective environmental policy; Developing and delivering meaningful objectives and targets; Analyzing and establishing operational controls; Building an effective communication, training, and awareness program; The importance of managing change; Making sense of EMS auditing; Understanding the certification / verification process; Achieving continual improvement with an Environmental Management System.

ENVI 637 - Environment & Public Health (2 Cr. : 2 Lec)

Understanding of the physical, biological and sociological environments and how these environments affect the health of individuals and communities. Protecting and improving the human environment; Ensuring safe food and water supplies; Preventing the spread of disease; Preventing and controlling pollution; The safe disposal of wastes; and the implementation of health education programs.

ENVI 642 - Aquatic Chemistry (3 Cr. : 3 Lec)

Chemical equilibrium in natural waters and engineered systems; Development of the theoretical basis for understanding and quantifying the chemical behavior of aquatic systems, with an emphasis on problem solving; The distribution and the cycling of chemical elements and their compounds in the environment are controlled by biotic (biological) and abiotic (chemical) processes; The theoretical framework needed for understanding the chemical composition and predicting chemical processes in natural waters, soil solutions, and waste waters using a chemical equilibrium approach. Understand how abiotic and biotic processes interact to control the biogeochemical cycles of elements in aquatic environment.

ENVI 643 - Solid Waste Management (2 Cr. : 2 Lec)

Characterization, collection, disposal and treatment of municipal and industrial residuals. Emphasis on regulations that control waste management, waste generation rates, waste characterization procedures, the flow of materials in society, materials processing for waste utilization (recycling), and landfill disposal.

ENVI 646 - Air Pollution & Air Quality Management (3 Cr. : 3 Lec)

The effects of air pollution on the environment and public health are explored. Primary pollutants, such as particulates, oxides of sulfur, nitrogen and carbon, hydrocarbons, lead and CFCS are considered, as are secondary pollutants, such as sulfuric acid, PAN, and surface ozone. The effect of atmospheric conditions on the dilution and dispersion of pollutants and the impact of pollution on the global atmosphere are explained. Air pollution disasters and the impacts and ramifications of the Clean Air Act of 1970, its 1990 amendments, and recent international accords are discussed. Case studies of air pollution reduction, management and regulation in local industry are included. Other contemporary topics include the loss of stratospheric ozone and global warming due to man's activities.

ENVI 647 - Hazardous & Toxic Waste Management (3 Cr. : 3 Lec.)

In - depth coverage of hazardous and toxic substance management including legal, economic and technical issues: Characterization of hazardous materials, economics of toxics minimization, hazardous materials use, storage and disposal, technical aspects of landfill siting, and selection and design of treatment technologies. Includes case studies of current waste management issues.

ENVI 649 - Environmental Isotope Geochemistry (3 Cr. : 3 Lec)

Applications of natural and anthropogenic radioactivity as well as variations in the isotope compositions of certain elements (C, H, O, N, S, Sr and Pb) in studies of the natural environment. Isotope geochemistry of Sr and the effects of mixing of two or more components on its isotope composition in water and sediment. Paleoclimatology based on O - isotope records; Isotope composition of water in the hydrologic cycle; Isotope geochemistry of C and N in the biosphere; Isotope geochemistry of S in organic and inorganic compounds.

ENVI 698 - Special Topics (3 Cr. : 3 Lec)***ENVI 699 - Thesis (6 Cr.)*****PhD Degree****- Environmental Science (40 credit hours) -****Program Description**

- The PhD degree requirements consist of 40 credits
- The student must register 18 course credits and 22 thesis credits
- The 18 course credits should be selected from an offered list of comprehensive courses dealing with current topics
- PhD courses are based on directed reading, literature reviews, instructor discussions and special projects

PhD Degree Courses

ENVI 770 - Landscape Ecology (3 Cr. : 3 Lec)

History and definition of landscape ecology, its relationship to other subfields of ecology; Causes of landscape pattern (abiotic, biotic, human land use and disturbance); Data for studying landscapes (GIS, remote sensing); Measuring landscape pattern (spatial statistics, landscape pattern analysis); Landscape disturbance dynamics; Effects of landscape pattern on organisms, populations, communities and ecosystem processes; Conservation ecology at the landscape scale.

ENVI 771 - Chemistry & Toxicology of Pesticides (3 Cr. : 3 Lec)

Pesticide usage; Mechanism of action and toxicity of pesticides; Chemical and physical properties affecting environmental movement and fate of these pesticides; Methods of analysis in biological samples, soil and water samples; Risk assessments; Trends of pesticide usage.

ENVI 774 - Principles of Environmental Informatics (3 Cr. : 3 Lec)

Description. Introduction to environmental data types and structures. Discussion of database design and tools, data warehousing; Environmental information management using Geographic Information Systems (GIS), theory and environmental application of remote - sensing technologies; environmental knowledge management and decision support using knowledge - based systems

ENVI 775 - Contaminated Land & Remediation (3 Cr. : 3 Lec)

This course consists of a series of core and optional taught units covering a range of contaminated land principles, investigation and remediation techniques. Fundamentals of contaminated land. Geomaterials for engineering construction. Remote sensing and GIS. Principles of soil behavior. Environmental auditing and assessment.

ENVI 776 - Environmental Economics & Sustainable Development (3 Cr. : 3 Lec)

Ecological economics starts from the premise that economies are open subsystems of ecosystems, subject to natural "laws" and constraints, such as entropy, carrying capacity limits, and conservation of matter-energy. Theories and evidence regarding the co-evolution of economies and ecosystems. Emphasizes disequilibrium processes, feedbacks, and irreversible change by drawing insights from social and biophysical sciences. Traces the debate about "strong" and "weak" conditions for sustainable economic development, exploring guidelines for sustainable use of natural capital, the "precautionary principle," and international regimes for environmental governance.

ENVI 777 - Genetically Modified Organisms (GMOs) & their Impact on the Environment (3 Cr. : 3 Lec)

DNA manipulation, techniques available for producing tailor - made organisms; Economical impact of GMOs; Release of GMOs into the environment; Risks associated with release of GMOs; Approaches available for monitoring GMOs in an ecosystem.

ENVI 778 - Desert Ecology (3 Cr. : 3 Lec)

Ecology, geology, natural history, and policy issues common to desert regions, composition and structure of desert communities, elevation induced life zones, animal adaptations to desert conditions, ecosystem management tools.

ENVI 779 - Environmental Auditing (3 Cr. : 3 Lec)

Audit findings, audit methodology, scope of audit, available data and information, on - site inspection and investigation, review findings with management, suggestions for further actions / investigations, agree actions needed, assessment of capital and operational requirements, rank actions and establish priorities, prepare program of work.

ENVI 781 - Environmental Radioactivity (3 Cr. : 3 Lec)

Comprehensive evaluation of the levels, distribution, and variability of radioactivity in the environment. Sources and transport of radionuclides in the atmosphere, hydrosphere, and biosphere. Health effects of radioactive pollution from natural sources, nuclear weapons testing, and the nuclear fuel cycle.

ENVI 782 - Sustainable Environmental Uncertainty (3 Cr. : 3 Lec)

This course demonstrates the history and contested understanding of the concept of sustainable development. It applies these concepts to explore important environmental science issues such as population, water management, sustainable cities, rural development, industrial; Ecology, and energy issues. This course provides a range of future scenarios and encourages students to develop their own vision of sustainability at the global and other scales, and to communicate their means of achieving this sustainability vision.

ENVI 783 - Understanding Environmental Uncertainty (3 Cr. : 3 Lec)

This course is designed for those without a science degree background, to explain the need to quantify and what are relevant measures. Describing and understanding uncertainty will be explained in the context of precautionary principles. Issues about measuring biodiversity and spatial and temporal problems of ecological systems will be introduced.

ENVI 798 - Directed Individual Study (3 Cr.)***ENVI 799 - Thesis (22 Cr.)***