Course Contents of the Mathematics Department

MATH 401: Functional Analysis **3 Cr. Hr. (L3+Sc 0)**
Prerequisite: (-)
Metric and topological spaces - Linear metric spaces (Subspaces, dimensionality, factor spsaces, convex sets –norms – Basic Distributions) - Normed linear spaces – Linear operators and funtionals – Banach – Steinhaus theorem – The open mapping and closed graph theorem – Hahn-Banach extension theorem – Weak convergence - Spectral Theory - Banach algebras - Hilbert space (lnner product and Hilbert spaces – Orthonormal sets – dual space)

MATH 402: Abstract Algebra (2) (Rings and Fields) **3 Cr. Hr. (L3+Sc 1)**
Prerequisite: MATH 301
Rings – subrings – Factor Rings and Ideals - Ring homomorphisms and homomorphism theorems. Rings of Polynomials – irreducibility - roots - integral domains - Field of quotient of an integral domain – Unique factorization Domains – Principle ideal domains Euclidean Domains.
Fields - characteristics. - Field extensions – Finite fields – Solution of algebraic equations.

MATH 403: Complex Analysis **3 Cr. Hr. (L3+Sc 0)**
Prerequisite: MATH 204
Functions of complex variable - Analytic functions and their properties - Cauchy-Riemann equations - Harmonic functions - Integration of complex functions – Cauchy's theorems - Cauchy integral formula and its applications - Poles and singularities - Liouville's theorem - Expansions of complex functions - Taylor and Laurent series - Residue calculus and their applications – Conformal mapping and some special transformations.

MATH 404: Partial Differential Equations **3 Cr. Hr. (L3+Sc 0)**
Prerequisite: MATH 202
Partial Differential Equations (PDE) of the first order - Classification of linear second order PDE. PDE of higher order with constant coefficients - Boundary conditions – Fourier series and Fourier Integrals. Applications. (Separation of variables for solving the wave equations, heat equation , Laplace equation, Poisson equation, D'Alembert solution of the wave equations)- homogeneous and non-homogeneous boundary conditions - non-homogeneous parabolic equation - Numerical solutions of parabolic and elliptic equations.

MATH 405: Research project in Pure Mathematics **2 Cr. Hr. (L0+Sc 4)**
Prerequisite:(-)
This course consists of a written essay on some approved topic or topics in the field of pure **Mathematics**, together with a short presentation on the essay

MATH 406: Advanced Linear Algebra **3 Cr. Hr. (L3+Sc 0)**
Prerequisite: MATH 203
Diagonalizability (Review), Matrix Limits and Markov Chains, Invariant Subspaces and the Cayley-Hamilton Theorem, Inner Products and Norms, The Gram-Schmidt Orthogonalization Process and Orthogonal Complements, The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem, Bilinear and Quadratic Forms, The Jordan Canonical Form

MATH 407: Algebraic Geometry 2 Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
Generalities: Prime ideals of commutative rings – Nilpotent – Radicals – Localization of commutative rings – The set of all prime ideals of commutative ring - Theory of Varieties – What is Algebraic Geometry (Commutative Case). Schemes: The Spectrum of a Commutative ring – Presheaves and sheaves – Operations on Sheaves – Quasi Coherent and Coherent Sheaves – Affine Schemes – Schemes. Sheaf Cohomology: Derived Functors – Cohomology of Sheaves – Cohomology of a Noetherian Affine Schemes – The Riemann Roch Theorem. Introduction to Graded Ring Theory – Non Commutative Algebraic Geometry.

MATH 408: Selected Topics in Pure Mathematics 3 Cr. Hr. (L3+Sc 0)
Prerequisite: Department Approval
Mathematics Department offer Selected Topics only occasionally and the selection is different every semester. This Selected Topics course do not repeat material presented by regular semester courses.

MATH 409: Graph Theory2 Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
Embedding of Graphs, connectivity, Eulerian and Hamiltonian graphs, labeled and unlabelled trees, Euler' formula for plane graphs, Graphs on other surfaces, Dual graphs, colouring problems and Chromatic polynomials, Labeling of graphs (Graceful, Harmonious, Cordial, Prime and etc.) - Geometric graphs - Sturm- Liouville differential equations on graphs - General theory of equations of the second order on graphs.

MATH 411: Theory of Solids 3 Cr. Hr. (L3+Sc 0)
Prerequisite: (-)
A. Lattice dynamics:,1. Introduction:lattice and crystals. 2. Classical treatment: Vibrations of atoms - Dispersion relation (Acoustic and Optical branches) - Monatomic and diatomic linear chains. 3. Quantum treatment: The Hamiltonian operator of lattice vibrations - Concept of phonons - Phonons creation and annihilation operators. B. Electrons in solids: Schrodinger equation of conduction electrons - Slater determinant form - Hartree-Fock approximation - The one electron mode -The nearly free electron model- The band structure and the different types of materials - The tightly bound model- The effective mass tensor + The concept of holes - The Fermi energy and surface - The lax two band model.

MATH 412: Statistical Mechanics 3 Cr. Hr. (L3+Sc 0)
Prerequisite: (-)
1. Basic concepts of probability 2. Maxwell distribution. 3.Boltzmann distribution. 4. Relation of Statistics to Thermodynamics:. Equation of state -Thermodynamic meaning of the free energy- Gibbs-Helmholtz equation -Entropy and its thermodynamic meaning - Statistical meaning of entropy -Entropy and the second law of thermodynamics -Real Gas -Heat capacity. 5. Bose-Einstein statistics:Bosons - Bose-Einstein distribution – Photons -Laws of thermal radiation - Phonons. 6.Fermi-Dirac statistics:Fermions -Fermi-Dirac distribution -

Electron gas in a potential well -Non-degenerate electron gas - Degenerate electron gas - Heat capacity of gases with account taken of quantum effects.

MATH 413: Theory of Relativity (Special and General Theory) 3Cr. Hr. (L3+Sc0)
Prerequisite: (-)
1. Basis of special theory of relativity.2. The basis of the general relativity: Mach's principle -Principle of equivalence - Principle of covariance- Principle of minimal gravitational coupling - Corresponding principle. 3. Tensor Analysis: Tensor algebra and tensor density - Affine connection and covariant differentiation - The Riemann Tensor and the curvature tensor. 4. Einstein's field equations: General relativity field equations - Perfect fluid and Newtonian limit - Schwarzchild solutions. 5. Classical test of general relativity: The precession of the perihelion of Mercury -The bending of light - Gravitational red shift. 6. Cosmology.

MATH 414:Celestial Mechanics 3 Cr. Hr. (L3+Sc 0)
Prerequisite: (-)
1.The Solar system. 2. The 2-body problem: Equations of motion - position and velocity - Integrals of motion - Kepler's equation - Elliptic expansions - Barycentric motion - The orbit in space- 3. The Restricted 3-body problem: Equations of motion - The Jacobi constant - Particle paths in the CRTBP - Zero velocity curves - The Tisserand relation - Lagrangian equilibrium points - Stability of equilibrium points - Motion around L4 and L5 - Tadpole and Horseshoe motion - New types of coorbital Motion. 4. The n-Body Problem: The n-body problem - Integrals of the n-body problem. 5. Perturbation in the Elements: Derivations of the equations for the variations of the elements - Applications.

MATH 415: Biomathematics (Discrete processes) 2 Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
1-The theory of linear difference equations applied to population growth: Biological models using difference equations (cell division, an insect population), Propagation of annual plants, Systems of linear difference equations, Qualitative behavior of solutions to linear difference equations, Applications(Growth of segmental organisms, A schematic model of red blood cell production, Ventilation volume and blood C02 levels). 2- Nonlinear Difference Equations: Nonlinear difference equation, Steady states, Stability and critical parameters, The logistic difference equation, Graphical methods for first-order equations, Systems. of nonlinear difference equations, Stability criteria for second-order equations. 3-Applications of nonlinear difference equations to population biology: Density dependence in single-species populations, Two-species interactions (Host-parasitoid systems), The Nicholson-Bailey model, Modification of the Nicholson-Bailey model, model for plant-herbivore interactions.

MATH 416: Research project in Applied Mathematics 2 Cr. Hr. (L0+Sc 4)
Prerequisite:(-)
This course consists of a written essay on some approved topic or topics in the field of applied **Mathematics**, together with a short presentation on the essay.

MATH 418: Cosmology 2 Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
The cosmological principle, Spaces of constant curvature, Hubble's law , The flat space models, Models with vanishing cosmological constant , Classification of Friedmann models, The de Sitter model, The steady-state theory, The event

horizon of the de Sitter universe, Particle and event horizons, Conformal structure of Robertson-Walker space-times, Conformal structure of de Sitter space-time, Inflation.

MATH 421: Numerical Linear Algebra **2 Cr. Hr. (L2+Sc 0)**
Prerequisite: MATH 203
Matrix inversion techniques and applications; spectral radius, techniques of finding eigenvalues of maximum modulus and the corresponding eigenvectors, singular values and the singular value decomposition, solution of systems of linear equations (overdeterminant and underdeterminant systems); direct and iterative methods comparison and error analysis; applications in optimization and other areas.

MATH 423: Research project in Pure Mathematics **1 Cr. Hr. (L0+Sc 2)**
Prerequisite:(-)
This course consists of a written essay on some approved topic or topics in the field of pure **Mathematics**, together with a short presentation on the essay. This course is for double major students.

MATH 424: Research project in Pure Mathematics **2 Cr. Hr. (L0+Sc 4)**
Prerequisite:(-)
This course consists of a written essay on some approved topic or topics in the field of pure **Mathematics**, together with a short presentation on the essay. This course is for double major students.

MATH 432: Quantum Optics **2 Cr. Hr. (L2+Sc 0)**
Prerequisite: (-)
1-Classical electromagnetic fields :Maxwell's equations in a vacuum -Maxwell's equations in a medium - Linear dipole oscillator - Coherence. 2- Density operator : The density matrix - Vector model of density matrix. 3.Field Quantization : Quantized harmonic oscillator and phone number states - Coherent states of the radiation field - Squeezed states of the radiation field - Quantization of the Radiation field. 4. Interaction between atoms and fields: Interaction of Atoms with optical fields in the semi-classical approximation - interaction between atoms and quantized field. 5- Optical stability: Simple theory of dispersive optical bistability- Absorptive optical bistability- Linear stability analysis.

MATH 434: Relativistic Quantum Mechanics **2 Cr. Hr. (L2+Sc 0)**
Prerequisite: (-)
1-Photons: The uncertainty principle in the relativistic case - Quantization of the free electromagnetic field – Photons - The angular momentum and parity of the photon. 2. The Klein-Gordon equation. 3. The Dirac Equation: Dirac equation - Free-particle solution of the Dirac equation - Dirac spinor and γ matrices - Probability density and current density for free Dirac equation -Non-relativistic limits for Dirac solutions - Interpretation for negative solution and hole theory - Charge conjugation and time reversal of spinor - Internal symmetry of particles and antiparticles - Introduction of A^{μ} into Dirac equation and reduction to the Pauli equation - Neutrino as massless spin 1/2 particle. 4. Propagator Theory.

MATH 438: Principles of Statistical Mechanics **2 Cr. Hr. (L2+Sc 0)**
Prerequisite: (-)
1. Basic concepts of probability 2. Maxwell distribution. 3.Boltzmann distribution. 4. Relation of Statistics to Thermodynamics:. Equation of state -Thermodynamic meaning of the free energy- Gibbs-Helmholtz equation -Entropy and its thermodynamic meaning - Statistical meaning of entropy -Entropy and the second law of thermodynamics -Real Gas -Heat

capacity. 5. Bose-Einstein statistics:Bosons - Bose-Einstein distribution – Photons -Phonons. 6.Fermi-Dirac statistics :Fermions -Fermi-Dirac distribution.

MATH 452: Principle ofCelestial Mechanics 2Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
1.The Solar system: Structure of the solar system - Kepler's laws - The Titius-Bode 'law- Resonance in the planetary system . 2. The 2-body problem: Equations of motion - position and velocity - Integrals of motion - Kepler's equation - Elliptic expansions - Barycentric motion - The orbit in space- 3. The Restricted 3-body problem: Equations of motion - The Jacobi constant - Particle paths in the CRTBP - Zero velocity curves - The Tisserand relation - Lagrangian equilibrium points - Stability of equilibrium points - Motion around L4 and L5 - Tadpole and Horseshoe motion - New types of coorbital Motion.

MATH456: Mathematical Models in Biology 4 Cr. Hr. (L3+Sc 2)
Prerequisite: (-)
1-The theory of linear difference equations applied to population growth: Biological models using difference equations Propagation of annual plants, Systems of linear difference equations, Qualitative behavior of solutions to linear difference equations, Application 2- Nonlinear Difference Equations: Steady states, Stability and critical parameters, The logistic difference equation, Graphical methods for first-order equations, Systems. of nonlinear difference equations, Stability criteria for second-order equations. 3-Application of nonlinear difference equations to population biology. 4. continuous models: 5. Phase-plane methods and qualitative solutions 6.Applications of continuous models to population dynamics.7. Models for molecular events

MATH 457: BioMathematics (continuous processes) 2 Cr. Hr. (L2+Sc 0)
Prerequisite: (-)
1- continuous models: Growth of microorganisms, Bacterial growth in a chemostat, Formulating a model, A saturating nutrient consumption rate, Dimensional analysis of the equations, Steady-state solutions, Stability and linearization, Applications 2. Phase-plane methods and qualitative solutions: Nullclines, Steady states, phase-plane diagrams of linear systems, Real eigenvalues, Complex eigenvalues, Classifying stability characteristics, Global behavior from local information, , 3.Applications of continuous models to population dynamics:Models for single-species populations, Predator-Prey systems and the Lotka-Volterra equations, Multiple-species communities and the Routh-Hurwitz Criteria, Qualitative Stability.

Course Contents of the Statistics

STAT 401: Advanced Distribution Theory 3 Cr.Hr.(L3 + Sc0)
Prerequisite: STAT 202
Classifying distributions – the role of parameters- parametric and scale distributions- families of continuous distributions (Pearson system- Bessel function distributions – Burr distributions) - families of discrete distributions (Lattice distributions – Power series distributions – Difference equation systems – Kemp families) - finite mixture distributions. Creating new distributions (multiplication by a constant- Raising to a power- Exponentiation- Mixing and compounding- Frailty models- Splicing- Marshall-Olkin method) – Relationships between distributions.

STAT 402: Research Project **4 Cr.Hr.(L2 + Sc4)**

Prerequisite: Department approval.

The objective of this course is training the student on research work on some approved topic or topics in mathematical statistics with applications on real data. the student's grade is based on a written essay and a presentation with discussion.

Ref.: This course consists of a written essay on some approved topic or topics in the field of mathematical statistics, together with a short presentation on the essay.

STAT 403: Statistical Packages **3 Cr.Hr. (L1+Sc4)**

Prerequisite: Department Approval.

Construct a data file – enter data into a data file – import data – analyze data – interpret the out put with respect to decision making conclusions in light of the data. Apply a statistical package on topics studied in previous courses especially experimental design – regression analysis –etc. .

STAT 404: Probability Theory (II) **3 Cr.Hr. (L3+Sc0)**

Prerequisite: STAT 102+Math 306

Measure space-Probability space-Measurable functions- Definition of integration and properties-Beppo Levi's theorem- Dominated convergence theorem- Borel- Cantelli lemma and its generalized form- random variables having finite *p*th moments -Jensen's inequality-Liapunov's inequality- L^P- spaces- Holder's inequality - Cauchy Schwarz inequality-Minkowsk's inequality- Random variable for which *p*th moment does not exists-Conditional expectation given σ algebra-Definition and properties - martingales- martingales differences-Sub martingales-Supper martingales.

STAT 405: Design and Analysis of Experiments **4 Cr.Hr. (L3+Sc2)**

Prerequisite: STAT 302

Partitioning of sum of squares - One-way analysis of variance (Equal/unequal sample sizes) - Expectation of mean squares and variances tests - Two-way analysis of variance with single observation per cell and missing observations - Two-way analysis of variance (n observations per cell) - Latin square design and missing observations - Greco – Latin square designs and missing observations - Factorial experiments (2^k and 3^p experiments) con founding principle.

STAT 406: Bayesian Statistics **3 Cr.Hr. (L3+Sc0)**

Prerequisite: STAT 302

Logic of probability and uncertainty, conditional probability - Bayes theorem-Prior and posterior distributions - Bayesian inference for discrete random variables - Informative and non-informative prior distributions - Conjugate prior distributions - Loss and risk functions-Bayes risk and minimax estimators - Point and interval Bayesian estimatiors Bayesian Decision theory – Prediction of a Future obseriotion- Elimination of nuisance parameters-Bayesian Robustness.

STAT 407: Applied Statistical Project **3 Cr.Hr. (L0+Sc6)**

Prerequisite: Department Approval.

The objective of this course is training student on collecting, organizing and analyzing real data. The student is asked to present an applied project and make a decision on a certain problem, decided and approved by the department.

STAT 408 Time Series **3 Cr.Hr. (L3+Sc0)**

Prerequisite: STAT 401

The classical time series model - Trend analysis – Analysis of cyclical variation - Measurement of seasonal variations - Applying seasonal Adjustments. Forecasting based on trend and seasonal factors. Cyclical forecasting and Business Indicators. Stationary time series Time Aeries regression.Delomposition methods and exponential smoothing. Introduction to the Bor- Jenkins modeling.

STAT 411: Sequential Analysis **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 302

Sequential experiments-Basic structure of sequential test-Definition and some important properties of the SPRT -Operating characteristic function -Average sample number function of the SPRT- Sequential sampling inspection. Efficiency of a Sequential Test Theory of sequential tests of simple and composite lypo theses a gainst a set of alternatives.

STAT 412: Queuing Theory **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 303

Basic elements of queuing models – single Channel queuing the ory. Kendall's notation for representing queuing models – Queues with combined arrivals and departures– Specialized Poisson queuing models – Multiple exponential channals Non – poisson queuing models deterministic models.

STAT 414: Selected Topics in Biostatistics **3 Cr.Hr. (L3+Sc0)**

Prerequisite: Department approval.

This course could be one of the following topics or any other recent topic on biostatistics approved by the department: Statistical methods in health field- Environmental biostatistics- Advanced categorical data analysis- Clinical trials.

STAT 415: Multivariate Analysis **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 202+Math 205

Multivariate normal distribution-Marginal and conditional distributions-Partial and multiple correlation-The distribution of the sample mean vector, inference concerning the mean when the covariance matrix is known-The distributions and uses of sample correlation coefficients; partial Sample and multiple correlation coefficients. Principle components- Factor analysis. Inferences a bout a mean Vector.Multivariate linear regression msdels .

STAT 416 : Renewal theory **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 102+STAT 204

The renewal functsen – Asy mptotic expansions- computation of the renewal function. Fundamental models of renewal processes- Distribution and moments of the number of renewals-Probability generating function of renewal processes-Number of renewals in a random time -Backward and forward recurrence time of renewal processes-Alternating renewal processes-Strategies of replacement. Renewal – Reward processes.

STAT 417: Decision Theory **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 302

Steps in decision theory approach- Criteria for decision making under condition of certainty- Criteria for decision under conditions of uncertainty- Criteria for decision making under conditions of risk- Maximum likelihood criteria- Expected value criterion for continuously distributed random variables-Bayes' rule for normal distributions- Decision trees and its applications-Theory of games and its applications- Methods of investment analysis.

STAT 418 Stochastic Processes (II) **2 Cr.Hr. (L2+Sc0)**

Prerequisite: STAT 303

Random walk—continuous time Markov chains (birth and death processes, transition probability function, limiting probabilities, time reversibility, computing the transition probabilities)- Renewal theory(distribution of the renewal number N(t), limit theorems and their applications, renewal reward processes, regenerative processes)- Brownian motion and stationary processes(Brownian motion- hitting time, ruin problem, Brownian motion with drift, geometric Brownian motion).

STAT 419: Principles of Demography Analysis **2 Cr.Hr. (L2+Sc 0)**

Prerequisite: Stat 102

Concepts of demography (person- family-household-dwelling unit- population size-population density- age- age pyramid- gender-marital status-area)- Population phenomena (population change factors- fertility- mortality- marriage rate- divorce rate -migration rate)- Population as basis for key ratios (key ratio- indicator for size of population phenomena-cross sectional information- information from the turn of the year- period information - information from a certain time period- cohort- a group experiencing the same event-population subject to population change events- mean population- average for two points of time)- Measurement of population phenomena The life table.

STAT 420: Statistics and programming (For Entomology Curricula)

3 Cr.Hr.(L2+Sc2)

Prerequisite: STAT 212

Tests of independence (χ^2 – Tests: goodness of fit- contingency tables) – Simple and multiple regression and correlation analysis – Non-parametric methods. Use of statistical packages: construct a data file – enter data into a data file – import data from a file stored in another format – record data into new variables – analyze data – interpret the output with respect to decision making and conclusions in light of the data.

~~**STAT 421: Statistics and programming For Biochemistry Curricula)**~~

~~**2Cr.Hr. (L1+Sc2)**~~

~~**Prerequisite:** STAT 321.~~

~~Tests of independence (χ^2 - Tests: goodness of fit – contingency tables) – Simple and multiple regression and correlation analysis – Non-parametric methods. Use of statistical packages: construct a data file – enter data into a data file – import data from a file stored in another format – record data into new variables – analyze data – interpret the output with respect to decision making and conclusions in light of the data.~~

~~**STAT 422: Statistics and programming For biological Curricula 2 Cr.Hr. (L1+Sc2)**~~
~~**Prerequisite:** STAT 212 OR STAT 331.~~

~~Tests of independence – Simple and multiple regression and correlation analysis – Non-parametric methods. Use of statistical packages: construct a data file – enter data into a data file – import data from a file stored in another format – record data into new variables – analyze data – interpret the output with respect to decision making and conclusions in light of the data.~~

STAT 424: Research Project in Statistics **2 Cr.Hr. (L1 + Sc2)**

Prerequisite: Department approval.

The objective of this course is training the student on research work on some approved topic or topics in mathematical statistics with applications on real data using. The student's grade is based on a written essay and a presentation with discussion.

STAT 426: Statistical Research Project in Statistics **3 Cr.Hr. (L2 + Sc2)**

Prerequisite: Department approval.

The objective of this course is training the student on research work on some approved topic or topics in mathematical statistics with applications on real data. The student's grade is based on a written essay and a presentation with discussion.

STAT 428: Statistical Packages and Applications **4Cr.Hr.(L2 +Sc4)**

Prerequisite: STAT 415 or STAT 417

Construct a data file – enter data into a data file – import data – analyze data – interpret the output with respect to decision making conclusions in light of the data. Apply a statistical package on topics studied in previous courses especially modeling and simulation – quality control – decision theory –etc. .

STAT 451: Introduction in Probability Theory and applications

2Cr. Hr. (L2+Sc1)

Prerequisite: (-)

Random experiment-Sample space-Events-Probability axioms-Counting techniques-Conditional probability-Independence-Mutually exclusive events-Bayes theorem-Random

variables ,Distribution functions and properties-Probability generating function ,Characteristic functions and applications-Markov's inequality, Chebyshev's inequality and the central limit theorem(without proof)-The Poisson distribution as an approximation to the binomial distribution- Some application on elementary stochastic processes.

Course contents of the Computer Science

COMP 401: Artificial Intelligence **3Cr.Hr (L3+P 0)**
Prerequisite:(-)
This course aims to give students a solid understanding of the definitions, abstractions, reasoning techniques, and topicsrelated to the field of artificial intelligence (AI). The main focus is on how to build and search structures for solving problems inAI. The course begins by defining agents and distinguishing them from programs in general. Problems in the field of AI that tend to receive the most attention are presented next. Topics include: knowledge representation formalisms; production systems; frame-based systems; semantic networks; types of reasoning; logic languages; inferences in first-order logic; and theorem proving.

COMP 402: Bioinformatics **3Cr.Hr (L3+P 0)**
Prerequisite:COMP 201, COMP 205
Bioinformatics involve the application of computational methods in order to address problems in molecular biology. This course provides an introduction to algorithms and their applications in bioinformatics. Topics include sequence alignment, phylogenetic tree reconstruction, prediction of RNA and protein structure, gene finding and sequence annotation, gene expression, and biomolecular computing.

COMP 403: Parallel and Distributed Processing **3Cr.Hr (L3+P 1)**
Prerequisite:(-)
This course will cover fundamental issues of parallel and distributed processing. Topics include introduction to parallel and distributed systems, architecture models, algorithmic techniques (such as balanced tree, divide and conquer, partitioning), performance evaluations (such as speedup, scalability, and reliability) and programming approaches (such as message passing, data parallel, Master/Slave, and SPMD).

COMP 404: Software Engineering **3Cr.Hr (L2+P 2)**
Prerequisite:COMP 205(or COMP 212 for double major)
Software engineering is the branch of computer science that creates practical, cost-effective solutions to computing and information processing problems, preferentially by applying scientific knowledge, developing software systems in the service of mankind. This course covers the fundamentals of software engineering, including understanding system requirements, finding appropriate engineering compromises, effective methods of design, coding, and testing, team software development, and the application of engineering tools.

COMP 405: Computer Project (A) **2Cr.Hr(L 0+ T 2+P 3)**
Prerequisite: (-)
This course and COMP 406 forms the project of computer science students.Student individuals or groups, during the final year of their studies, undertake full end-to-end development of a substantial project, taking it from initial concept through to final delivery. Topics range from applied software development to assignments on basic research. Students identify their chosen project area and are allocated a supervisor who is a member of the

academic staff, responsible for providing support and guidance. Students are responsible for organizing themselves and their work, with advice from their supervisor with whom they should meet on a regular basis, as agreed with the supervisor.

COMP 406: Computer Project (B) **4Cr.Hr(L 0+ T 4+P 4)**
Prerequisite:(-)
This course informally can be considered as a continuation of research or software carried out in COMP 405.They intend to allow undergraduate students to actively and productively participate in research. This coursecontinues the research and/or software carried out in COMP 405. Itcontinues study, implementing of the selected research and/or software. It also continues generation of a well-documented report, and a presentation of the results.

COMP 407: Image Processing **3Cr.Hr (L3+P 1)**
Prerequisite:(-)
The course focuses on the fundamental techniques in digital image processing. Topics include fundamental of digital image processing techniques such as image sampling and quantization, color, point operations, segmentation, morphological image processing, linear image filtering and correlation, image transforms, eigenimages, multiresolution image processing, noise reduction and restoration, feature extraction and recognition tasks, image registration. Emphasis is on the general principles of image processing.

COMP 408: Advanced Topics in Artificial Intelligence **3Cr.Hr (L3+P 0)**
Prerequisite: (-)
This course covers deeper details about the design and analysis of decisive and rational agents in AI that do the right thing in the face of limited information and computational resources, and how they learn from experience. It explains how various problems in AI are approached differently. Topics vary from one offering to another,but are likely to be drawn from the following list: non-classical logical languages; intelligent multi-agent systems; modern deterministic and decision-theoretic planning techniques; automated reasoning; game theory; basic supervised machine learning methods; Bayesian network inference and learning; cognitive architectures; among other topics.

COMP 409: Network Security **3Cr.Hr (L3+P 0)**
Prerequisite:COMP 204, COMP 308.
The course surveys computer networks and cryptographic tools used to provide security aspects of networks, the web and/or the Internet. Topics include how cryptographic tools are utilized in the network protocols and applications such as security at application layer, transport layer, and network layer (SSL/TLS, IPSEC, Kerberos, PGP, S/MIME, SET). The course may also cover one or more of the following topics: viruses, intrusion, and firewalls.

COMP 410: Computer Vision **3Cr.Hr (L2+P 2)**
Prerequisite:COMP 201, COMP 205.
Computer vision or image understanding is the extraction of information from an image. This course gives insights into the fundamentals of image formation and analysis, as well as the ability to extract information much above the pixel level. Topics include an introduction to classification and recognition, camera models and views, lighting, image features, image motion, color spaces and segmentation, 3D perception, tracking and human visual system.

COMP 411: Computational Geometry **3Cr.Hr (L3+P 0)**
Prerequisite:COMP 201, COMP 205

This is an introductory course on computational geometry and its applications. The primary focus is on algorithms and data structures for processing multi-dimensional and geometric data. The main topics covered in the course include the following: multi-dimensional range searching, convex hulls, intersection detection, polygon triangulation, point location, proximity and voronoi diagram, delaunay triangulation, arrangements, sampling and epsilon nets, and lower bounds.

COMP 412: Selected Topics in Information Security 3Cr.Hr (L3+P 0)
Prerequisite:(-)
The course will focus on the models, the tools, and the techniques for enforcement of security policies. The course covers one or more of the following topics: operating system protection mechanisms, intrusion detection systems, formal models of security, mathematical cryptography, and distributed system security, worms, viruses, secure applications, homeland cyber-security policy, and government regulation of information technology.

COMP 413: Selected Topics in Algorithms 3Cr.Hr (L3+P 0)
Prerequisite:COMP 201
This course covers one or more approaches in algorithms. These approaches focus on trying to design algorithms for solving problems and to accept their (worst case) exponential complexity if they are efficient and fast enough or to accept feasible solution that does near to optimal. Topics include a review of deterministic algorithms for solving problems. The course also contains selecting one or more approaches in algorithms such as approximation, heuristics, and genetic algorithms for obtaining optimal or near to optimal solutions to specific problems.

COMP 414: Selected Topics in Computing 3Cr.Hr (L3+P 0)
Prerequisite:COMP 205
This course aims to enable students to use one or more modernarchitecturesto provide solutions to problems encountered in a range of fields of science. This course covers one or more approaches in modern computing such as mobile computing, grid computing, cluster computing, cloud computing, wireless computing, multicores computing, graphical process units computing. The course includes architecture models, algorithmic techniques, and programming approaches for the selected models.

COMP 415: Advanced Compilers 3Cr.Hr (L2+P 2)
Prerequisite:COMP 304 and Comp 303
This course is intended to give the students a thorough knowledge of compiler design techniques and tools for modern computer programming languages. This course covers advanced topics in design and implementation of modern compilers. Topics include a review of basic compiler design techniques, the advanced techniques behind compilers construction phases: semantic analyzer and intermediate code generator, selecting one or more approaches in compilers design such as advanced techniques in constructing compilers design and optimizations and code generation techniques.

COMP 416: Data and Web Mining 3Cr.Hr (L3+P 0)
Prerequisite:COMP 207
The course is a road map of data and web mining. The course consists of two parts. Part I introduces knowledge discovery in databases, data mining techniques and concepts, data warehousing, data cleaning and preparation, mining association rules, classification, prediction, clustering. Part II presents web mining, web mining classification, introduction to

techniques of mining information from the web, search engines, web basics and HTTP, web personalization, working with logs, forms, and cookies, user identification and path analysis.

COMP 418: Computer Project (for double major) 3Cr.Hr(L 0+ T 2+P 4)
Prerequisite: (-)
This course forms the project fordouble major computer science students. It focuses on research and analysis that lead to a useful sophisticated piece of software or a good study of theoretical computer science. It includes formal project proposal, generation of a well-documented report, and a presentation of the results. It intends to allow undergraduate students to actively and productively participate in research.

COMP 428: Computer applications in chemistry 2Cr.Hr (L1+P 3)
Prerequisite:(-)
This course provides an introduction to solve problems using a computer. The course teaches how real-world problems in Chemistry can be solved computationally using a computer programming language such as C++ or some Mathematical packages such as MATLAB. For example, topics of MATLAB include simple operations and working with variables, matrices, access matrix elements, matrix operations,relational and logical operators, plotting in two-dimensions, plotting in three-dimensions, interpolation, MATLAB functions, input / output and data management.

COMP 434: Computer applications in Geophysics 2Cr.Hr (L1+P 3)
Prerequisite:(-)
This course teaches how real-world problems inGeophysics can be solved computationally using a computer programming language such as C++ or some Mathematical packages such as MATLAB. Topics may include one or more of the following: solving equations numerically (Newton's Method, the Secant Method, False Position Method), polynomial interpolation (Lagrange Polynomial, Newton Polynomial), curve fitting (Linear Least Squares, Linear Regression, Polynomial Least Squares , Exponential Least Squares - Non Linear Curve Fitting), calculus (Limits , Differentiation, Integration), and image analysis .

Course Contents of the Physics Department

PHYS 401: Solid State II 3 Cr. Hr. (L3+Sc1)
Prerequisite: PHYS 307
Classical DC Transport - Acoustical Properties - Dielectric materials - Doped semiconductors - Principles of semiconductor devices: Quantum Hall Effect- Superconductivity - Magnetic properties - Microscopic Theory.

PHYS 403: Electronics 2Cr (L2+Sc0)
Prerequisite: --
Diodes, Common Diode Applications, Basic Power Supply Circuits, Common Diode Applications: Clippers, Clampers, Multipliers, and Displays, Special Applications Diodes, Bipolar Junction Transistors, DC Biasing Circuits, Introduction to Amplifiers, Common-

Emitter Amplifiers, Other BJT Amplifiers, Power Amplifiers, Field-Effect Transistors, Mosefts, Amplifier Frequency Response, Oscillators

PHYS 404: Nuclear Physics II **3 Cr. Hr. (L3+Sc1)**
Prerequisite: PHYS309
Nuclear models and stability: Mean potential model / The Liquid-Drop Model / The Fermi gas model / The shell model and magic numbers – Nuclear reactions – Fission – Fusion - Accelerators: Van de Graaff / Linear Induction / Cyclotrons / Betatrons – Applications

PHYS 405: Optics II: Atomic Spectra and Laser Physics **3 Cr. Hr. (L3+Sc1)**
Prerequisite: PHYS 303
Interference of electron waves in stationary orbits - Spectral series of hydrogen and alkali elements - Rutherford's atoms - Bohr's stationary orbits - Relativistic correction and space quantization - Fine and hyperfine structure of spectral lines - Line widths - Introduction to molecular spectra - Introduction to lasers - Stimulated transitions: the classical oscillator model - Atomic rate equations - The Rabi frequency - Nonlinear optical pulse propagation

PHYS 407: Physics Research I **1 Cr. Hr. (L0 +P3)**
Prerequisite: (-)
Scientific Thinking - Scientific Method – Research Methodology – Reasoning
Scientific methodology: Observation - Problems – Hypothesis - scientific rationality and basic notions – Research Analysis - Baconian inductivism - Popper's falsificationism – Interpretations -Inductive logic and confirmation theory: the classic problem of induction - the logic of confirmation - Hypothetico-Deductivism - Bayesianism

PHYS 408: Electronics (2) (Digital Electronics) **3 Cr. Hr. (L3+Sc1)**
Prerequisite: PHYS 304
Introduction to Digital Systems , Number Systems, Operations, and Codes , Logic Gates and Gate Combinations Combinational Logic Functions of Combinational Logic, Latches, Flip-Flops, and Timers, Shift Registers, Counters, Programmable Logic, Memory and Storage, Data Transmission, Signal Conversion and Processing , Data Processing and Control, Buses, Networks, and Interfacing

PHYS 410: Physics Research II **1 Cr. Hr. (L0 +P3)**
Prerequisite: (-)
Writing Instructions and Protocols - Scientific Posters and Talks - Evaluating Figures and Making Better Ones - Letters of Recommendation - Constructing a Logical Argument - Revising Technical Manuscripts - Ethics and case studies - Abstract Review - Final Research Talks.

PHYS 411: Elementary Particle Physics **3Cr (L3 +Sc1)**
Prerequisite: (-)
Elementary particle dynamics - Relativistic Kinematics – Symmetries - The Feynman Calculus - Quantum Electrodynamics - Electrodynamics of Quarks and Hadrons - Weak Interactions.

PHYS 412: Group Theory in Physics **3Cr (L3+Sc1)**
Prerequisite: (-)
Symmetry and physics - Symmetry and group theory – Group Theory and Quantum Mechanics - Group representations - group characters - irreducible representations - Product groups and product representations - Induced representations – Continuous Groups -

Applications to Atomic Spectra – Applications to Molecular Spectra – Applications to Solids – Applications to Particle Physics.

PHYS 413: String Theory for Undergraduates 3Cr (L3+Sc1)
Prerequisite: (-)
Energy and momentum - Relativistic electrodynamics - The relativistic point particle - Static gauge, transverse velocity - string action - General motion or open strings - Rotating open strings Solution of the open string motion in the light-cone gauge - Light-cone fields and particles - Open strings - Critical dimension - Closed strings – Superstrings.

PHYS 414 : Theoretical Atomic Physics 3Cr (L3+Sc1)
Prerequisite: (-)
One-electron Atom - Fine and hyperfine structures -Two and many electron Atom Molecular structure and Spectra- Atomic collisions - Applications

PHYS 415: Theory of Quantum Computing 3Cr (L3+Sc1)
Prerequisite: (-)
Introduction to the basic concepts and tools of Classical Information Theory - Quantum Information Theory (QIT) - quantum states, quantum oper ations, generalized measurements

PHYS 416: Selective Topics in Theoretical Physics 3 Cr. Hr. (L3 + P0)
Prerequisite: (-)
Some selected recent topics in theoretical physics given by the department

PHYS 417: Mathematical physics (2) 3 Cr. Hr. (L3+Sc1)
Prerequisite: (-)
Complex plane and complex algebra - Infinite complex series, disc of convergence, complex functions - Euler formula, powers and roots, exponential and trigonometric – functions - Hyperbolic functions, logarithms, complex roots and powers - Analytic functions, Cauchy Riemann conditions, harmonic functions - Contour integrations, Cauchy's theorem, Taylor series- Laurent series, types of singularities - Cauchy integral formula and the residue theorem. - Different methods of finding residues - Calculating real integrals using residues - Real integrals, multivalued functions, branch cuts –Mapping - Review

PHYS 421: Optical Properties of Solids 3Cr (L3+Sc1)
Prerequisite: (-)
Classification of optical processes- The complex refractive index and dielectric constant, Optical Materials- Propagation of light in dense optical media, the dipole oscillator - Electronic levels, Optical absorption and excitons, The quantum confined Stark effect, Optical emission - Electronic states in conjugated molecules.

PHYS. 422 Physics of Non-crystalline solids 3Cr (L3+Sc1)
Prerequisite: (-)
Amorphous semiconductors, structure and structure determination, band structure models, electrical properties and its applications - Molecular structure of glass - The shapes of polymer molecules.

PHYS 423: Magnetic properties of Solids 3 Cr. Hr. (L3+Sc1)
Prerequisite: (-)
Anti-ferromagnetism – Ferromagnetism - Magnetic anisotropy – Magnetostriction - Domain wall structure - Fine particles and thin films - Application of magnetic materials.

PHYS. 424: Physics of nano-materials and their properties 3Cr (L3+Sc1)
Prerequisite: (-)
theoretical basis - synthetic processes - experimental techniques for nano-materials Nanotechnology tools - Uses of Nanotechnology in biomedical applications.

PHYS 425: Photonics 3Cr (L3+Sc1)
Prerequisite: (-)
dielectric waveguides - basics of optical fibre communication - optical properties of crystals and semiconductors - stimulated emission and population inversion - diode laser threshold modulators .

PHYS 426 Physics of Alloys and Composite material 3Cr (L3+Sc1)
Prerequisite: (-)
phase diagram of steel alloys - aluminum alloys and copper alloys - mechanism of corrosion - composite materials and composite manufacturing - autoclave molding of thermoset polymer matrix composites - material behavior and process modeling liquid.

PHYS 431: Acousto Optics 3Cr (L3+Sc1)
Prerequisite: (-)
comprehensive treatment of Acousto-optic theory - photon-phonon interaction in materials - The Sound Field as a Phase Grating - The Sound Field as a Plane-Wave Composition - Coupled Mode Analysis - Normal Mode Analysis - The Generalized Raman-Nath Equations - Weak Scattering Analysis - Plane-Wave Interaction Analysis - Eikonal Theory of Bragg Diffraction - Strong Interaction with Curved Sound Wavefronts - Truncation of the Raman-Nath Equations - Multiple Bragg Incidence - The NOA Method - Successive Diffraction - The Fourier Transform Approach - Selected Applications.

PHYS 432: Optics of Materials 3Cr (L3+Sc1)
Prerequisite: (-)
Wave propagation and dispersion - Optical properties of conductors - Optical properties of insulators - Optical properties of semiconductors - Optical gain and lasers - Nonlinear optical processes in materials.

PHYS 433: Molecular and Laser Spectroscopy 3Cr (L3+Sc1)
Prerequisite: (-)
Electronic states of diatomic and polyatomic molecules - Molecular vibration - Molecular rotation - Rotational spectroscopy - Vibrational spectroscopy - Electronic spectroscopy - Absorption and emission of light - Widths and profiles of spectral lines - Spectroscopic instrumentation - Lasers as spectroscopic light sources - Intensity stabilization - Wavelength stabilization - Nonlinear optical mixing techniques - Difference-frequency spectrometer - Optical parametric oscillator - Tunable Raman lasers.

PHYS 434: Fiber Optics 3 Cr. Hr. (L3+Sc1)
Prerequisite: (-)
Review of electromagnetic theory - Introduction to optical fibers - Basic Waveguide equations, wave and ray optics - Dielectric slab waveguide - The step-index fiber - The

graded-index fiber - Fabrication of optical fibers - Fiber measurements - Fiber system examples.

PHYS 435: Thin Film optics **3Cr (L3+Sc1)**
Prerequisite: (-)
Physics of Thin Films: Introduction and overview, Basic Physics, Chemistry and Materials Science, Solid State Physics, Ideal solids and crystal structure, Defects in solids, Bonds and Electrons, Thermodynamics and Phase Diagrams, Kinetics and Diffusion, Nucleation and Growth. Film Deposition Methods Properties of Thin Films: optical properties, electrical properties, magnetic properties, mechanical properties. Thin Film Characterization, Imaging Techniques, Structural Techniques, Chemical Techniques. Applications for Thin Film of Advanced: Materials, Transparent conducting coating, Optical coating and Sensors. Transmittance, reflection abd absorption measurement and determination the optical constant

PHYS 436 Non-linear Optics **3Cr (L3 +SC1)**
Prerequisite: (-)
introduction to lasers - description of the nonlinear interaction of laser light with transparent materials - multi-photon interactions - Molecular hyperpolarizabilities and macroscopic nonlinearities - Second and third harmonic generation - Wave interaction in anisotropic crystals.

PHYS 437 Quantum Optics **3Cr (L3 +SC1)**
Prerequisite: (-)
introduction to the quantum description of the electromagnetic field - classical optics - canonical quantization of the electromagnetic field - introduction of the corresponding vector space ("Fock space") and field operators - basic case studies of photon-atom interactions in the full quantum approach - cavity quantum electrodynamics.

PHYS 438: Experimental Physics **1 Cr. Hr. (L0+P4)**
Prerequisite: PHYS 382, 448
Selected experiments in electronics and optics

PHYS 441: Nuclear Reactors **3Cr (L3+Sc1)**
Prerequisite: (-)
Reactor Fundamentals - Neutron Sources - Radioactive Decay - Neutron Slowing Down - Power Reactors - Power Reactors - Transport Equation - Delayed Neutrons - Prompt Jump Approximation - Diffusion Equation - Bare Reactors – Reflectors - Control Rods - Burnable Poisons - Energy Transport - Reactivity Feedback – Transients - Reactor Control.

PHYS 442: Neutron Physics **3Cr (L3+Sc1)**
Prerequisite: (-)
Production and Nuclear Interaction of Neutrons - Neutron Sources - Neutron Detectors - Measurement of Cross Sections - Neutron Fields - Application of Elementary Diffusion Theory - Slowing Down - The Spatial Distribution of Moderated Neutrons - Thermalization of Neutrons - The Determination of Flux and Spectrum in a Neutron Field - The Determination of Neutron Transport Parameters.

PHYS 443 Nuclear Detectors **3Cr (L2+Sc1)**
Prerequisite: (-)
theoretical and experimental knowledge of the detection of ionizing radiation - measurement of small currents and charges - pulse height analysis - statistics and dead time corrections -

Gas-, scintillation- and semiconductor detectors - neutron detectors - gamma spectroscopy - experimental determination of activity.

PHYS 444: Charged Particles Accelerators **3 Cr. Hr. (L3+Sc1)**
Prerequisite: (-)
Particle Accelerators an Overview- Relativity for Accelerator Physicists- Building Blocks of Particle Accelerators- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators- Symplectic Maps & Analysis of Maps- Particle Tracking- Linear & Circular Machines- Cyclotrons- Free Electron Lasers- Collective effects in linear approximation- Preview of Particle Accelerator Physics and Modeling II

PHYS 445 Nuclear Medicine **3 Cr. Hr. (L3+Sc1)**
Prerequisite: (-)
review of the structure of atoms and molecules - electromagnetic forces - mass/energy conversion - ionization, and excitation - nuclear structure – stabilities - radioactive series - radioactive decay - Detection of radiation with gas-filled detectors and scintillation detectors - study of uptake probes - bone densitometers - gamma cameras - interfacing with a computer.

PHYS 446: Nuclear Energy Sources and Environment **3 Cr. Hr. (L3+Sc1)**
Prerequisite: (-)
Waste streams - Radioactive waste- High-level waste- Other waste - Power plant emissions- Radioactive gases and effluents (Tritium - Uranium mining) - Risk of cancer - Comparison to coal-fired generation - Contrast of radioactive accident emissions with industrial emissions - Waste heat - Environmental effects of accidents and attacks: Fukushima disaster - Chernobyl disaster -SL-1 meltdown - Attacks and sabotage - Natural disasters - Water Consumption - Greenhouse gas emissions - Sustainability - Decommissioning.

PHYS 447: Selective Topics **3 Cr. Hr. (L3 + P0)**
Prerequisite: (-)
Some selected recent topics in physics given by the department

PHYS 448: Digital Electronics **2 Cr (L2+Sc1)**
Prerequisite:PHYS 356
basics of electronics and digital systems - the building blocks to many products you use - Basic logic operations and functions - integrated circuits - decimal and binary numbers - binary arithmetic - octal numbers - digital codes – AND – OR - NAND and NOR gates - Boolean algebra - shift registers - memories and programming devices - system interfacing - microprocessor-based system.

PHYS 451: Radio Frequency Electronics **3Cr (L3+Sc1)**
Prerequisite: (-)
Fundamentals of wireless communications, Introduction, Electromagnetic fields and waves, transmission line theory and transient signals on lines transmission lines and waveguides, scattering parameters, RF components and circuits Antennas and, Radio wave propagation.

PHYS 452: Telecommunications **3Cr (L3+Sc1)**
Prerequisite: (-)
Introduction to Analog & Digital communications, Introduction, Fourier Representation of signals and systems, Amplitude Modulation, Angle Modulation, Pulse Modulation (Transition from Analog to Digital communications), Baseband Data transmission, Digital Band-Pass

Modulation Techniques, Random Signals and Noise, Noise in Analog Communications, Noise in Digital Communications and system and Noise calculations.

PHYS 453: Microwaves **3Cr (L3+Sc1)**
Prerequisite: (-)
The two-conductor transmission line, emf equations, the wave equation and its solution in waveguides, discontinuities and impedances in waveguides, microwave resonators, microwave tubes, the klystron, the magnetron, the travelling wave tube, microwave semiconductor devices (the gunn diode,the avalanche diodes, microwave transistors).

PHYS 454: Antennas **3Cr (L3+Sc1)**
Prerequisite: (-)
Antennas, Fundamental Parameters of Antennas, Radiation Integrals and Auxiliary Potential Functions, Linear Wire Antennas, Arrays: Linear, Planar, and Circular, Broad band Dipoles and Matching Techniques, Frequency Independent Antennas, Antenna Miniaturization, and Fractal Antennas, Horn Antennas, Microstrip antenna, Smart antenna.

PHYS 455: Electronic Devices and applications **3Cr (L3+Sc1)**
Prerequisite: (-)
Introduction to semiconductor devices & technology, semiconductor physics, semiconductor Devices, semiconductor technology

PHYS 456 : Nano-Electronics **3Cr (L3+Sc1)**
Prerequisite: (-)
Single Electron and Few Electron phenomena and Devices, Tunnel Junction and application of tunneling, Coulomb Blockade and the Single – Electron Transistor, Particle Statistics and Density of states, Models of Semiconductor Quantum Wells, Quantum Wires and Quantum dots, Nanowires, Ballistic Transport, and Spin Transport.

PHYS 457: Signal processing & integrated circuits **3Cr (L3+Sc1)**
Prerequisite: (-)
Introduction (Analog, Digital & Mixed Mode signal processing), Analog (continues Time) and digital signal processing, Analog MOS integrated circuits for signal processing, switched – capacitor and mixed-mode signal processing.

PHYS 458: Experimental Physics **1 Cr. Hr. (L0+P4)**
Prerequisite: PHYS 356, 358
Selected experiments in physics

PHYS 459 Advanced Microscopy and its Applications **2Cr (L2+Sc1)**
Prerequisite: PHYS 315, 337
Confocal Laser Scanning Microscopy (CLSM) - Confocal Fluorescence Resonance Energy Transfer (FRET) microscopy - Spinning disk confocal microscopy - Fluorescence recovery after photobleaching (FRAP), fluorescence loss in photobleaching (FLIP) & photoacivation microscopy - time-domain fluorescence lifetime imaging microscopy (td-FLIM) - frequency-domain FLIM - FRET-FLIM - Fluorescence correlation spectroscopy (FCS) - Live cell tracking microscopy - Controlled light exposure microscopy (CLEM) - Total Internal Reflection Fluorescence (TIRF) Microscopy - super-resolution microscopy (PALM, GS-DIM) - Correlated light and Electron Microscopy (CLEM) - Electron Microscopy and tomography - Flow cytometry and cell sorting

PHYS 461: Nano Physics and Nano Applications 3 Cr. Hr. (L3 + Sc1)
rerequiste: PHYS 337
quantum electronic transport both coherent and incoherent - Coulomb blockade and the quantum Hall effect - The physical description of these phenomena is illustrated by examples from current research in nanophysics.

PHYS 463: Experimental Physics (VII) 2Cr. Hr. (L0+P4)
Prerequisite: PHYS 366
Selected experiments in physics

PHYS 465 Laser optics 3 Cr. Hr. (L3+Sc1)
Prerequisite: PHYS 380
Principles of laser – properties and manipulation of laser light – physical effects and operating principles of photonic components and devices including light modulators, displays and optical fibers – elements of photonic telecommunications.

PHYS 466: Experimental Physics (VIII) 1 Cr. Hr. (L0+P3)
Prerequisite: PHYS 463
Selected experiments in physics

PHYS 467 Solar Energy 2Cr (L2+Sc1)
Prerequisite: PHYS 337, 356
fundamentals of solar energy conversion,solar cells, optical engineering, photoelectrochemical cells, thermoelectric generators, and energy storage and distribution systems. The course covers solar energy insolation and global energy needs,current trends in photovoltaic energy engineering, solar cell material science, design and installation of solar panels for residential and industrial applications and connections to the national grid and cost analysis of the overall system. In addition, basic manufacturing processes for the production of solar panels, environmental impacts, and the related system engineering aspects will be included to provide a comprehensive state-of-the art approach to solar energy utilization.

PHYS 468 Electrical, Optical, and Magnetic Properties of Materials 2Cr (L2+Sc0)
Prerequisite: PHYS 358
Origin of electrical, magnetic and optical properties of materials, simple molecules and bonds, and the behavior of electrons in solids and energy bands. Introducing the variation principle as a method for the calculation of wave functions - How and why materials respond to different electrical, magnetic and electromagnetic fields and probes and study of the conductivity, dielectric function, and magnetic permeability in metals, semiconductors, and insulators. A survey of common devices such as transistors, magnetic storage media, optical fibers.

PHYS 469. Quantum Electronics 2 Cr (L2+Sc1)
Prerequisite: PHYS 315
fundamentals of optical and optoelectronic phenomena and devices - classical and quantum properties of radiation - Maxwell's electromagnetic waves - resonators and beams - quantum theory of light - matter and its interaction - classical and quantum noise - lasers and laser dynamics.

PHYS 470 Semiconductors and its Applications 2Cr (L2+Sc1)
Prerequisite: PHYS 337, 448
Semiconductor physics and optical processes in semiconductors. Operating principles and practical device features of semiconductor optoelectronic materials and heterostructures.

Devices include: optical detectors (p-i-n, avalanche, and MSM); light emitting diodes; electroabsorptive modulators (Franz-Keldysh and QCSE), electrorefractive (directional couplers, Mach-Zehnder), switches (SEEDs); and lasers (waveguide and vertical cavity surface emitting). Prerequisites: semiconductor devices and solid state physics such as EE 216 and 228 or equivalents. Recommended: basic quantum mechanics and lasers such as EE 216 and 231 or equivalents.

PHYS 471: Introduction to Photonic materials 2 Cr (L2+Sc1)
Prerequisite: PHYS337, 356
Photonics, optical sensors, and fiber optics. Conceptual and mathematical tools for design and analysis of optical communication and sensor systems. Experimental characterization of semiconductor lasers, optical fibers, photodetectors, receiver circuitry, fiber optic links, optical amplifiers, and optical sensors. Class project aimed on confocal microscopy for biomedical applications.

PHYS 472 electronic Material 2Cr (L2+Sc0)
Prerequisite: PHYS 315, 335
crystal structure - reciprocal lattice - crystal binding - lattice dynamics - theory of free electrons - energy bands – semiconductor - Fermi-surfaces - magnetism and superconductivity - semiconductor low-dimensional structures and photonic crystals - behavior of light in periodic dielectric media.

PHYS 474: Bases of Crystallography and its Application 2Cr (L2+P0)
Prerequisite: PHYS 358
The crystal structure of materials - symmetries, point groups, and space groups - The theory of X-ray diffraction by crystalline matter - the experimental x-ray methods used to determine the crystal structure of materials - Application of X-ray diffraction to proteins - electron diffraction - neutron diffraction will be briefly discussed.

PHYS 476: Computational Physics and Applications 3 Cr (L3+Sc0)
Prerequisite: PHYS 360
Elements of programming logic -Iterative techniques -Interpolation and Approximation - Function formulation - Recursion techniques - Numerical Integration - Computer Simulation - Numerical solution of differential Equation.

Course contents of Biophysics

BIOP 401 Molecular biophysics (2) 3 Cr.Hr. (L2 + P3)
Prerequisite: BIOP 301
Chemistry and mechanics of biological membranes. The role of membranes in organizing cells, mediating interactions with the outside world, and responding to therapeutic intervention.- Molecular forces in biological media, proteins, protein isolation, crystallization.

BIOP 402 Basis of NMR and Medical Imaging 3Cr.Hr. (L2+P3)
Prerequisite: BIOP 322
Physical Basis of NMR, NMR theory & quantum mechanics, Description of NMR magnetization, interaction of protons with a radio wave, Free Induction Decay (FID), MRI

imaging process, Image Contrast - Introduction to Medical Imaging, X-ray Computed Tomography (CT), CT Scanner – Principle, Image Reconstruction, CT – 5th generation system - fast cardiac imaging, helical or spiral CT.

BIOP 411 Advanced Bio-optics **3 Cr.Hr. (L2 + P3)**
Prerequisite: PHYS 282
Fundamentals of Advanced Optical Technologies, Optical Metrology, Optics in Communication, Optical Material Processing, Optical Material and Systems, Computational Optics, Optics in Medicine

BIOP 412 Biophysical techniques **3 Cr.Hr. (L2 + P3)**
Prerequisite: BIOP 301
Spectroscopy- Microscopy- Chromatography- Electrophoresis- Centrifugation techniques- Ultracentrifugation- Nano Biotechnology

BIOP 421 Medical radioactive isotopes, Radiation Safety and Protection 2Cr.Hr. (L2+P0)
Prerequisite: BIOP 302
Basic nuclear concepts, nuclear reactions, production of radio nuclides, radioactive isotopes in nuclear medicine - Radiation units, radiation detectors, radiation dose meters, absorbed dose limits for public and workers, safety measure principles of radiation protection.

BIOP 422 Structure of Biological Macromolecules by using x-ray **2 Cr.Hr. (L2 + P0)**
Prerequisite: BIOP 331
Survey of different techniques used in getting the structure of biological molecules, Different techniques used to get a crystal, Application of x-ray diffraction methods to get the structure, Structure justification.

BIOP 431: Biomagnetism **2 Cr.Hr. (L2 + P0)**
Prerequisite: PHYS 302& PHYS 362
Origin of magnetism-Diamagnetism-Theory of paramagnetism-Magnetically ordered state-The domain model. Basics of magnetic resonance. Biological applications (magnetic fluid hyperthermia).

BIOP 432 Biomaterials and Prosthesis **2 Cr.Hr. (L2 + P0)**
Prerequisite: PHYS 362
Introduction to biomaterial, Classes of materials used in medicine, metals, ceramics, Glasses and glass ceramics, Polymers, Composites, Biological testing of biomaterials, Degradation of materials in biological environment - Basic principles of orthosis and prosthesis, body motion and the principles of biomechanics, characteristics of biomaterials used in prosthesis.

BIOP 433 General Biophysics (for biochemistry) **3 Cr.Hr. (L2 + P3)**
Prerequisite: (-)
How the human body functions and malfunctions from a physics perspective - applying basic physical principles to organs, cells, and biomolecules

BIOP 441 Project research **2Cr.Hr. (L0+P4)**

Selected recent topics in Biophysics

BIOP 442 Technologies of Biological Thin Film 2Cr.Hr. (L2+P0)
Prerequisite: BIOP 212
Physics of Thin Films- Film Deposition Methods: Physical methods of films deposition Evaporation – thermal, e-beam, Sputter Deposition - DC, MF, RF, Microwave, pulsed laser, Ion Beam Arc Deposition – Cathodic, Anodic, Molecular Beam Epitaxial, Chemical methods of Film deposition, Deposition of Inorganic Films From Solutions, Chemical Vapor Deposition -Electrolysis, Anodization, Spray pyrolysis, polymerization, Other techniques- Properties of Thin Films: optical properties, electrical properties, magnetic properties, mechanical properties. Thin Film Characterization- Applications for Thin Film of Advanced

BIOP 451 Nanotechnology 2Cr.Hr. (L2+P0)
Prerequisite: (-)
the general topics of nanostructures and nanotechnology - conceptual development in quantum physics – confinement - electronic properties and their measurements - new phenomena at nano-scale.

BIOP 452 Electronics of biological systems 3Cr.Hr. (L2+P3)
Prerequisite: BIOP 312
Cable theory and propagation of nerve impulse, electronic devices used in both voltage and patch clamp technique, brain activity and neural nets.

BIOP 461 Planning radiotherapy 2Cr.Hr. (L2+P0)
Prerequisite: BIOP 302
Radiation quantities, Radiation therapy equipment, X – ray machine, Cobalt – 60 machine, Linear machine, Effective energy, Percentage depth dose, Tissue – air ratio, Measurement of absorbed dose, Radiation protection, Personnel monitoring equipment, Brachy therapy, Calibration of brachy therapy sources

BIOP 471 Nuclear Medicine 2Cr.Hr. (L2+P0)
Prerequisite: BIOP 302
Nuclear medicine, Radioactive elements, Isotopes, Gamma-ray camera, Tomographic images, SPECT and PET scanning.

BIOP 472 Control and communication biophysics 2 Cr.Hr. (L2 + P0)
Prerequisite: BIOP 212
Characteristics of control systems, Quantitative description for feedback control, Human body control systems, Voltage gated channels, Body temperature, Cardiac cycle, Pacemaker, Blood pressure, Communication systems chemical communication, Mechanical properties of biological systems.

BIOP 481 Selected Topics 2 Cr.Hr. (L2 + P0)
Prerequisite: ------
Composition and function of blood components, Haemolysis of erythrocytes and its types, Biophysical techniques used to detect haemolysis of erythrocytes, Flow rate and viscosity of blood and their medical applications, Osmosis in the living cells and the osmotic fragility test and their medical applications, Dielectric properties of living cells.

BIOP 482 Biomodeling & Simulation **2Cr.Hr. (L2 + P0)**
Prerequisite: MATH 321
Cable theory– Hodgkin Huxley model, Models in genetics, Compartment model for diabetes mellitus, Models for diffusion in artificial kidney, Models of carrier transport

BIOP 491 Biophysical Techniques in Cancer therapy **2Cr.Hr. (L2+P0)**
Prerequisite: BIOP 302
Different methods for radiotherapy planning techniques, Quality assurance and quality control, Methods of dose verification.

Course Contents of Chemistry Department

CHEM 403:*Physical chemistry* **2 Cr.Hr. (L2+P 0)**
Prerequisite: (-)
Part 1: Electrochemistry: Kinetics of electrochemical reactions: Electrode polarization, types of polarization, Tafel line, cathodic hydrogen evolution, anodic oxygen evolution, anodic dissolution, passivation, theories of rotating disc electrode, rotating ring electrode & their applications, anodic oxidation & cathodic reduction for some organic compounds, organic reactions at electrode surface.
Part 2: Corrosion: Introduction, types of corrosion, corrosion rate, atmospheric corrosion, electrochemical corrosion, Evans diagrams, Pourbaux diagrams, localized corrosion, pitting corrosion, intergranular corrosion, corrosion fatigue, microbiological corrosion, methods of protection, cathodic protection, anodic protection, inhibitors, coatings, types of coatings (metallic, inorganic and organic coatings). Anodization, methods of determination of the rate of corrosion.
Part 3: Polymer Science: Polymers (1) Introduction to polymer Science: Polymer science: classification of polymers – synthesis of polymers – physical states transitions and degradation – molecular weight measurements – characterization and testing of polymers – fabrication processes of plastics - Polymer processing.

CHEM 410: *Solid Wastes Management*1 **Cr. Hr. (L1+P 0)**
Prerequisite: (-)
Types, characteristics, sources, effects and methods of solid waste management: Municipal waste. Industrial waste. Agricultural waste. Medical waste. Demolition waste. Electronic waste. Miscellaneous hazardous waste. Effects of solid waste pollution.Types of waste disposal. Volume reduction. Biodegradation and biological treatment. Land filling.
Incineration and combustion: Pyrolysis. Microwave treatment. Chemical treatment. Recovery and recycling. Plasma gasification. Composting and digestion.International systems dealing with solid waste management. Egyptian laws, regulation and guidelines regarding waste management.

CHEM 411:*Organic chemistry (Physico-Organic Chemistry 2)* **2 Cr.Hr. (L2+P 0)**
Prerequisite: CHEM 312
Fundamental concepts, (Acid-Base theory, heat, progress, rate and relative rates of reaction, energy of activation, collision theory, transition state). Effect of structure on reactivity (electronic and steric factors, Hammet and Taft equation). Methods for determining reaction mechanisms (kinetic and non kinetic). Substitution reactions (nucleophilic substitution at a saturated C-atom, effect of solvent and structure, stereochemical implication of mechanism SN^2, SN^1, racemization, SN^i mechanism, neighbouring group participation, effect of entering

and leaving groups). Electrophilic and nucleophilic aromatic substitution (π and σ- complex, nitration, halogenation ...etc). Electrophilic attack on C_6H_5-Y (partial rate factors, steric effect, O/P ratios, kinetic and thermodynamic control). Nucleophilic attack on aromatic species (substitution via aryne intermediate).

CHEM 412:*Organic chemistry (Natural products)*2Cr.Hr. (L2+P 0)
Prerequisite: CHEM 314
Part 1 :Alkaloids: Definition -extraction - methods of determining structure (Zeisel methods , Herzing-Meyer method , Hofmann's exhaustive methylation method , Emde degradation method). Synthesis - classification and representative examples ,phenylethylamine group (ephedrine, hordenine and adrenaline), pyrrolidine (hygrine) , pyridine and piperidine (coniine, piperine) , pyrrolidine and pyridine (nicotine , atropine and cocaiine) , quinoline (cusparine , quinine), isoquinoline (papaverine), phenanthrene group (morphine , codeine).
Part 2 :Steroides: Definition - sterols - zoosterols (e.g. cholestrol , structure of the ring system , position of the hydroxyl group, and double bond , nature and position of the side chain , position of the two angular methyl groups). Pyto and myco sterols (e.g. ergoserol , structure , - bile acids - sex hormones .
Part 3: Terpenoids.: Introduction - occurrences and isolation- structure, determination of terpenoides- study of the structures of mono-di –sesquiterpenes

CHEM 413:*Organic chemistry (Carbohydrates)* **1 Cr.Hr. (L1+P 0)**
Prerequisite:CHEM 211
Introduction, nomenclature - some characteristic reactions. Monosaccharides (determination of the configuration. ring structure, mutarotation, methods for determining the size of the sugar rings. Disaccharides (sucrose, maltose.cellobiose, lactose, mellibiose, etc) - structure and reactions. Polysaccharides (starch,cellulose,etc…) structure and reactions: structure of amylase - end group analysis-structure of amylopectin.

CHEM 414: *Practical organic chemistry 5* **1 Cr.Hr. (L0+P 3)**
Prerequisite:CHEM316
Microanalysis (Estimation of Iodine number, number of amino groups, Estimation of phenols, Vitamin C in juice, lactic acid in milk), and preparation of some organic compounds (preparation of some heterocyclic compounds and aromatic compounds.

CHEM 415: *Organic chemistry* **2Cr.Hr. (L2+P 0)**
Prerequisite: CHEM 311
Part 1: Amino Acids and Proteins: Classification- methods of preparation (Gabriel's, Strecker, malonic ester, Curtius, Darapsky and Erlenmeyer azlactone etc ….synthesis) - analysis of amino -acids protein hydrolisates, reactions due to both amino and carboxyl groups - protein; classification, peptide linkage, the primary structure of peptides. synthesis of peptides, c-terminal and n-terminal amino-acid determinations , partial hydrolysis of peptides, synthesis of peptides, spatial arrangement of protein molecules.
Part 2: Vitamins: Definition- structure elucidation by using spectroscopy, chemical methods and synthesis of vitamin B complex group as water soluble. Vitamins includes: Vitamin b1 (Thiamine), vitamin B2 (Riboflavin or lactoflavin). Pantothenic acid, folic acid(peroylglutamic acid), biotins (vitamin H), pyridoxine (adermin, vitamin B6) vitamin B12 (cyanocobalamin), nicotinic acid and nicotinamide - Vitamin E group: Tocopherols - vitamin K group:vitamin K1 (phylloquinone) and vitamin K2.
Part 3: Chemotherapy: Introduction sulphonamidese.g(sulphanilamide ,sulphapyridine,

sulphathiazole,sulphadiazinesulphaguanidine , pontolsil) antimalarialse.g (plasmoquine , mepacrine , proguanil), arsenical drugs e.g (arsphenamine , atoxyl)anytibioticse.gpenecilline chloramphenicol ,streptomycin , iodinin , javanicin , cycloserine , erythromycin.

CHEM 416:*Organic chemistry (Textile Chemistry)*1 Cr.Hr. (L1+P 0)

Prerequisite: CHEM 211

Textile Materials and Their Performance, Fiber Classification and Theory, Fiber Identification, Textile Labeling. Textile Fiber Production, Processing, Properties, Natural Fibers (Protein and Cellulosic), Manufactured Fibers (Regenerated Natural and Synthetic), Textile Formation and Structure, Finishing and Coloration.

CHEM 417:*Industrial Chemistry 1*2 Cr.Hr. (L2+P 0)

Prerequisite: CHEM 313

Part 1: Rubber Industries -Natural rubber - synthetic rubbers -monomer production , synthetic rubbers polymerizations , butadiene styrene copolymers , , rubber fabrication , latex compounds , reclaimed rubber , rubber derivatives .

Part 2: Detergent manufacturing Soaps and detergents: Detergent raw materials - manufacture of detergent - biodegradability of surfactants - soap - glycerin. Plastic industries: Resin manufacturing processes - condensation polymerization products - addition polymerization products - chemical intermediates for resins.

CHEM 419:*Pericyclic Reactions* **2 Cr.Hr. (L2+P 0)**

Prerequisite: (-)

Classification and investigation of reaction mechanisms. Theory of concerted reactions. Electrocyclic reactions. Cycloadditions: Introduction. Cycloadditions and elemenations involving six electrons. Sigmatropic rearrangements and related reactions.

CHEM 421: *Inorganic Chemistry 5* **2Cr.Hr (2+0).**

Prerequisite:CHEM 321

Part 1: Nuclear Chemistry (1): Radioactivity, The nuclear fuel cycle, Uranium enrichment, Radioactive waste, The kinetics of radioactive decay, α, β and gamma ray, Spontaneous fission, fission and fusion, Detectors. Reaction and formation of transuranic elements, Radiation safety precautions.

Part 2: Organometallic(1): General properties of organometallic complexes, comparison between classic and non-classic complexes, 18-electron rule, studies of different types of complexes of π-acid ligands metal carbonyls and phosphine and other π-complexes, types of bonding, preparation and characterization. The chemistry of metal alkyls, aryls, alkenes and alkynes.

CHEM 422: *Inorganic Chemistry 6* **2 Cr.Hr (L2+P0)**

Prerequisite: 322

Part 1: Group theory (1): Group Theory: Principles of symmetry, character tables, Applications in structure and bonding.

Part 2: Spectroscopy Chemistry (1): Quantum Theory of absorption and emission of light, broadening and shapes of spectral lines, correlations between theory and experiments, Electronic states, and terminology, examples and applications of states in d & f elements and energy transfer therein, Orgel and Tanabe Saugano diagrams.

CHEM 423: *Inorganic Chemistry* **2 Cr.Hr. (L2+P 0)**

Prerequisite: (-)

Part 1: Nano Chemistry: Particle size and characteristics. Production of nanomaterials. Methods of characterization including recent microscopic methods. Description of the concepts and methods developed for synthesizing range of nanoscale building blocks with strictly controlled size, shape, bulk and surface structure and composition, and properties.

Part 2: Solar Chemistry: Basics of Solar and Light Energy including light energy conversion. Solar cells. Solar Reactors and solar collectors: Design and technology. Solar Furnace and Production of Materials. Efficiency of solar collectors, receivers and concentrated solar collectors. Thermodynamic Cycles and power generation.

CHEM 424:*Inorganic photochemistry* **2 Cr. Hr. (L2+P 0)**

Prerequisite: CHEM 322

Principles of inorganic photochemistry.Energy states terminology in photochemistry. Monomolecular and bimolecular decay of the excited states. Solute-solvent interactions. Photochemistry of coordination compounds and their applications. Allowed and forbidden transitions in coordination compounds and their use in photochemical applications. Applications of photochemistry.

CHEM 425: *Inorg. chem. (Methods of characterization of coordination compounds)*2 Cr. Hr. (L2+P 0)

Prerequisite: (CHEM 321& CHEM 314)

Applications of several techniques to characterize coordination compounds, that involve measurements of magnetic susceptibility, conductivity, oxidation reduction potentials, X-ray diffraction, IR, UV-vis, NMR (variable temperature, multinuclear, multidimensional), optical rotation, ESR, Mössbauer, and mass spectrometry, electronic properties (band gaps, conductivity, etc.).

CHEM 426: *Inorganic chemistry (Radiation Chemistry)* 2 Cr. Hr. (L2+P 0)

Prerequisite: CHEM 421

The nuclear fuel cycle . Uranium enrichment. Radioactive radiation in everyday life. Waste management. Cosmic ray. Fundamental particles. Application of radiation in industry. Application of radiation in medicine. Application of radiation in chemistry. Application of radiation in geology. Application of radiation in agricultural. Dangerous and safety precautions of non ionizic radiation (Mobile, UV radiation, Computer and Microwave, oven).

CHEM 428:*Industrial Chemistry 2* **2 Cr.Hr. (L2+P 0)**

Prerequisite: CHEM 321

Part 1: Applied Inorganic Chemistry of Polymers: Polymers on the basis of S; P; Ge; Se; Si etc. Adhesives. Silane Coupling Agents. Silicones and silicon rubbers. Nano materials and polymer composites. Fillers. Clays and Asbestos.

Part 2: Silicon Technology: Introduction of Silicon as an element of vital importance in many areas of modern synthetic chemistry, the electronics industry and in materials science – Structure of silicon – Silicon application

CHEM 431:*Analytical Chemistry 3 (Electroanalysis)* **2 Cr.Hr. (L1+P 3)**

Prerequisite: CHEM 331

Fundamentals of electroanalytical methods and their applications in analytical chemistry. It covers the basics of electrochemical cells, types of electrodes, potentiometric methods (direct and indirect), and electrolytic techniques (e.g. voltammetry, polarography, coulometry, Conductometry and electro-gravimetry).

Practical: Preparation of working and references electrodes as well as design and running of electroanalysis experiments. Students will gain skills in analysis using calibration, standard addition and titrations using different electroanlaysis techniques. Moreover, students will learn how to handle and analyse real samples.

CHEM 432: ***Analytical Chemistry 4 (Separation techniques 1)*** **1 Cr.Hr. (L1+P 0)**

Prerequisite: CHEM 331

The principles of chromatography, different chromatographic parameters, efficiency of the chromatographic process, Van Deemter equation, and optimization of chromatographic process. The course provides rigorous detailed theory, instrumentation and applications of gas and liquid chromatography, as well as high performance liquid chromatography. Various types of liquid chromatography including: ion exchange, gel permeation, affinity, adsorption, and partition chromatography are covered in this course.

CHEM 434: ***Analytical chemistry (Separation techniques 2)*** **2 Cr. Hr. (L2+P 0)**

Prerequisite: CHEM 331

Advanced separation techniques as well as hyphenated techniques will be covered in this course. A special emphasis will be given to mass spectrometric detection. Applications of advanced chromatographic techniques to analysis of various real samples will be covered in this course. Introduction to contemporary separation methods such as supercritical fluid chromatography/extraction, electrophoresis, capillary electrophoresis, and hyphenated techniques such as HPLC-MS, and GC-MS. Industrial applications of separation methods.

CHEM 441:*Physical Chemistry (6)* **2Cr.Hr. (L2+P 0)**

Prerequisite: CHEM 342

Part 1: Chemistry of Cement [1]: General points and nomenclature, types of cements, the mechanism of cementing action. Hydration of Portland cement: hydration of pure cement components, factors affecting the rate of hydration, mechanism of Portland cement hydration. Cements made from blast-furnace slag: composition and processing of blast-furnace slag, lime-slag cement, Portland blast-furnace slag cement, kinetics and mechanism of hydration of slag cement, super-sulfate cement.

Part 2: Electrochemistry [2] (Kinetics of electrochemical reactions/Irreversible electrode processes): Polarization and overpotential, Measurement of polarization, Causes and types of polarization, Resistance polarization, Concentration polarization and oxygen reduction reaction, theories of rotating disc electrode, rotating ring-disc electrode & their applications Activation(charge transfer) polarization, Butler – Volmer eqation, Tafel Equation. Real polarization Curve (I-E voltammogram), Methods of determining the current-overpotential curves (Tafel plots) and cathodic hydrogen evolution reaction.

CHEM 442:*Physical Chemistry (7)***3Cr.Hr. (L3+P 0)**

Prerequisite: CHEM241

Part 1: Physical Properties of Polymers: Introduction to polymer Science: Polymer science: classification of polymers – synthesis of polymers – physical states transitions and degradation – molecular weight measurements – characterization and testing of polymers – fabrication processes of plastics - Polymer processing.

Part 2: Quantum Chemistry: Introduction, general differential equation of simple harmonic motion, progressive waves, standing waves, the Schrodinger wave equation. Particle in a one dimensional box, normalization of wave functions, orthogonality: quantum mechanical operators; the postulates of quantum mechanics; particle in a rectangular three - dimensional box; applications of the postulates to simple systems; perturbation theory. The electronic structure of conjugated systems, the linear combinations of atomic orbitals (LCAO-MO) and

molecular orbital theory for conjugated hydrocarbons. The simple Huckel method. The use of symmetry to simplify quantum mechanical calculation.

Part 3: Corrosion: Classification of corrosion. Electrochemical corrosion (galvanic corrosion cell, concentration and electrolytic corrosion cells). Thermodynamics of corrosion (calculation of ΔG and EMF series, galvanic series and reversible potential - pH, Pourbaix diagram. Kinetics of corrosion (Evan diagram, passivity and methodology of determining the corrosion rate). Forms of corrosion (uniform corrosion, localized corrosion). Corrosion protection (corrosion control by material selection, design, surface coatings, changing the environment and changing the metal potential).

APCH 443: ***Applied Physical Chemistry (C)*** **2Cr.Hr. (L2+P 0)**

Prerequisite: CHEM341

Part 1: Applied Surface Chemistry:

Friction and Lubrication: Friction between Unlubricated Surfaces, Amontons Law, Metallic Friction-Effect of oxides Films, Frictions between non-metals, Friction Between Lubricated Surfaces, Boundary Lubrication, The Mechanism of Boundary, Lubrication. Adhesions: Ideal Adhesion, Practical Adhesion. Wetting, Floatation and Detergency: Contact angle, Capillary action Phenomenon, Tertiary Oil Recovery, Water Repellency, Floatation of Metallic Minerals, Floatation of Non-metallic Minerals, General Aspects of Soil Removal, Detergents in Commercial Use. Emulsions and Foams: General Properties, Emulsion Stability, Spontaneous Emulsification, Foam structure, Foam Drainage, Foam stability, Foaming Agents.

Part 2: Membrane Technology and Applications: Overview on basic principles, concepts, state-of-the-art and industrial relevance, membrane materials, preparation and manufacturing of membranes, characterization of membranes, transport in membranes, polarization phenomena, membrane fouling, membrane modules, membrane processes, pressure-driven membrane processes, electrically-driven membrane processes, thermally driven membrane processes, gas separation and vapor permeation membrane bioreactors.

CHEM 444:*PracticalAdvanced Physical Chemistry***1 Cr.Hr. (L0+P 3)**

Prerequisite: CHEM344

Experiments on advanced physical chemistry

CHEM 446:*Physical Chemistry (D) (Technology of Building Materials)* **1Cr.Hr. (L1+P 0)**

Prerequisite: CHEM342

Blast-furnace slag, formation, treatment and use in composite cements, factors affecting suitability for use in a composite cements, hydration chemistry of slag cement, X-ray microanalysis, stoichiometry of slag cement hydration, supersulphated cement. Pulverized fuel ash, low in CaO, properties, the nature of the pozzolanic reaction, stoichiometry of pfa cement hydration. Natural pozzolans, properties, hydration reactions. Microsilica (condensed silica fume), properties, hydration reactions. Other mineral action, class-C fly ash, other pozzolanic or hydraulic additions, calcium carbonate and other fillers. Pore structure and their relation to physical properties, porosities and pore size distributions.

CHEM 450:*Essay or Research Project* **1 Cr.Hr. (L1+P 0)**

Prerequisite: (pass 75% of credit hours)

Each student writes a professional essay about a specific organic chemistry subject. Students search chemical abstracts, chemistry databases, and internet sites to collect materials relevant to the tackled research subject.

CHEM 451:*Essay or Research Project* **1 Cr.Hr. (L1+P 0)**

Prerequisite: (pass 75% of credit hours)

Each student writes a professional essay about a specific (non-organic) chemistry subject. Students search chemical abstracts, chemistry databases, and internet sites to collect materials relevant to the tackled research subject.

CHEM 460:*Organic Chemistry* **4 Cr.Hr. (L3+P 3)**

Prerequisite: CHEM 361

Part 1: Heterocyclic Chemistry: Systematic nomenclature of heterocyclic compounds containing one hetero atom (pyrrole, furan, thiophene, indole, quinoline, isoquinoline, coumarin,chromone) and their derivatives,di-hetero atoms and tri-hetero atoms. General preparation of hetero cyclic compounds (mono hetero atom) and its benzoderivatives . Preparation of mono heterocycles contains more than one hetero atom and their reactions. Applications of heterocylic compounds in pharmaceutical drugs .

Part 2 :Alkaloids: Definition -extraction - methods of determining structure (Zeisel methods , Herzing-Meyer method , Hofmann's exhaustive methylation method , Emde degradation method). Synthesis - classification and representative examples ,phenylethylamine group (ephedrine, hordenine and adrenaline), pyrrolidine (hygrine) , pyridine and piperidine (coniine, piperine) , pyrrolidine and pyridine (nicotine , atropine and cocaiine) , quinoline (cusparine , quinine), isoquinoline (papaverine), phenanthrene group (morphine , codeine).

Practical: Related to the above topics.

CHEM 461:*Organic Chemistry* **4 Cr.Hr. (L3+P 3)**

Prerequisite: CHEM 260

Part 1: Reaction Mechanism: Addition reactions to carbon-carbon multibonds. Addition to carbon heteroatom multibonds. Electrophilic and nucleophilic aromatic substitution reactions. Base induced elimination reactions. Acid induced elimination reaction. Rearrangement to electron deficient carbon, nitrogen and oxygen.

Part 2: Terpenoids: Introduction - occurrences and isolation- structure, determination of terpenoides- study of the structures of mono-di –sesquiterpenes

Practical: Related to the above topics.

CHEM 462:*Organic Chemistry* **2 Cr.Hr. (L2+P 0)**

Prerequisite: CHEM 360

Part 1: Photochemistry: Energy is quantized, types of excitation, selection rules, the fate of the excited molecule. Intramolecular reactions of olefin bonds: Geometrical isomerisation, cyclization reaction of conjugated olefins, rearrangements, 1,5-dienes and the sigmatropic reaction. Intramolecular reactions of the carbonyl group: Saturated acyclic and side chain carbonyl compounds, saturated cyclic carbonyl compounds, α, β- and β, γ- unsaturated carbonyl compounds, cyclohexadienones. Intermolecular cycloaddition reactions: Photochemical reactions in general, regioselectivity of photocylcoaddition, the Paterno-Buchi reaction, the dimerization of olefins, cross- coupling of olefins.

Part 2 :Lipids: Introduction, simple lipids, acids and fats, chemical properties of fatty acids, isomerisation, separation and determination of fatty acids, synthesis of glycerides, physical properties of fats and oils, chemical properties of fats and oils, rancidity of edible fats,

CHEM 490: ***Physical Chemistry(Photochemistry)*****2 Cr.Hr. (L1+P 3)**
Prerequisite: (CHEM 292& CHEM 391)
Definitions, light and dark reactions, nature of light, basic laws of photochemistry, sequence of processes in photochemical reactions, quantum yield, determination of intensity of light. Absorption of radiation: absorption and emission processes, spectroscopic nomenclature, general rules for the order of energy terms, selection rules for optical transition, Franck-Condon principle. Radiative transition : luminescence, fluorescence, phosphorescence, chemiluminescence. Energy transfer and charge transfer: energy transfer, excimer and exciplex, oxygen quenching, heavy atom quenching, kinetics of quenching, charge transfer and electron transfer, flash photolysis, laser.
Practical: Experiments in surface chemistry, catalysis, electrochemistry, polymers and photochemistry.

CHEM 491:*Physical Chemistry (Thermodynamics of electrolytic solutions)*1 Cr.Hr. (L1+P 0)
Prerequisite: CHEM 290
Electrolytic solutions and electrical double layer, electrolytic solutions, electrical conductance, Arrhanuis theory for electrolytic dissociation, migration of ions, mobility of ions, transport number, deviation of electrolytic solutions from ideal solutions, Van't Hoff factor, solvation, activity and activity coefficient, partial molar quantities, Debye and Huckel's theory for strong electrolytes, ionic association theory. Models of electrical double layer. Capacity of electrical double layer.

CHEM 492:*Physical Chemistry* 2Cr. Hr. (L2+P0)
Prerequisite: CHEM 391
Part 1:Surface Chemistry [2]: Gas-solid and solution-solid interface: Sorption–adsorption of gases, energy and adsorption forces, physisorption and chemisorption, potential energy in relation to surface structure, monolayer capacity, heats of adsorption, theories of adsorption: Freundlich equation, Langmuir theory, multimolecular theory of adsorption (BET equation and its derivation), determination of the specific surface area, desorption, surface area in the pores and pore structure, thickness of the adsorbed layer in the capillary condensation region, adsorption from solution, mechanisms of adsorption, adsorption isotherms, pore size determination, determination of acidic properties on solid surfaces, acid strength.
Part 2:Applied Catalysis: Reactor design: material balance, types, performance and kinetic equations, industrial catalyst design, resistances to chemical reactions on solid catalysts, catalyst deactivation, supported catalysts: preparation, theory of active ensembles, structure sensitive and structure insensitive reactions, mobility and sintering, hydrogen-spillover, applications in practice: in petroleum, petrochemical and environmental fields, Grand families of catalyst materials, e.g. zeolites, heteropoly acids, etc.

CHEM 493*: Physical Chemistry*2Cr.Hr. (L2+P 0)
Prerequisite: CHEM 391
Part 1: Chemistry of Cement: General points and nomenclature, types of cements, the mechanism of cementing action. Hydration of Portland cement: hydration of pure cement components, factors affecting the rate of hydration, mechanism of Portland cement hydration. Cements made from blast-furnace slag: composition and processing of blast-furnace slag, lime-slag cement, Portland blast-furnace slag cement, kinetics and mechanism of hydration of

slag cement, super-sulfate cement.

Part 2: Phase Equilibria: The phase rule. Systems of one component: the water system, polymorphism, the sulfur system, forms of ice. Two components systems: solutions of gases in liquids, liquid-liquid equilibria. Solid-liquid systems: two components are completely miscible in the liquid state and insoluble in the solid state, two components are partially miscible in the liquid state and insoluble in the solid state, two components form a compound with a congruent melting point, two components form a compound with an incongruent melting point, two components form a continuous series of solid solutions, two components are completely miscible in the solid state.

Applied Chemistry

APCH 411: *Applied Organic Chemistry 3 (Heterocyclic Compounds)* 2 Cr.Hr. (L2+P0)

Prerequisite: APCH 211

Systematic nomenclature of heterocyclic compounds containing one hetero atom (pyrrole, furan, thiophene, indole, quinoline, isoquinoline, coumarin,chromone) and their derivatives, di-hetero atoms and tri-hetero atoms. General preparation of hetero cyclic compounds (mono hetero atom) and its benzoderivatives. Preparation of mono heterocycles contains more than one hetero atom and their reactions. Applications of heterocyclic compounds in pharmaceutical drugs.

APCH 412: *Applied Organic Chemistry* 1 Cr.Hr. (L1+P0)

Prerequisite: APCH 311

Part 1: Rubber Industries : Statistics and economic-natural rubber - synthetic rubbers - monomer production , synthetic rubbers polymerizations , butadiene styrene copolymers, butadiene-acrylonitrle rubber, silicon rubbers , butyl rubber, urethane rubber , hyplone, sterospe rubber, ethylene - propylene polymers and terpolymers, rubber fabrication, latex compounds, reclaimed rubber, rubber derivatives .

Part 2: Soaps and detergents: Detergent raw materials -manufacture of detergent-biodegradability of surfactants -straight chain alkyl benzenes -fatty acids and alcohols -soap - glycerin. Plastic industries: Resin manufacturing processes -condensation polymerization products -addition polymerization products - natural products and their derivatives manufacture laminates and other types - chemical intermediates for resins - phenol, formaldehyde - hexamethylenetetramine vinyl esters - phthalic anhydride.

APCH 413: *Practical Applied Organic Chemistry 3* 1Cr.Hr..(L0+P3)

Prerequisite: APCH 311

Part 1: Synthesis of dyes (definitions, type of dues, how to prepare an azo-dye, what are the applications of dyes).

Part 2: Preparation of polymers (1- Types of polymers, 2- Physical properties of polymers, 3- Synthesis of polymers, 4- Applications of polymers).

APCH 414:*Practical Applied Organic Chemistry 4* 1 Cr.Hr.(L0+P3)

Prerequisite: APCH 311

Extraction of cellulose (methods, procedures for the extraction of cellulose and solvents used for the extraction of cellulose)and preparation of cellulose derivatives (different methods used for the preparation of cellulose derivatives.

APCH 415:*Organic Chemistry* 2 Cr.Hr. (L2+P0)

Prerequisite: CHEM 212

Part 1: Amino Acids and Proteins:

Classification- methods of preparation (Gabriel's, strecker, malonic ester, curtius, Darapsky and Erlenmeyer azlactone etc ....synthesis) - analysis of amino -acids protein hydolisates reactions due to amino carboxyl and due to both the amino and carboxyl groups - protein; classification, peptide linkage, the primary structure of peptides. synthesis of peptides, c-terminal and n-terminal amino-acid determinations , partial hydrolysis of peptides, synthesis of peptides, spatial arrangement of protein molecules

Part 2: Vitamins: Definition- structure elucidation by using spectroscopy, chemical methods and synthesis of vitamin B complex group as water soluble. Vitamins includes: Vitamin B1 (Thiamine), vitamin B2 (Riboflavin or lactoflavin). Pantothenic acid, folic acid (peroylglutamicacid), biotins (vitamin H), pyridoxine (adermin, vitamin B6) vitamin B12 (cyanocobalamin), nicotinic acid and nictoinamide - Vitamin E group (Tocopherols) -vitamin K group: vitamin k1 (phylloquinone) and vitamin k2

APCH 416*: OrganicPolymers* 1Cr.Hr. (L1+P0)

Prerequisite: (-)

Introduction - classification - polymerization reactions (addition , free radical , ionic , condensation , polymerizations) polymerizations techniques (Bulk , solution , suspension , emulsion , interfacial - polymerization)-physical properties of polymer thermoplastics (polyethylene , polypropylene , chloride , polystyrene and styrene copolymers) - synthetic fibers (polyester polyamide and acrylic fibers). Unit processes.

APCH 417: *Organic Chemistry* 2 Cr.Hr. (L2+P0)

Prerequisite: APCH 311

Part 1:Alkaloid: Definition -extraction - methods of determining structure (Zeisel methods , Herzing-Meyer method , Hofmann's exhaustive methylation method , Emde degradation method). Synthesis - classification and representative examples ,phenylethylamine group (ephedrine, hordenine and adrenaline), pyrrolidine (hygrine) , pyridine and piperidine (coniine, piperine) , pyrrolidine and pyridine (nicotine , atropine and cocaiine) , quinoline (cusparine , quinine), isoquinoline (papaverine), phenanthrene group (morphine , codeine).

Part 2:Terpenoids: Introduction - occurrence and isolation - structure determination of terpenoides - study of the structures of mono- bi-sesqui terpenes.

APCH 418: *Chemoinformaticsand Chemical processing* 2Cr.Hr. (L1+P0)

Prerequisite: (-)

Part 1:Chemoinformatics draws upon techniques from many disciplines including computer science, mathematics, computational chemistry and data visualisation to tackle these problems.

Part 2: Chemical processing - information sources - basic chemical data - batch versus continuous processing - chemical processing selection - design and operation - chemical processing control and instrumentation - chemical processing economic - market evaluation - plant locations - safety hazards (e.g. fire and toxic materials).

APCH 419: *Industrial chemistry 1* 2 Cr.Hr. (L2+P 0)

Prerequisite: (-)

Part 1: The Pharmaceutical Chemistry: Structure, properties, and analysis (both qualitative and quantitative) of pharmaceutical agents and metabolites as well as the fundamental techniques used for near patient testing in clinical laboratories. Some basic concepts in

medicinal chemistry as well as methods of pharmaceutical and biomedical analysis such as: 1) the drug discovery and development process, 2) review of organic functional groups found in drug molecules, 3) drug-target interactions, 4) physicochemical properties related to drug action such as acid-base properties, equilibrium, and stereochemistry, 5) Chemistry of OTC in organic drugs, 6) Effect of chemical structure on the metabolism of drug molecules, 7) Fundamentals of neurochemistry, 8) Chromatographic analysis of pharmaceutical agents, metabolites, and clinical samples, 9) Methods for identification of pharmaceutical agents and metabolites, and 10) Spectral techniques used in quantitative analysis of clinical samples.

Part 2: Agricultural chemistry: Chemical compositions and changes involved in the production, protection, and use of crops and livestock. Understand the processes by which humans obtain food and fiber for themselves and feed for their animals. Agricultural chemists work with food producers to increase yields, improve quality, and reduce costs. The causes and effects of bio-chemical reactions related to plant and animal growth, ways to control these reactions, and develop chemical products that provide help in controlling these reactions. Chemical products developed to assist in the production of food, feed, and fiber include herbicides, fungicides, insecticides, plant growth regulators, fertilizers, and animal feed supplements.

APCH 423:*Inorganic chemistryIron and steel industry. Alloys industry*1Cr. Hr. (L1 + P0)

Prerequisite: (CHEM 321)

Introduction, Classification and properties of metals (metallic characteristic-metals and periodic table-effect of temperature on the properties of metal- examples), Alloy and Hume Rothery rules.Phase diagrams of binary alloys, Microstructure and Properties of Steels and Cast irons. Industrial Applications of steels, some metals and alloys(Types of metals and alloys- ferrous alloys- low, medium and high carbon steels- non Ferrous alloys- Copper and its alloys- Aluminum and its alloys- Magnesium and its alloys).

APCH 424:*Industrial Chemistry 2*2Cr.Hr. (L2+P0)

Prerequisite: CHEM 321

Part 1: Applied Inorganic Chemistry of Polymers: Polymers on the basis of S; P; Ge; Se; Si etc. Adhesives. Silane Coupling Agents. Silicones and silicon rubbers. Nano materials and polymer composites.Fillers. Clays and Asbestos.

Part 2: Silicon Technology: Introduction of Silicon as an element of vital importance in many areas of modern synthetic chemistry, the electronics industry and in materials science – Structure of silicon – Silicon application

APCH 426: *Applied Nuclear Chemistry* **2 Cr. Hr. (L2 +P0)**

Prerequisite: CHEM 321

The nuclear fuel cycle . Uranium enrichment. Radioactive radiation in everyday life. Waste management. Cosmic ray. Fundamental particles. Application of radiation in industry. Application of radiation in medicine. Application of radiation in chemistry. Application of radiation in geology. Application of radiation in agricultural. Dangerous and safety precautions of non ionizic radiation (Mobile, UV radiation, Computer and Microwave, oven).

APCH 428: *Lasers in Chemistry and Applied photochemistry* **2Cr.Hr. (L2+P0)**

Prerequisite: (CHEM 321)

Principles of lasers, masers, population inversion, types of electronic transitions, three and four type lasers. Gas, liquid, solid and semiconductor lasers. Lasers based on energy transfer phenomena. Dye lasers mechanism and usage. Civil and military application of lasers. Solar