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COURSE CATALOG

OF

UNDERGRADUATE PROGRAMS

SCHOOL OF SCIENCE

UNIVERSITY OF SCIENCE AND TECHNOLOGY

ZEWAIL CITY OF SCIENCE, TECHNOLOGY AND INNOVATION

SEPTEMBER 2023

Courses	Description
BIOL 101	Biology I Credits: 3 (3+0) Coreq: BIOL 111 This course provides foundation to the general concepts of life and cellular biology. The course covers the cellular basis of life, the cellular functions in different organisms, and the core concepts of evolutional biology in relation to different systems.
BIOL 102	Biology II Credits: 3 (3+0) Coreq: BIOL 112 Prereq: BIOL 101 This course covers the fundamentals of cellular structure and function as they relate to the molecular biology of the cell. These include understanding of the basics of modern molecular biology, genes and gene expression, DNA replication and repair, genomes and the evolution.
BIOL 111	Biology I Lab Credits: 1 (0+3) Coreq: BIOL 101 Laboratory concurrent with BIOL 101. Experiments include the metric system and measurement, microscopy, cellular respiration, photosynthesis, scientific method, enzymes, and mitosis and meiosis.
BIOL 112	Biology II Lab Credits: 1 (0+3) Coreq: BIOL 102 Laboratory concurrent with BIOL 102. Experiments include bacterial transformation, plasmid extraction, and gel electrophoresis.
BMS 201	General Microbiology Credits: 3 (3+0) Coreq: BMS 211 Prereq: BIOL 102 This course will cover microorganisms, especially bacteria and viruses. Students will be introduced to molecular biology of the bacterial cell, the mechanisms of microbial pathogens, and concepts of microbial genetics.
BMS 202	Cell Biology Credits: 3 (3+0) Coreq: BMS 212 Prereq: BIOL 102 This course will cover basic cellular structure and functions. These include membrane structure, cell organization, how genes work, transcription, RNA processing, DNA replication, DNA repair, DNA recombination, organelle biogenesis, cell interactions, and cell cycle.

Courses	Description
BMS 203	Principles of Genetics Credits: 3 (3+0) Coreq: BMS 213 Prereq: BIOL 102 This course introduces students to the principles of genetics. The course will cover the classical theory of heredity and special emphasis will be placed on the molecular basis of heredity, such as DNA and RNA structure, DNA replication, and recombinant DNA technology.
BMS 204	Biochemistry Credits: 3 (3+0) Coreq: BMS 214 Prereq: CHEM 201 This course covers the fundamentals of biochemistry including structure, function, and metabolism of proteins, nucleic acids, carbohydrates, fatty acids, lipids, vitamins and other substances within biological systems.
BMS 205	Human Physiology Credits: 3 (3+0) Coreq: BMS 215 Prereq: BIOL 102 This course is designed to provide students with an understanding of the function of various systems of the human body including the neural, cardiovascular, musculoskeletal, gastrointestinal and endocrine system. The interaction between different organs and systems to maintain homeostasis will be covered.
BMS 211	General Microbiology Lab Credits: 1 (0+3) Coreq: BMS 201 This lab course is concurrent with BMS 201. Experiments will cover basic aspects of microbiology such as laboratory safety, microscopy, aseptic techniques and cultivation, staining, bacterial growth, Kirby-Bauer assay, and isolation of normal flora.
BMS 212	Cell Biology Lab Credits: 1 (0+3) Coreq: BMS 202 This lab course is concurrent with BMS 202. Experiments will cover cell and tissue cultures and cell biology techniques.
BMS 213	Principles of Genetics Lab Credits: 1 (0+3) Coreq: BMS 203 This lab course is concurrent with BMS 203. The course will cover experiments in basic classical and molecular genetics such as chi-square and Mendelian genetics, gene mapping, library screening, DNA extraction and amplification, restriction analysis, and Southern blotting.

Courses	Description
BMS 214	Biochemistry Lab Credits: 1 (0+3) Coreq: BMS 204 This laboratory course introduces students to standard biochemical techniques in the context of research projects. Examples of techniques to be included in research include protein purification, enzyme assays, enzyme kinetics (Km determination), enzymatic proteolysis, and chromatography.
BMS 215	Human Physiology Lab Credits: 1 (0+3) Coreq: BMS 205 Human Physiology laboratory, the lab component of Human Physiology. The course introduces human physiology, structure and function of human tissues in an integrated hands-on approach. Laboratory exercises cover a wide range of topics, including classic experiments on nervous system, muscles, respiration, cardiac vascular physiology, and exercise physiology.
BMS 301	Molecular Biology Credits: 3 (3+0) Coreq: BMS 311 Prereq: BMS 202 This course introduces students to the essentials of molecular biology, including the structure and function of cell macromolecules and the molecular basis and regulation of cellular processes such as DNA replication, transcription and translation. The empirical foundation of modern molecular biology will be illustrated by key historical experiments.
BMS 303	Experimental Design and Data Analysis Credits: 3 (2+3) Prereq: BIOL 102 This course covers the practical aspects of experimental designs. These include how to formulate hypothesis, design experiments, analyze data and derive conclusions.
BMS 304	Biomedical Scientific Ethics and Safety Credits: 2 (2+0) Prereq: BIOL 102 Conducting research challenges many ethical issues, such as fraud, bias, plagiarism, conflicts of interest, and fabrication of research results. This course will cover ethical, social, environmental, and safety issues surrounding important scientific advances, including biological hazards, radioactive materials, microbiological organisms, animal cloning, and stem cells. The course will also cover the biosafety issue and help students to learn how to handle biological and chemical wastes, in relation to national and international biosafety regulations. By the end of this course, students will be able to critically analyse their research ethics topics and manage and evaluate their research projects.

Courses	Description
BMS 311	Molecular Biology Lab Credits: 1 (0+3) Coreq: BMS 301 This lab course is concurrent with BMS 301. Experiments include common methods and protocols of molecular biology such as DNA isolation, PCR, RNA isolation, and gene cloning.
BMS 313	Human Anatomy Lab Credits: 1 (0+3) Coreq: BMS 330 BMS 313 is Human Anatomy laboratory, the lab component of Human Anatomy. The course introduces human anatomy, structure and function of human tissues in an integrated hands-on approach. Laboratory material includes human system models, skeleton, dissection of animal organs, and microscopic slides of human tissues. The course will cover human skeletal system, cardiovascular, and major body system on both the gross anatomy and microscopic level.
BMS 320	Introduction to Bioinform and Prog Languag Credits: 3 (2+3) Prereq: BIOL 102 AND CSCI 101 AND MATH 102 This course explores how computer science and mathematics, supported by information technology, have combined with modern laboratory technologies to solve previously intractable problems in the life sciences. The main course objectives:Understand how to apply computer science algorithms in biology, and be able to apply probability theories to explain biological data. Students will understand the algorithms used for sequence alignment, and how data analysis is used to explain gene expression measurements.
BMS 321	Programming for Computational Biology Credits: 3 (2+3) Prereq: BIOL 102 AND MATH 102 The course provides a practical programming for students who have some background and programming experience. The course will also be offered in the summer as intensive hands-on continued programming practice. Fundamental scientific algorithms, analytical skills, simulation, optimization, and modern programming language will be practiced. Some programming skills and biology knowledge are required.

Courses	Description
BMS 322	Structural Biology Credits: 3 (3+0) Prereq: BIOL 102 AND (CHEM 202 OR PHYS 201) What is Life? in 1942, the Physicist Erwin Schrodinger noted with surprise that early Molecular Biology had shown that ordered, living systems are dependent on a relatively small number of large molecules. This course studies the physical properties of these large molecules, the proteins, nucleic acids, and lipids, and how these properties enable these biological macromolecules to perform specific biological roles. The course covers those parameters and common motifs that define the structure, folding and dynamics of proteins and nucleic acids, interactions between proteins, nucleic acids, lipids, membranes and small molecules, and the structural basis behind catalysis, regulation of gene expression, signaling, and formation of macromolecular assemblies. There will be special emphasis on computational tools to visualize biomacromolecules, and to process and analyze experimental data and databases.
BMS 323	Comparative Biology Credits: 3 (3+0) Prereq: BMS 203 This course introduces students to evolution theories and how evolution affects different organisms and their adaptation to the surrounding environment.
BMS 324	Molecular Genetics and Cell Regulation Credits: 3 (3+0) Prereq: BMS 202 Based on recent availability of the human genome sequence, this course provides students with fundamental genetic concepts of human and quantitative genetics, gene regulation, epigenetics and genetic variations.
BMS 325	Clinical Sciences Credits: 3 (3+0) Prereq: BIOL 102 This course aims to introduce clinical and translational sciences for biomedical students. It aims to establish a link between basic sciences and the real clinical problems in our community, to help pin point areas which require innovation. The course will focus on the clinical presentation of human diseases in various systems. It will introduce the basics of clinical symptoms, signs, diagnosis and management plans for common medical disorders. It includes field study and opportunities for clinical shadowing in clinical sites. This course is ideal for BMS students who are planning to prepare for medical schools and those who are interested in pursuing a career as clinician scientists.
BMS 326	Molecular Mechanisms of Cell Signaling Credits: 3 (3+0) Prereq: BMS 202 This course covers the concepts of cell signaling, signal transduction and its role and effect on cell fate during development and disease.

Courses	Description
BMS 327	Neurobiology and Practicum Credits: 3 (3+0) Prereq: BMS 202 This course introduces students to the structure and function of the human central nervous system, the sensory and motor systems, and different functions of the brain. Basic concepts of neurobiology, synaptic transmission and learning and memory dysfunction will be covered.
BMS 328	Computer Science II Credits: 3 (2+3) Prereq: CSCI 101 This course introduces formal techniques to support the design and analysis of algorithms, focusing on both the underlying mathematical theory and practical considerations of efficiency. Introduced design approaches will be supported by some common data structures, with a focus on some advanced ones. Topics include: mathematics foundation, divided-and-conquer, dynamic programming, greedy method, NP-completeness complexity, approximation algorithms, randomized algorithms, and backtracking algorithms. In addition to some advanced data structures: Binary trees, Heaps, Priority Queues, and Huffman Coding Trees.
BMS 330	Human Anatomy Credits: 3 (3+0) Coreq: BMS 313 Prereq: BIOL 102 This course introduces students to basic human anatomy, and its different systems. The structure of the central nervous system, gastrointestinal system, bone and muscle, cardiovascular system, respiratory system and other systems will be covered in lecture and simulation format.
BMS 331	Numerical Analysis and Mat Lab Credits: 3 (3+0) Prereq: MATH 201 The course will introduce the basic concepts in numerical analysis, numerical differentiation and integration, polynomial interpolation, and ordinary differential equations. The course will give students fluency in Matlab through problem-based matlab assignments.

Courses	Description
BMS 332	Drug Discovery and Development Credits: 3 (3+0) Prereq: BMS 204 This course discusses the drug discovery process. Initial hit identification, hit to lead modification and lead optimization concepts will be covered. A focus will be given to metabolism –phase I & II- along with ADMET. The course also covers high throughput discovery technologies: Assays and Screening. Principles of clinical trials and drug approval processes will be discussed. Production of a druggable and marketable molecules: Process chemistry and scale up constraints, Patents and marketing will be introduced.
BMS 333	Drug Design and Computational Chemistry Credits: 3 (3+0) Prereq: BMS 204 This course provides a background on the fundamental aspects and methodologies used for lead discovery, identification and optimization. Included are empirical de novo, linear free energy, and quantum statistical approaches. The course will also introduce students to foundations for algorithmic and mathematics application in computational chemistry. Students will learn a variety of commonly used techniques, such as geometry optimization, location of transition states, conformational analysis, and prediction of molecular and spectroscopic properties.
BMS 334	Pharmacokinetics and Pharmacodynamics Credits: 3 (3+0) Prereq: BIOL 102 AND CHEM 203 This course presents the fundamentals of pharmacokinetics and pharmacodynamics as they apply to the chemical structure of drugs. There will be specific discussion of the role of medicinal chemistry in the drug discovery process; how chemical structure affects the absorption, distribution, metabolism and excretion (ADME properties) of drugs; and drug affinity and efficacy (Pharmacodynamics). This course will also present the diverse pharmacokinetic-pharmacodynamic modeling concepts to describe and predict the time course of drug effects under various physiological and pathological conditions. The study of PK/PD and Disease Progression relationships can be of considerable value in understanding drug action, summarizing extensive data, building a knowledge repository, finding optimal dosing regimens, and in making predictions under new circumstances. By the end of this course, students should be able to understand the role of pharmacokinetics and pharmacodynamics in the process of drug discovery and development.

Courses	Description
BMS 335	Advanced Microbiology and Practicum Credits: 3 (2+3) Prereq: BMS 201 This course will introduce students to the application of the knowledge of fundamental microbiology to address health problems which exist in today's life. The course topics will be discussed using problem-based learning and case studies and will include emerging infectious diseases, antibiotic resistance, diseases and biotechnology, bioterrorism, microbial biotechnology and archaeal, viral and prion biology.
BMS 336	Stem Cells and Regenerative Medicine and Practicum Credits: 3 (3+0) Prereq: BIOL 102 This course introduces students to the basics of stem cell biology, origin and function, the different types of stem cells and their current applications in therapy. It also highlights the ethical and regulatory factors of stem cell applications.
BMS 337	Cancer Biology and Practicum Credits: 3 (3+0) Prereq: BMS 202 This course introduces students to cancer and the biological processes that are affected by it. Molecular pathways that control or are involved in cell proliferation, differentiation, cell cycle, apoptosis, metastasis, and oncogenesis will be covered.
BMS 339	Principles of Pharmacology and Toxicology Credits: 3 (3+0) Prereq: BMS 204 AND BMS 205 This course emphasizes on the pharmacological characteristics of various drug classes. The course also focuses on drugs' mechanism of action and identifying their respective drug targets, as well as toxicology of the studied classes. Topics also covered include: receptor structure/function and signal transduction pathways; pharmacokinetics (ADME) and pharmacodynamics of drugs.
BMS 340	Advanced BMS Laboratory Techniques Credits: 4 (4+0) Prereq: BIOL 102 This course is a laboratory based course. The course explores advanced biomedical techniques in research centres and labs. The course combines advanced laboratory skills and professional research attitudes. Safe and professional lab practices including universal precautions will be introduced to students in this course. Students will learn how to use and write standardized protocols for conducting research in different biomedical science research labs. Special research studies will be conducted by students to enable them to apply very specialized professional skills and concepts.

Courses	Description
BMS 343	Drug Design and Computational Chemistry Lab Credits: 1 (0+3) Coreq: BMS 333 This course provides a background on the fundamental aspects and methodologies used for lead discovery, identification and optimization. Included are empirical de novo, linear free energy, and quantum statistical approaches. The course will also introduce students to foundations for algorithmic and mathematics application in computational chemistry. Students will learn a variety of commonly used techniques, such as geometry optimization, location of transition states, conformational analysis, and prediction of molecular and spectroscopic properties.
BMS 344	Human Embryology Credits: 3 (2+3) Prereq: BIOL 102 This course provides comprehensive understanding of embryological development using human body systems by following systematic approach to the body system. The course will focus on anatomy based approach and some comparative molecular approach. Topics include fertilization, implantation, in vitro fertilization, embryonic stem cell, gastrulation, and organogenesis.
BMS 349	Principles of Pharmacology and Toxicology Laboratory Credits: 1 (0+3) Coreq: BMS 339 The course aims to enable students to know and understand the pharmacological investigation techniques applied in the research and drug development (functional studies, binding and biochemical tests). Students will learn to correctly and critically interpret the results of virtual experiments demonstrating independence of judgment, in depth learning and proper communication of the results in writing.
BMS 364	Biophysics Credits: 3 (3+0) Prereq: CHEM 202 OR PHYS 201 This course introduces students to the physical principles that underlie diverse phenomena in cell biology. It also reviews the properties of biological macromolecules as soft material. Polymer and colloid science and statistical and thermal physics are integrated in understanding cell and molecular biology.

Courses	Description
BMS 399	Internship (For BIOMEDICAL SCIENCES PROGRAM) Credits: 2 (0+6) Pass/Fail This course is a two-credit hour for biomedical science students in Year 3, 4 who are engaged in off campus activities related to biomedical sciences in any of the four concentrations. The internship provides experimental and filed study experience to apply course work material in practical setting. Internships include working research labs, shadowing in hospitals, rotating in pharmaceutical labs and units, international laboratory working experience.
BMS 401	Senior Project I Credits: 3 (3+0) This course will provide students with the opportunity to conduct a research project. They will be taught how to plan and execute experiments and how to analyze and write the data.
BMS 402	Senior Project II Credits: 3 (3+0) Students will continue to work on and finalize the project initiated in Senior Project I. Students will present their thesis project at the graduation seminar orally or in a poster session.
BMS 404	Biostatistics Credits: 3 (3+0) Prereq: BIOL 101 This course introduces students to the concepts of basic statistical methods of data analysis in biomedical sciences. Topics include the basic concepts of the mean, standard deviation, significance, correlation, analysis of variance, non-parametric methods and the concepts of power and sample size calculation.
BMS 405	Medicinal and Biological Chemistry Credits: 3 (3+0) Prereq: CHEM 203 AND BMS 339 This course reviews the general principles of drug action and the pharmacological activities of various classes of drugs. The major focus is on the molecular mechanisms of drug action, with a detailed discussion of one or more prototypes of each drug class. Selected examples of drug discovery and development are also discussed. At the completion of the course, students will have a knowledge of the molecular basis of pharmacological activity, the mode of action of major classes of therapeutic agents for the purpose of drug design utilizing mechanistic information.

Courses	Description
BMS 406	Molecular Modeling and Targeted Drug Design Credits: 3 (3+0) Prereq: CHEM 203 AND BMS 333 The course covers the process of drug design based on molecular modeling technology. Students will learn structure and ligand-based drug design, and molecular and binding requirements of receptors with the aid of computational laboratory component. The course will cover virtual screening and how to search for compounds with specific properties in large compound databases. Hands-on experience in using computational software and visualization tool teaches the types of protein–ligand interactions methods, quantitative structure-reactivity relationship, and de novo ligand design in dynamic simulations.
BMS 409	Drug Target Identification and Validation Credits: 3 (3+0) Prereq: BMS 205 AND BMS 339 This course will introduce students to current methodologies adopted in discovery and validation of new targets for drug intervention. The particular topics to be discussed include: the concepts of target identification and validation; in vitro and in vivo techniques (e.g. microarrays, proteomics, siRNA, antisense, knockout mice).
BMS 415	Medicinal and Biological Chemistry Lab Credits: 1 (0+3) Coreq: BMS 405 The course aims to teach students the principles of planning and carrying out syntheses of simple pharmaceutical substances. Various purification methods of the reaction products will be also taught to students. Additionally, students will learn how to interpret spectra (IR, MS and NMR) of simple organic molecules for the sake of structural elucidation/confirmation thereof. Proper reporting of the experimental results is an integral component of the course.
BMS 416	Molecular Modeling and Targeted Drug Design lab Credits: 1 (0+3) Coreq: BMS 406 This lab course is concurrent with BMS 201. The course covers the process of drug design based on molecular modeling technology. Students will learn structure and ligand-based drug design, and molecular and binding requirements of receptors with the aid of computational laboratory component. The course will cover virtual screening and how to search for compounds with specific properties in large compound databases. Hands-on experience in using computational software and visualization tool teaches the types of protein–ligand interactions methods, quantitative structure-reactivity relationship, and de novo ligand design in dynamic simulations.

Courses	Description
BMS 422	Algorithmic Foundations of Comp Biology Credits: 3 (3+0) Prereq: BMS 321 AND MATH 201 This course provides students with the foundation needed for algorithmic and mathematical applications in genomic analysis, such as sequence analysis of DNA, RNA, regulatory genomics, gene-finding and genomic organization, protein and nucleic acid folding and structure prediction, molecular dynamics and sequence alliance. Students solve biological problems using influential programs, illustrating canonical algorithmic and computational approaches.
BMS 425	Protein Structure and Function Credits: 3 (3+0) Prereq: BMS 204 AND PHYS 102 AND MATH 102 AND (CHEM 202 OR PHYS 202) This course addresses the relationship between protein structure and function. Biophysical principles governing protein and nucleic acid structure and common folding motifs will be described and analyzed within the context of cell signaling, post-translational regulation, protein-protein, protein-nucleic acid, and protein-lipid interactions, and interactions with other small molecules and cellular components.
BMS 426	Developmental Biology and Genomics Credits: 3 (3+0) Prereq: BMS 202 AND BMS 203 This course introduces students to the processes of growth and development of biological systems, such as cell differentiation, morphogenesis, and the role of genetics in development.
BMS 428	Pathology Credits: 3 (3+0) Prereq: BMS 330 This course will cover the cellular and molecular basis of disease. Topics include the effect of disease on cellular homeostasis, inflammation and repair, tissue death, necrosis, apoptosis and regeneration.
BMS 429	Molecular Immunology Credits: 3 (2+3) Prereq: BMS 202 This course covers the immune system and interactions between organisms and the environment. Topics include organs, cells and molecules of the immune system, immune cell interactions and immune regulatory mechanisms. Diseases of the immune system, including autoimmunity and immune rejection will be covered.

Courses	Description
BMS 430	Advanced Strategies in Organic Synthesis Credits: 3 (3+0) Prereq: CHEM 201 AND CHEM 203 This course introduces students to selected advanced topics in organic synthetic chemistry. It also will discuss modern approaches in experimental chemistry with focus on Click Chemistry and Combinatorial Chemistry. This course will emphasize on the medicinal and synthetic organic chemistry aspects of combinatorial chemistry.
BMS 432	Structural Elucidation and Instrumental Analysis Credits: 3 (3+0) Prereq: CHEM 201 AND BMS 201 This course covers the basics of modern ionization methods and mass analyzers; small molecule structure assignment, quantitative assay development by LC-MS and metabolomics; quantitative discovery-based proteomics and validation methods; and peptide sequence determination, post-translational modification mapping, and protein structure determination methods.
BMS 434	Epigenetics in Health and Disease Credits: 3 (3+0) Prereq: BMS 202 Each mammalian cell carries basically the same genetic information, yet each cell performs a very specific and unique function according to its type. How does each cell “know” its identity and how does the gene expression pattern differ between various cell types is the topic of this class. Epigenetics has been a hot area of research for the past decade or so. In this course we will discuss the basis and mechanisms of epigenetic control of gene expression, how this epigenetic control influences cellular development/identity and how when that goes wrong, it results in disease.
BMS 435	Legal Aspects in Drug Desig Development Credits: 1 (1+0) This course will discuss the national and international regulations for registration of new drugs.
BMS 438	Human Pathophysiology Credits: 3 (3+0) Prereq: BMS 330 The purpose of this course is to provide the student with basic understanding of pathophysiology as a change from normal physiological functioning of the various systems of the human body. The course focuses on the general principles of disease and then further explores information dealing with specific disorders of body systems or individual organs.

Courses	Description
BMS 444	Metagenomics Credits: 3 (3+0) Prereq: BMS 202 In this course, the students are introduced to application of gene sequencing to a single genome or a community of microbial genomes. The course covers fundamental concepts of experimental design in metagenomics using next generation sequencing. The students will be introduced to various methods to process data and apply the appropriate functional and taxonomical characterization to a metagenomic set of data. Examples include mapping to whole genome databases and analysis of high-throughput sequencing data (HTS). The course covers both the theoretical bases and practical approach to data analysis.
BMS 448	Pathology Lab Credits: 1 (0+3) Coreq: BMS 428 This course provides the knowledge and skills to understand the principles of pathological processes, common and specific structures of cells and tissues and how diseases are diagnosed and graded according to changes of gross and microscopic picture . The course also provides the basic principles of different techniques of staining (including immunohistochemistry) and how selection between different stains is performed according to the pathology and the organ affected by the disease process.
BMS 451	Biology of Ageing Credits: 3 (3+0) Prereq: BMS 202 AND BMS 301 This course introduces students to different theories of aging. Aging disorders and diseases linked to aging will be covered. The course will focus on the molecular biology of aging.
BMS 452	Mitochondria in Health and Disease Credits: 3 (3+0) Prereq: BMS 202 AND BMS 301 This course focuses on the role of mitochondria in health and disease. The course includes the effect of diseases on mitochondrial number, mitogenesis, and the diseases caused by mitochondria malfunction.
BMS 455	Cellular and Molecular Imaging Credits: 3 (3+0) Prereq: BMS 204 This course provides students with fundamental understanding of cellular and molecular imaging. The course will focus on biomedical imaging, including whole body imaging (MRI and Tomography), and will address the tools and key techniques that can be used with most of the common cell imaging equipment, including fluorescent agents and types of microscopy. Cell imaging from the industrial perspective and its applications will be covered.

Courses	Description
BMS 456	Forensic Biology Credits: 3 (3+0) Prereq: BMS 202 AND BMS 204 This course teaches students how to apply different methods of biology, including molecular biology and chemistry, to prove or refute a link between a suspect and a crime scene.
BMS 457	Clinical Nutrition Credits: 3 (3+0) Prereq: BIOL 102 This course addresses the relation between food and health. Introduction to nutrition, nutrition across the life span, and nutrition disorders will be covered. Special focus will be placed on the obesity epidemic and diabetes.
BMS 458	Fermentation Credits: 3 (3+0) Prereq: BIOL 202 AND BIOL 204 This course introduces students to the fundamentals of fermentation technology. The bioprocess development and gene expression in bacteria and cell culture will be covered. The course includes batch and continuous process, bio-mass production, and fermentor design.
BMS 459	Pathogens and Host Defense Credits: 3 (3+0) Prereq: BIOL 102 This course covers the biology of pathogens of medical importance and how they cause diseases. The course addresses how the body responds to infections and the novel tools used to diagnose them.
BMS 460	Development and Commercialization Credits: 3 (3+0) This course will cover the steps required for developing a product from the discovery process up until it hits the market. This includes product discovery, preclinical trials, clinical trials, release approval, guidelines, commercialization steps and problems encountered during each of these steps. The course will focus on drug development and will cover other aspects.
BMS 462	Pharmacogenomics Credits: 3 (3+0) Prereq: BMS 202 AND BMS 204 This course covers the influence of genetic variations on drug response. Genes such as cytochrome P450, pharmacogenomics tests and their applications to different diseases and disorders will be addressed.

Courses	Description
BMS 463	Vaccines Credits: 3 (3+0) Coreq: BMS 429 This course introduces students to various types of vaccines including protein, DNA, and other vaccines. The course will focus on the latest technologies for vaccine construction, biosafety aspects and global challenges facing vaccine usage.
BMS 465	Virology Credits: 3 (3+0) Prereq: BIOL 102 This course introduces students to the principles and foundations of virology. The course covers viral infectious cycle, molecular biology, structure, attachment and entry, transcription strategies, gene replication strategies, control of translation, intracellular trafficking, and virus particle assembly. The course will focus on mammalian viruses and others such as bacteriophage, plant viruses, viroids, and prions.
BMS 467	Bacteriophages as Antibacterial Agent Credits: 3 (3+0) Prereq: BMS 201 The course will introduce phage therapy as an alternative to conventional antibiotic treatments for bacterial infection. The course will cover the Phage therapy pharmacokinetics, the safety of phage therapy, its mode of action and safety profile, phage approaches for the treatment of specific diseases, phage therapy and immune system, and phage therapy applications.
BMS 471	Clinical Trials Design, Administration and Management Credits: 3 (2+3) Prereq: CHEM 202 AND BMS 333 This course will introduce and apply the theory of clinical trials design and analysis, discuss the practical issues of financing and implementing clinical trials, and describe issues of monitoring trials and working in cooperative groups. Under direct supervision by the instructor, the scholar will design and present to a group of peers a concept paper for a phase I/II and phase II/III clinical trial.
BMS 473	Foundations of Computational and Systems Biology Credits: 3 (3+0) Prereq: BIOL 101 AND MATH 102 AND CSCI 101 This course covers the implementation of some key requirements of living systems in both mathematical analysis and quantitative experimental methods. These include mathematical models approaches and limitations, computational analysis as well as introduction to genomics and metagenomice methods.

Courses	Description
BMS 474	Genomics and Data Sciences Credits: 3 (2+3) Prereq: MATH 201 AND BMS 321 The course will focus on the basic numerical methods for numerical linear algebra. This course will focus on the numerical solutions and the theoretical treatments of both integral equations and differential equations.
BMS 475	Bio Chemistry of Hormones and Vitamins Credits: 3 (3+0) Prereq: BMS 204 This course emphasizes advanced concepts in Biochemistry, including structure and function of proteins, lipids and nucleic acids; enzyme kinetics, signaling and metabolic regulation, DNA replication; transcription, translation, and regulation of gene expression.
BMS 477	The Human Genome and Disease Credits: 3 (3+0) Prereq: BMS 202 AND BMS 203 This course will cover causes and types of DNA damage, the mechanisms employed by living cells to repair DNA damage, and the relevance of genomic instability for human disease.
BMS 499	Selected Topics in BMS Credits: 3 (3+0) This course is designed to provide senior students with in depth training in a selected topic of their choice, that relates to the student's research project and/or future career plan. The course will be offered to students in any of the four concentrations of Molecular Biology, Computational Biology and Genetics, Medical Sciences or Drug Design and Development. The subject matter will differ based on the needs of the student and the recommendation of the instructor. The course will be a series of selected topics spanning different areas of Biomedical Sciences. A specific topic will be assigned to a student/group of students and they will have to deliver a presentation and write a report about that topic. The topics will be selected by the course instructor. Topics (presentation's titles), minimal content of a presentation are summarized in detail in the course Detailed Syllabus document.
CHEM 101	Chemistry I Credits: 3 (3+0) Coreq: CHEM 111 This course covers the basics of general and physical chemistry required for all ZU majors. These include the atomic structure and periodicity, states and characteristics of matter, chemical stoichiometry, an overview of chemical bonding and intermolecular forces, molecular structures, symmetry and molecular orbital theory, ionic solutions and electrochemistry, acid-base chemistry and pH, oxidation and reduction processes. In addition, the course introduces the fundamentals of organic chemistry.

Courses	Description
CHEM 102	Chemistry II Credits: 3 (3+0) Coreq: CHEM 112 Prereq: CHEM 101 This course covers the introduction to inorganic and nuclear chemistry, introduction to spectroscopy, photochemistry, foundations of physical chemistry including chemical thermodynamics, chemical equilibrium, basics of chemical reaction kinetics and kinetic theory of gases, surface chemistry and catalysis, colloidal chemistry, general reactions mechanisms, introduction to quantum theory, in addition to an introduction to polymers and their applications.
CHEM 111	Chemistry I Lab Credits: 1 (0+3) Coreq: CHEM 101 Laboratory concurrent with CHEM 101. Experiments cover the fundamentals of general, physical and organic chemistry such as the physical and chemical properties of matter, chemical stoichiometry, and determination of empirical formulas, molecular structure, molecular shapes and molar volumes of gases, acid-base titrations, pH measurements, oxidation-reduction reactions, and synthesis of simple organic compounds.
CHEM 112	Chemistry II Lab Credits: 1 (0+3) Coreq: CHEM 102 Laboratory concurrent with CHEM 102. The experiments cover the basics of chemical thermodynamics, chemical equilibrium, chemical reaction kinetics, molecular modeling, and resolution of matter into pure substances using techniques such as chromatography and fractional distillation. Applied chemistry experiments (chemistry around us) include water purification, water quality, biofuel preparation, and simple polymers preparation at the nano-scale.
CHEM 201	Organic Chemistry Credits: 3 (3+0) Coreq: CHEM 211 Prereq: CHEM 101 This course introduces students to the modern description of molecules, molecular orbital theory, hybridization and molecular structure, structure and function of major classes of organic compounds. Introduction to stereochemistry, ring systems and aromaticity will be covered. Overview of the different types of reaction mechanisms, introduction to polymers, macromolecules and the different types of polymerization reactions will be discussed as well as natural and biomedical polymers and polymer additives will also be covered.

Courses	Description
CHEM 202	Analytical & Physical Chemistry Credits: 3 (3+0) Coreq: CHEM 212 Prereq: CHEM 102 This course covers core concepts in physical chemistry, thermodynamics, electrochemistry and principles of chemical equilibrium.
CHEM 203	Organic Chemistry II Credits: 3 (3+0) Prereq: CHEM 201 This course is designed to provide a fundamental overview of organic chemistry to students interested in pursuing a career in the science, particularly BMS, DDD, MS, and NS. Upon successful completion of this course, students will be able to understand the relationship between structure and function of organic molecules, the major categories of reactions, reaction mechanisms, the principle classes of organic molecules, and synthesis of various organic compounds. Many chapters in the selected textbook also integrate the societal, pharmaceutical or industrial importance of some of the studied compounds.
CHEM 211	Organic Chemistry Lab Credits: 1 (0+3) Coreq: CHEM 201 This lab covers experiments designed to reinforce concepts described in CHEM 201. These include the synthesis of simple organic molecules from different classes of organic compounds, estimation of purity, concentration and other physicochemical characteristics of organic moieties. Basic phytochemical tests, and investigation methods to identify simple organic molecules will be covered as well as preparation, simple characterization and evaluation of some common polymers.
CHEM 212	Analytical & Physical Chemistry Lab Credits: 1 (0+3) Coreq: CHEM 202 The experiments selected for this laboratory demonstrate concepts described in CHEM 202. Students are introduced to modern laboratory instrumentation and experimental techniques in physical chemistry to explore fundamental concepts in spectroscopy, electrochemistry, chemical thermodynamics and chemical kinetics.

Courses	Description
CIE 202	Fundamentals of Computer Programming Credits: 3 (2+3) Prereq: CSCI 101 This course aims to provide the students with an understanding of the role of computations in solving engineering and scientific problems through introducing them to different programming paradigms. The course will focus on procedure-oriented and object-oriented programming models. Topics include primitive data types, input/output, control structures, arrays and lists, built-in and user-defined functions, classes, objects, inheritance, encapsulation, and polymorphism. By the end of the course, the students will be able to differentiate between the two design approaches. In addition, they will be able to develop high quality, working software that solves real problems using the object-oriented programming approach.
CIE 205	Data Structures and Algorithm Analysis Credits: 3 (2+3) Prereq: CIE 202 This course introduces formal techniques to support the design and analysis of algorithms, focusing on both the underlying mathematical theory and practical considerations of efficiency. Introduced design approaches will be supported by some common data structures, with a focus on some advanced ones. Topics include: mathematics foundation, divided-and-conquer, dynamic programming, greedy method, NP-completeness complexity, approximation algorithms, randomized algorithms, and backtracking algorithms. In addition to some advanced data structures: Binary trees, Heaps, Priority Queues, and Huffman Coding Trees.
CIE 470	Introduction to Quantum Computation and Quantum Information Credits: 3 (2+3) Prereq: MATH 201 Quantum information and quantum computation are newborn sciences that benefit from the quantum-mechanical nature to launch the next huge revolution of information and communications technology. In quantum information and quantum computation, elementary quantum systems like photons and subatomic systems are used to build fascinating quantum devices and protocols superior to the traditional classical ones. On that scale, instead of the binarized classical information unit (the bit), quantum mechanics offers another more featured unit; the quantum bit (qubit), that supports coherent superposition (and interference) and thereby can take an infinite number of values. In this course, we will attempt to cover the fundamentals of Quantum computation and quantum information. We will shed light on some of the famous quantum protocols such as quantum teleportation, quantum superdense coding, quantum key distribution, quantum privacy amplification, quantum error correction. We will study possible quantum-circuit implementations.

Courses	Description
CSCI 101	Introduction to Computer Science Credits: 2 (1+3) In this course, students identify how various forms of data are represented digitally, how the major hardware components store and operate on such data, and how software is developed to control these systems. Students learn the basics of computational problem solving, algorithm design and analysis, and data structures. The course will also include an introduction to computer programming to maximize the depth of experience in designing and writing computer programs by teaching the students how to write programs using Python programming language. In the end of the course, the students should be able to use the computer to solve the problems they face in other university's courses by writing efficient Python programs.
ENGL 152	Effective Speaking and Composition Credits: 2 (2+0) Prereq: ENGL 004 if the student was placed in ENGL 003 or ENGL 004 after the English placement exam The focus of the course is twofold; the first part of the course introduces the meaning and strategies of rhetoric; it aims to enhance the students' skills in identifying, comprehending, evaluating, and producing different elements and types of written arguments. This entails developing the rhetorical analysis skills and instilling deeper insights to develop solid arguments while addressing a variety of audiences. The students will further demonstrate an understanding of various types of audiences, explicit and implicit purposes, and positive/negative/neutral tones constituting a rhetorical situation. Throughout the first half of the semester, students will practice critical thinking, reading, and writing; they will develop research skills in which they will identify and evaluate primary and secondary sources that include different types of evidence to support their own stance towards a controversial topic. Using the enhanced critical thinking and argumentation skills, the second part of the course aims to instill the public speaking skills that are now of incremental significance whether in the scientific field or for marketing purposes. The focus of the second part of the course will be enabling the students to deliver different types of speeches in different settings, for different purposes, and addressing different audiences.
ENGL 153	Scientific Writing Credits: 2 (2+0) Prereq: ENGL 152 In designing this course, the main priority was to enhance the required skills needed in scientific research design and writing; accordingly, the course takes students through a step-by-step process to identify and avoid wordy writing, integrate scientific collocations in writing, understand the different scientific approaches, identify different types of scientific articles, critically review a scientific article, synthesize different valid and reliable sources, write a full-fledged research grant proposal, avoid plagiarism by applying summarizing/paraphrasing techniques and using an acknowledged documentation style and deliver an effective poster presentation.

Courses	Description
ENGR 207	Fluid Mechanics Credits: 3 (2+3) Prereq: MATH 102 AND PHYS 101 Fluid properties; Fluid statics; Bernoulli equation; Fluid kinematics; Energy equation; Finite control volume analysis; Dimensional analysis; Viscous flow in pipes; Flow around immersed bodies.
ENV 301	Environmental Laws, Policies, and Economics Credits: 3 (3+0) Principles of environmental legislation and obligations under environmental legislation are covered, including the Environmental Protection Act. Appropriate and realistic environmental management models through environmental law and regulations are presented and evaluated, to support the idea of sustainable development via environmental law. In addition, Egypt Environmental Laws and Regulations are introduced and Environmental Ethics are discussed. An introduction to the methods economists use to measure the cost of environmental pollution is presented.
MATH 101	Calculus I Credits: 3 (2+2) Calculus I course discusses the definite integral, applications of definite integrals to different physical problems (area, volume, surface area and arc length), calculus of important transcendental functions (Natural Logarithms, Exponential functions, Inverse Trigonometric functions, Hyperbolic functions), techniques of integrations, Numerical Integration and Improper integrals, and methods for solving first order differential equations.
MATH 102	Calculus II Credits: 3 (2+2) Prereq: MATH 101 Calculus II course discusses convergence and divergence of sequences and series, power series, Taylor series, Binomial series, parametric equations, polar coordinates, lines and planes in space, functions of several variables, partial derivatives, multiple integrals, cylindrical and spherical coordinates, line integrals and work, integrals on vector fields.
MATH 201	Linear Algebra and Vector Geometry Credits: 3 (2+2) In this course, students are introduced to systems of simultaneous equations and the use of matrices to describe multidimensional spaces, matrix algebra, vector spaces and bases sets, eigenvalues and eigenvectors. The course covers the following topics: Systems of linear equations, matrix algebra, vector spaces and Bases, eigenvalues and eigenvectors, orthogonality and least squares, applications.

Courses	Description
MATH 202	Ordinary Differential Equations Credits: 3 (2+2) Prereq: MATH 102 This course demonstrates the usefulness and importance of using differential equations as mathematical models for real world problems that emerged in science and engineering. The course covers the following topics: first order, second order and higher order ordinary differential equations, modeling and applications, a system of linear differential equations with constant coefficients, numerical methods, Laplace transform, series solutions to DEs, Fourier series, and an introduction to partial differential equations.
MATH 301	Probability and Statistics Credits: 3 (2+2) Prereq: MATH 102 This course introduces the students to the basic concepts of probability and statistics that can be used in many engineering fields and in particular in the analysis of experimental data. The examples and exercises emphasize applications in engineering as general and space, physics, chemical, and mineral resources in particular. MINITAB will be used during tutorial Lab. The course covers the basic tools for the collection, analysis, and presentation of data in all areas of engineering. Emphasis on principles of mathematical statistical reasoning, underlying assumptions, and careful interpretation of results is considered. Topics covered include: Tools for describing central tendency and variability in data; random variables, their distributions, expectations and correlations, methods for performing inference on population means and proportions via sample data; statistical hypothesis testing and its applications to group comparisons; ANOVA; correlation, and regression. While there are some formulae and computational elements to the course, the emphasis is on interpretations and concepts.
MATH 302	Partial Differential Equations and Complex Analysis Credits: 3 (2+2) Prereq: MATH 202 One of the fundamental mathematical tools used in studying systems that change over time and space is partial differential equations (PDEs). They are widely used in diverse areas of engineering, physical sciences, biology, economics and finance. The course first introduces some special functions that usually appear in the solutions of PDEs such as Bessel and Legendre functions. Some theoretical concepts about the Sturm-Liouville problem are discussed. It also introduces solutions of PDEs using different methods such as separation of variables, integral transforms and Green's function for both homogeneous and non-homogeneous cases. It also provides solutions to higher order PDEs. In the complex analysis part, the following topics are covered: analytical functions, Cauchy-Riemann equations, contour integrals, Cauchy's integral formulas, Taylor and Laurent series, the calculus of residues, the evaluation of contour integrals and inverse Laplace transform and conformal mappings and their applications in solving PDEs.

Courses	Description
MATH 306	Numerical Analysis Credits: 3 (2+2) Prereq: MATH 201 AND MATH 202 Numerical methods are techniques by which mathematical problems are formulated so that they can be solved with arithmetic operations. Although there are many kinds of numerical methods, they have one common characteristic: they invariably involve large numbers of tedious arithmetic calculations. It is little wonder that with the development of fast, efficient digital computers, the role of numerical methods in engineering problem solving has increased dramatically in recent years. The course will develop numerical methods aided by technology (programming using Matlab) to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integrals numerically. It also shed a light on curve fitting including regression and interpolation models and optimization for constrained and unconstrained problems. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs. The course will further develop problem solving skills needed in engineering and science.
MATH 308	Discrete Mathematics Credits: 3 (2+2) This course demonstrates the usefulness and importance of using discrete mathematics as mathematical tools for real world problems that emerged in science and engineering. The course covers the following topics: Proofs, mathematical induction, recursion. Efficient exponentiation and multiplication Greatest common divisor, Euclid algorithm. Prime numbers, modular arithmetic, Fermat Little theorem. Public-key cryptography, RSA. Counting, the binomial theorem, elementary probability theory. Generating random numbers with their factorization. Elementary graph theory: connectivity, trees, planarity. De Bruijn sequences and Gray codes
MATH 310	Abstract Algebra Credits: 3 (3+0) Prereq: MATH 201 The goal of this course is to introduce students to abstract mathematical thinking through the study of these simple, beautiful mathematical constructions, and to explore the relationship to other areas of mathematics. The main objects of study are groups, which are abstract mathematical objects that reflect the most basic features of many other mathematical constructions. Also, topics like linear groups and group representations will be studied. We will also study rings and other abstract mathematical objects, which can be thought of as groups with additional structure. Abstract algebra provides students with good mathematical maturity and enables learners to build mathematical thinking and skill.

Courses	Description
MATH 403	Introduction to Real Analysis and Topology Credits: 3 (3+0) Prereq: Math 202 This course has two strong components. The first is to provide a very solid foundation for real analysis and an introduction to topology. The aim is to extend the student knowledge of the topics from calculus, emphasizing the theoretical ideas. Also, to build differential calculus from the axioms of the real numbers, with a strong emphasis on formality. Topics include the real numbers, sequences, continuity, differentiability, integrability and convergences of functions. In addition, it gives an introduction to metric and topological spaces. The second objective is for the students to learn how to make proper mathematical proofs. The students are expected to be able to prove theorems, and to develop an intuition as to which proof methods work for different situation. The course also provides some applications of real analysis in Economics and Physics.
MATSCI 201	Fundamentals of Materials Science and Engineering Credits: 3 (3+0) Prereq: CHEM 101 This course introduces students to the fundamentals of structure and mechanical properties of materials. Topics covered include structure of metals, ceramics, composites, polymers. Imperfections in solids and grain size and diffusion mechanisms in solids. This course also covers mechanical properties like elasticity, hardness, tensile properties, stress, strain and sheer in solids. Pathways to strengthen solids, deformation mechanisms, failure due to fracture, fatigue, and creep. Lab sessions that will focus on the following will be included: Mechanical testing (Tensile, Compressive, Hardness, and Impact tests); Metallographic sample preparation; Diffusion in liquids; and Solidification of alloys and phase diagrams development for simple alloys.
MATSCI 204	Inorganic chemistry Credits: 3 (3+0) Prereq: CHEM 102 Introduction to inorganic chemistry principles including atomic structure, symmetry, orbitals and bonding models for molecules and solids. Main group (s- and p-block) elements, transition metals, molecular orbital theory, inorganic complexes and the different techniques for characterization of inorganic complexes will also be discussed.
MATSCI 301	Catalysis Credits: 3 (3+0) Prereq: CHEM 102 In this course many of industrially-relevant catalytic processes will be discussed. Additionally, principles and examples of applications on surface-catalysis and heterogeneous catalysis will be demonstrated.

Courses	Description
MATSCI 302	Solid State Physics Credits: 3 (3+0) Prereq: PHYS 202 The course will provide a valuable introduction and an overview of the basic applications of the physics of solids. The course includes theoretical description of crystal and electronic structure, lattice dynamics, and optical characteristics of different materials (semiconductors, metals, dielectrics, magnetic materials and superconductors) based on both classical and quantum physics principles. The theoretical basics of various advanced experiments related to studying the physics of solids such as X-ray diffraction, Raman Scattering, Photoluminescence, etc., will be described and discussed.
MATSCI 303	Macromolecular Chemistry Credits: 3 (3+0) Prereq: CHEM 102 This course covers the various approaches for synthesis and characterization of macromolecular/polymeric materials including linear, branched, dendrimetric, star polymers, and hydrogel matrices. Physiochemical properties, crystallinity, mechanical, optical, and thermal characteristics of various polymeric types will be also described. The course also explores the kinetics of living polymerization and applications of the nanostructure polymeric materials.
MATSCI 304	Modern Characterization Techniques II Credits: 3 (3+0) Prereq: CHEM 102 AND PHYS 102 This course introduces students to a variety of optical and electron microscopy and mass spectrometry techniques including detailed description of the instruments and hands-on experiments to familiarize with data acquisition, processing, and interpretation.
MATSCI 308	Computational modeling Credits: 3 (3+0) Prereq: PHYS 202 AND MATH 202 Introduction to different programming languages used in materials modeling. Modeling the crystal/chemical structures of chemical systems and characterize them using computational chemistry software packages. How to employ the High-performance Computers (HPC) technology in materials modeling. Applying the different advanced techniques of computational modeling to simulate the materials properties.
MATSCI 480	Self-assembled Systems Credits: 3 (3+0) Prereq: CHEM 201 Introduction to molecular recognition, complimentary chemical functionalities, reversible interactions and self-assembly. The course will also cover supramolecular chemistry, crystal engineering, cocrystals, and polymorphism.

Courses	Description
NANENG 301	Micro/Nano Fabrication Techniques Credits: 3 (2+3) Prereq: CHEM 102 AND MATSCI 201 The course provides an in-depth understanding of electronic device fabrication steps. Focus is on developing knowledge of the process design, the device different fabrication techniques and the experimentation related to CMOS manufacturing. Both concepts and practical aspects are covered. Cleanroom processes and fabrication techniques are aimed to be learned through lectures in class, then in the Lab and educational cleanroom. In addition, students will design a process flow using a commercial TCAD tool.
NANOSC 301	Spectroscopy of Nanomaterials Credits: 3 (3+0) Introduction to electromagnetic spectrum and radiation-matter interaction. Different regions of electromagnetic spectrum and associated nuclear, electronic, and molecular spectroscopy. Students will be introduced to spectrum acquisition, processing, and interpretation on selected spectroscopic techniques. The course also offers an introduction to spectroscopic structural characterization of simple organic molecules.
NANOSC 302	Modern Characterization Techniques I Credits: 3 (3+0) Coreq: NANOSC 312 This course covers a variety of spectroscopic characterization techniques. The techniques covered in this course will include atomic absorption, electronic absorption and fluorescence spectroscopic techniques. The course is structured to offer a thorough theoretical background on the principles of spectrophotometers alongside with hands-on lab experiments and demonstrations on UV-vis, IR, NMR, Atomic Absorption, and XRF spectrophotometers.

Courses	Description
NANOSC 303	Quantum Mechanics Credits: 3 (3+0) Prereq: PHYS 202 This course is a substantial introduction to quantum mechanics and how to use it. The course covers many topics including; how quantum mechanics is important in the everyday world, the aspects and continuing evolution of quantum mechanics, and how we need it for nano-based modern technology, Schroedinger's wave equation, getting to Schroedinger's wave equation, the key ideas in using quantum waves and probability densities and linearity. It also includes the "two slit" experiment/setup and its paradoxes, getting "quantum" behavior, the "particle in a box", eigen values and eigen functions, mathematics of the quantum mechanical waves. The quantum mechanics of systems that change in time, time variation by superposition of wave functions. Besides, it will cover the harmonic oscillator, movement in quantum mechanics, wave packets, group velocity and particle current. The course also covers the measurement in quantum mechanics (Operators in quantum mechanics, and the quantum-mechanical Hamiltonian, and the Stern-Gerlach experiment). It also covers angular momentum in quantum mechanics, atomic orbitals, quantum mechanics with more than one particle, solving for the hydrogen atom, and studying the nature of the states of atoms.
NANOSC 305	Synthesis/Fabrication of Nanomaterials Credits: 3 (3+0) Coreq: NANOSC 315 This course will explore both top-down nano-structuring and (by traditional and alternative lithographic techniques) and bottom-up nano-structuring (by self-organization and molecular self-assembly). For instance, the course covers the methods to fabricate polymer nanoparticles and other nanoparticles, nanocomposites, thin films, Ferro-fluids, and other types of nanomaterials. The course also covers the self-assembly, advanced nano fabrication techniques, eco-friendly nano- manufacturing. Each part will include basic concepts in addition to more recent topics in the nano-manufacturing. Besides, the lithographic techniques applied at the nanoscale, as the key to the production of devices for the electronic and related industries, will be also covered. Also, projection and proximity techniques (electron, XUV, and ion beams) and writing processes (ion beam, electron beam, and scanning probe) will be described. Focus will also be placed on the soft lithographic methods including stamping and dip-pen nanolithography
NANOSC 306	Statistical Mechanics & Therm Nanscale S Credits: 3 (3+0) This course describes applications of the thermodynamics and statistical mechanics to nanoscale materials and systems with a focus on the thermodynamics laws, phase equilibria, Gibbs-Duhem relation, chemical potential, Boltzman, Fermi-Dirac, and Bose-Einstein distribution functions, ensemble behavior.

Courses	Description
NANOSC 307	Nanosciences Research Lab Rotations Credits: 1 (0+3) Rotations into different research labs to establish direct contact with research techniques and researchers working within different areas at Zewail City.
NANOSC 308	Introduction to Polymer Science Credits: 3 (3+0) Introduction to polymer science course provides an integrated view of the principles of polymer science and engineering. It includes the chemical structure of various polymeric compounds, polymerization kinetics and reactors, and polymer processing technologies.
NANOSC 309	Principles of Pharmacokinetics Credits: 3 (3+0) This course introduces students to the basics of pharmacokinetics in correlation with the chemical structure of bioactive compounds. The course will cover the various pharmacokinetics modelling concepts to define and calculate the time course of drug effects under various physiological and pathological conditions. The course will enable the students to understand and expect drug action, summarize extensive data, build a knowledge repository, find optimal dosing regimens, and to make predictions under new circumstances. Also, by the end of the course, students will be able to know the vital role of pharmacokinetics in the process of drug discovery and development.
NANOSC 310	Computer Aided Drug Design Credits: 3 (3+0) This course presents the fundamental aspects and approaches applied for exploring, identification and optimization of bioactivity. This involves, for instance, linear free energy calculations, quantum statistical approaches along with empirical de novo. There will be also a good foundation for algorithmic and mathematics application in computer aided drug design. The course will also cover a number of essential computational strategies and techniques. This include, location of transition states, prediction of molecular and spectroscopic characteristics of compounds, conformational analysis, along with geometry optimization.
NANOSC 312	Modern Characterization Techniques Lab I Credits: 1 (0+3) Coreq: NANOSC 302 The experiments selected for this lab course were designed to emphasize concepts described in NANOSCI 302. The lab course covers the microscopy, spectroscopy, and nanotechnology instrumentation for characterization of nanomaterials. During the lab course, the instructor will assist students in learning and practicing the techniques for using laboratory instruments common to the nanoscience field. These techniques such as UV-vis-NIR spectroscopy, FTIR, and Raman spectroscopy, ion scattering, electron spectroscopy, X-ray diffraction, SEM, TEM, AFM, and thin film growth/deposition methods.

Courses	Description
NANOSC 313	Advanced Characterization Techniques Credits: 3 (3+0) Prereq: CHEM 201 AND PHYS 202 This course presents the fundamentals of the most commonly used electron and optical microscopy, various X-Ray techniques, 1d and 2D Nuclear Magnetic Resonance (NMR) techniques, as well as mass spectrometry techniques including detailed description of basics of the instruments, their components as well as hands-on experiments to familiarize with data acquisition, processing, and interpretation.
NANOSC 315	Synthesis/Fabrication of Nanomateria Lab Credits: 1 (0+3) Coreq: NANOSC 305 The experiments selected for this lab course were designed to emphasize concepts described in NANOSCI 305. The lab course will cover the methods to fabricate polymer nanoparticles and other nanostructures, nanocomposites, thin films, Ferro-fluids, and other types of nanomaterials. The course also covers the development of self-assembly, advanced nano fabrication techniques, and eco-friendly nano- manufacturing.
NANOSC 317	Special Topics in Bio-Nanotechnology Credits: 3 (3+0) Prereq: BIOL 102 AND CHEM 201 The course is aiming to give the students an understanding of the biomolecular structures and functions in the central cellular processes with a focus on the nanoscale principles and explains how biomolecules can be designed and used for creation of new nanotechnologies. The course covers the folding and self-assembly of biological complexes and macromolecules, membrane and cell signalling, molecular recognition, and biomolecular motors, molecular biological techniques and characterization of biomolecules, selection and rational design of biomolecules, DNA nanotechnology and DNA origami, nanoparticles-mediated controlled drug delivery, stem cells and nanotechnology, tissue engineering using nano- and biocompatible materials, biosensors, DNA computing, and synthetic biology.
NANOSC 322	Chemistry & Physics of Nanomaterials Credits: 3 (3+0) Prereq: MATH 201 This course aims to provide knowledge about physical chemistry based nanoprocess, and nano-synthesis, nano-formulations. The students will be able to design and conduct experiments relevant to physicochemical characteristics of nanostructures as well as to enhance the various nanosynthesis techniques and to identify and solve related problems.

Courses	Description
NANOSC 328	Biological Nanomaterials Credits: 3 (3+0) Prereq: CHEM 202 Biological systems provide a rich range of examples of chemical systems that are structured on the nanoscale. For instance, nanofibres, microtubules, viruses, and ribosomes are some examples of systems that can be investigated from the perspective of nanoscience. This course will explore the use of these systems or developing artificial systems which mimic their functionality as important growth areas in nanoscience.
NANOSC 392	Introduction to Nanochemistry Credits: 3 (3+0) Prereq: CHEM 202 The course was designed in such a way to discuss and cover the key milestones in nanochemistry such as supramolecular chemistry and inorganic nano-structures.
NANOSC 399	Internship (For NANO SCIENCE PROGRAM) Credits: 2 (2+0) Pass/Fail An internship is a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting. Internships give students the opportunity to gain valuable applied experience.
NANOSC 401	Nanotexicology Credits: 3 (3+0) Prereq: NANOSC 305 This course defines the importance of the emerging science of Nanotoxicology, the importance of nanoparticle characterization in toxicity testing of nanomaterials, and the physicochemical characteristics of various nanoparticles that mediate their toxicity. The course also focuses on toxicokinetics (ADME) and toxicodynamics of nanostructures, as well their adverse impacts on various organs and systems inside the body. Topics also covered include: In Vitro and In Vivo models for nanotoxicity testing, as well the strategies for risk assessment of nanomaterials and their evaluation.
NANOSC 402	Nanoimaging Credits: 3 (3+0) Prereq: NANOSC 302 AND NANOSC 305 This course provides an overview of the use of nanoparticles and nano-structures with the aid of various microscopy techniques for in vitro and in vivo diagnostic medical imaging and therapy, and in various biomedical applications.

Courses	Description
NANOSC 403	Special Topics in Nanomedicine Credits: 3 (3+0) Coreq: NANOSC 417 Prereq: NANOSC 305 AND BIOL 102 The course introduces the students to the main medical applications of nanoscience for diagnosis, treatment and management of human health. The course covers numerous aspects of nanomedicine focused on (a) bioimaging and nanoparticles-based drug delivery, and (b) nanotechnology in regenerative medicine and tissue engineering. A basic understanding of the host responses to foreign nanomaterials and surfaces will be utilized as an introduction to the current nano-based drug delivery and imaging approaches and medical implants in the clinic. Besides, regulatory aspects such as nanotoxicology issues will be covered. Students will have the opportunity during the course to identify the current therapeutic shortcomings and suggest/design nanomedicine solutions tailored to a particular defect/disease.
NANOSC 404	Principles of Pharmacology Credits: 3 (3+0) Prereq: BIOL 102 AND BMS 204 This course is designed to cover the principles of pharmacology including mathematics and calculations, rules and regulations governing medications, medication administration and safety issues. Medications specific to different diseases and disorders will be explained emphasizing desired effects, side effects, and contraindications. The course also covers the principles of toxicology: bioaccumulation, and environmental toxicology (ecotoxicology). Toxicology models: structure-activity relationships. Toxicology prediction. Experimental toxicology studies: Conventional bioassays. Dose-response studies. Cell culture studies. In vitro studies, and Toxicology mechanisms, etc. Importance of biological membrane in toxicology: Phase partitioning behaviour. Toxicology and bioaccumulation of nanoparticles: Ecotoxicology of nanoparticles in atmospheric and aqueous systems. Introduction to nanomaterials: Biologically active nanomaterials eg Ag nanoparticles for anti microbial effects. "Safe" nanomaterials. SiO2, TiO2, ZnO, CaCO3, peptide nanomaterials, latex particles, etc. Application of toxicology studies to study toxicology and bioaccumulation of nanomaterials.
NANOSC 405	Nanopharmaceutics Credits: 3 (3+0) Prereq: NANOSC 305 This course is concerned with the design and development of new drugs for clinical purposes. It explores the different pharmaceutical formulations and dosage forms, how they work, their different types starting from traditional ones such as tablet, cream, inhaler, etc, and the highly advanced formulations based on nontoxic, biocompatible, and biodegradable nanomaterials. How these formulations are analysed and tested. Besides, this course provides an understanding of all aspects of the pharmaceutical industry.

Courses	Description
NANOSC 406	Nanomat for Reg Med Tissue Engin Credits: 3 (3+0) Prereq: NANOSC 305 Tissue engineering for regenerative medicine as a discipline shows enormous potential for future health. The course's primary focus is on strategies to repair, replace and ultimately regenerate various tissues and organs to solve major clinical problems. The courses provide a comprehensive insight into topical issues including stem cells, polymer technology, surface fabrication and gene delivery. Besides, the designing of biologically active scaffolds with optimal characteristics is one of the key factors for successful tissue engineering. Recently, nanomaterials have received a considerable interest as leading candidates for engineered tissue scaffolds due to their unique compositional and structural similarities to the natural extracellular matrix, in addition to their desirable framework for cellular proliferation and survival. The course will cover all these issues in addition to describing the ability to control the shape, porosity, surface morphology, and size of nanomaterials–based scaffolds which could create new opportunities to overcome various challenges in tissue engineering such as vascularization, tissue architecture and simultaneous seeding of multiple cells. This course also provides an overview of the different types of nanomaterials, the approaches that can be used to fabricate their matrices with specific features and their recent applications in regenerative medicine and tissue engineering. Special attention will be also given to the various design considerations for an efficient scaffold in tissue engineering.
NANOSC 408	Synthetic Biology Credits: 3 (3+0) The goal of this course is to enable the predictable reprogramming of cells to execute complex physiological activities. The grand challenge for synthetic biology is how to reconcile the desire for a predictable, formalized design process with the inherent 'squishiness' of biology. The course focuses on how the complexity of biological systems, combined with traditional engineering approaches, results in the appearance of new design principles for synthetic biology. The students will be introduced to the design-build-test cycle, in which libraries of biological parts are composed into larger modules and evaluated using a variety of high-throughput techniques. Students also will learn how to solve challenges and learn how bacterial and eukaryotic regulation of different forms – transcriptional, translational, post-translational, and the epigenetic can be used to engineer cells to do beneficial things.
NANOSC 409	Thin Film & Surface Science Credits: 3 (3+0) Description of several techniques to fabricate and characterize thin films including vapor deposition, electroplating, spin coating, ink-jet printing and other techniques. The course also will describe in details the surface characteristics.

Courses	Description
NANOSC 411	Bio-Nanotechnology Lab Credits: 1 (0+3) Prereq: NANOSC 315 AND NANOSC 317 The experiments selected for this lab course were designed to emphasize concepts described in NANOSC 317, and covers the main recent directions of bionanotechnology.
NANOSC 412	Nanochemistry Lab Credits: 1 (0+3) Prereq: NANOSC 315 AND NANOSC 392 The experiments designed and used for this lab course were developed to emphasize the topics and concepts described in NANOSC 392 (Introduction to Nanochemistry). The lab course aims to introduce the students to experimental solid state chemistry and nanochemistry. The course will introduce the student to synthesis, identification and characterization, properties, functionalization and use of solid materials and nanomaterials such as nano-porous materials, etc.
NANOSC 413	Photonics & Laser Physics Credits: 3 (3+0) Prereq: PHYS 202 This course provides students with a good working knowledge of optical physics; including diffraction and physical optics, atomic physics, and also optical spectroscopy, photonics and laser physics. The course content includes: Polarisation and birefringence, Fresnel equations and the multi-layer dielectric coatings, Fresnel-Kirchhoff integral and diffraction, Fourier optics, image processing, and Abbe's theory of imaging. Besides, optical fibres, micro-structured optical fibres, fibres Bragg gratings, fibres-based sensors, optical materials and nanomaterials, and photonic crystals. Lasers physics; Einstein equations, spontaneous and stimulated emission and absorption, optical amplification, modes and resonators, rate equations, continuous and pulsed lasers, and mode-locked lasers.
NANOSC 415	Elect & Mag Properties of Nano Materials Credits: 3 (3+0) Prereq: PHYS 202 The course covers the electron transport in metals, properties of dielectric nanomaterials including semiconductors and insulators. Topical areas such as electron energies in solids, statistical physics of carrier concentration, motion in crystals, and energy band models in silicon as well as compound semiconductors will be described.

Courses	Description
NANOSC 416	Modeling of Nano Materials Credits: 3 (3+0) Prereq: PHYS 202 This course aims at introducing some of the techniques used for modeling the properties of nanoparticles. We will focus on the use of density functional theory (DFT) to calculate the electronic, mechanical, optical, and magnetic properties of nanomaterials, such as graphene, carbon nanotubes, fullerenes, and a few more. The course will be accompanied by some computational work using an open source package (Quantum Espresso).
NANOSC 417	Nanomedicine Lab Credits: 1 (0+1) Coreq: NANOSC 403 Prereq: NANOSC 305 AND BIOL 102 The experiments selected for this lab course were designed to emphasize concepts described in NANOSC 403. The lab course will cover the main recent directions of nanomedicine field which include, in particular, basics of controlled (targeted and sustained) drug delivery, principles of nano- and smart materials-based scaffolds for regenerative medicine and tissue engineering, as well as the development and evaluation of various nanomaterials-based microbial and biosensors.
NANOSC 420	Physics of Nanostructured Semiconductors Credits: 3 (3+0) Prereq: PHYS 202 The course will describe the principle physics of electronic, vibrational, transport, and optical characteristics of semiconductors and nanoscaled solids based on quantum mechanics. The course will also focus on nanostructured hetero-structures, quantum size and the low-dimensional effects, and application to the modern electronics and optoelectronics.
NANOSC 421	Nanostructured Mat & Nanosc Thin Film Credits: 3 (3+0) Prereq: NANOSC 302 AND NANOSC 305 This course covers the basic knowledge of materials science and mechanics of micro- and nanoscale thin films with a focus on the mechanical characteristics of thin films and the failure mechanisms in electronic devices.
NANOSC 424	Kinetics & Energetics Nanobiological Syt Credits: 3 (3+0) Prereq: CHEM 202 AND BIOL 102 In this course, energy transduction, kinetics, and transport for various nano-biological systems will be described. The topical areas covered will include electron transport, oxidation/reduction pathways, chemical/electrical gradients, energy transduction and the basic biochemical kinetics.

Courses	Description
NANOSC 425	Quantum Theory for Nanoscale Systems Credits: 3 (3+0) Prereq: CHEM 202 This course is an introduction to the solid-state quantum theory for nanoscale systems. The course also covers the fundamental quantum mechanical formalisms applicable to solid-state materials, the solution of Schrödinger equation for period potentials and application to nanoscale phenomena, such as localization and tunneling.
NANOSC 426	Colloidal Nanoscience Credits: 3 (3+0) Prereq: CHEM 202 This course covers the basics of nanoscale colloidal processes, intermolecular forces and electrostatic phenomena at the interfaces, London and electrostatic forces in disperse systems, boundary tensions at interfaces, self-assembly and interactions of polymer colloids, nanoparticles, surfactants and biomolecules. The course also covers several applications such as microfluidics, lab-on-a-chip, vesicles, nano-biocolloids, polymersomes, colloidosomes, and polymeric hydrogel nano-and microparticles for drug delivery biomedical applications.
NANOSC 427	Biol Routes of Nanomat Syn & Gr of NS Ma Credits: 3 (3+0) Prereq: BIOL 102 This course describes applications of biological synthesis routes for the fabrication of nanomaterials. A focus will be placed on adaptation of biochemical and genetic routes for the development of tailored materials for molecular self-assembly or nanoscale interfacial engineering. The course also covers the nucleation and growth in confined systems, growth of carbon nanotubes, nature of plasmas, and the plasma and thermally assisted deposition processes.
NANOSC 431	Nanobiology Credits: 3 (3+0) Prereq: BIOL 102 The course provides an understanding of how structure, functionality, energy transduction and kinetic characteristics of biological systems can be applied to the nanotechnology. The course will cover topical areas such as biosensors, bio-MEMS/NEMS, energy production, biomolecular electronics, or other nano-biological systems.

Courses	Description
NANOSC 433	Nano- & Biophotonics Credits: 3 (3+0) Prereq: PHYS 202 Nano- and biophotonics are multidisciplinary areas that deal with the interaction of light with nano and biological matter. The course covers various aspects such as nanoscale and bioimaging, micromanipulation by light and biosensing and the corresponding applications in photonics, biomedical sciences and nanotechnology. The course is aiming to provide the students with a solid introduction to the photonics concepts and tools in these fields. The course includes an introduction to light and matter interaction and related spectroscopic techniques. It also focuses on the chosen topics of interaction of light with nanoparticles, bio-imaging with light microscopy, imaging with nanoscale resolution, for instance with super-resolution microscopy and micromaniputaion by light.
NANOSC 458	Nanoscience Capstone Research Project I Credits: 3 (0+9) This 3 Cr research project will provide students with experience in a laboratory setting. Students will work with faculty in their research laboratories on research topics of current interest. Then, a final written paper/short thesis and oral presentation of the work will be presented by the students. Restrictions: Instructor consent required.
NANOSC 498	Nanoscience Capstone Research Project II Credits: 3 (0+9) Part 2 of NANOSC 458 course: This 3 Cr research project will provide students with experience in a laboratory setting. Students will work with faculty in their research laboratories on research topics of current interest. Then, a final written paper/short thesis and oral presentation of the work will be presented by the students. Restrictions: Instructor consent required.
NANOSC 499	Nanoscience Capstone Research Project Credits: 4 (0+12) This 4 Cr research project will provide students with experience in a laboratory setting. Students will work with faculty in their research laboratories on research topics of current interest. Then, a final written paper/short thesis and oral presentation of the work will be presented by the students. Restrictions: Instructor consent required.
PHYS 101	Introduction to Classical Mechanics Credits: 3 (3+0) Coreq: PHYS 111 This course introduces students to the basic physics concepts required by all ZU majors. These include classical Newtonian formalism for mechanics, including kinematics, conservation of energy and momentum, Newton's laws of motion, force diagrams, friction, centripetal and centrifugal force, rotational motion and angular momentum, gravitation and periodic motion.

Courses	Description
PHYS 102	Introduction to Electromagnetism Credits: 3 (3+0) Coreq: PHYS 112 Prereq: PHYS 101 AND MATH 101 This course covers classical electromagnetism, from electric charges and Coulomb's law to Maxwell's equations and electromagnetic waves, including Gauss' law; Ohm's Law and elementary DC circuits; magnetic fields and forces; and electromagnetic induction.
PHYS 111	Introduction to Classical Mechanics Lab Credits: 1 (0+3) Coreq: PHYS 101 Laboratory concurrent with PHYS 101. Experiments include classical mechanics involving data collection and reporting, and error analysis.
PHYS 112	Introduction to Electromagnetism Lab Credits: 1 (0+3) Coreq: PHYS 102 Laboratory concurrent with PHYS 102. Experiments include classical electromagnetism involving data collection and reporting, and error analysis.
PHYS 201	Thermodynamics, Wave Motion and Optics Credits: 3 (3+0) Coreq: PHYS 211 Prereq: PHYS 102 This course concludes the introduction to classical physics, with modules in thermodynamics, including thermal physics, ideal gases entropy and the first and second laws, wave mechanics, including interference, standing waves, and sound, optics, including geometric optics and fluid mechanics including buoyancy and the continuity equation.
PHYS 202	Modern Physics Credits: 3 (3+0) Coreq: PHYS 212 Prereq: PHYS 102 This course will introduce the basic concepts of quantum mechanics including wave-particle duality, de Broglie wavelength and the Schrodinger equation and the Uncertainty Principle, along with an introduction to special and general relativity and atomic physics. Segments of the course will take a historical approach describing key experimental observations such as the photoelectric effect, blackbody radiation and the Michelson-Morley experiment.

Courses	Description
PHYS 204	Analytical Mechanics Credits: 3 (3+0) Prereq: PHYS 101 This course presents a modern, generalized mathematical expression of Newtonian classical mechanics, including the Lagrangian and Hamiltonian formalisms and applications to one dimensional motion, rigid bodies, the perturbation theory, statistical mechanics, and chaotic dynamics.
PHYS 205	Introduction to Modern Astrophysics Credits: 3 (3+0) Prereq: PHYS 101 This course introduces students to the basic observational and theoretical methods, techniques and technical language of astronomy.
PHYS 208	Electrodynamics I Credits: 3 (3+0) Prereq: PHYS 102 The course is divided into three main parts: Electrostatics, Magnetostatics and Time-Varying (Electrodynamics) The electrostatic part deals with the electric field, divergence and curl of the electric field, Electric potential, work and energy in electrostatics, conductors, and studying special techniques to solve Laplace equation using separation of variables. The modeling of dielectric material is introduced to solve electric field in matter, polarization, the field of a polarized object, and the electric displacement. Magnetostatics part starts with the Lorentz force law, The Biot-Savart law, then calculation of divergence and curl of B. Magnetic vector potential is then introduced. Topic related to study of magnetic material are magnetic field in matter, magnetization, the field of a magnetized object, Finally time varying fields are introduced through these topics: Electromotive force, Electromagnetic induction, Maxwell's equations.
PHYS 210	Advanced Electromagnetism Credits: 3 (3+0) Prereq: PHYS 102 This course covers the advanced classical electromagnetic theory: electrostatics of point charges, multipoles, Coulomb, Laplace and Poisson equations, Gauss' Law and applications to boundary value problems, magnetism, Faraday's Law, Maxwell equations, electromagnetic waves, and applications, including waveguides, radiation and diffraction.
PHYS 211	Thermodynamics, Wave Motion and Optics Lab Credits: 1 (0+3) Coreq: PHYS 201 Laboratory course accompanying PHYS 201. Experiments in thermodynamics, waves, optics and fluid mechanics involving data collection and reporting, and error analysis.

Courses	Description
PHYS 212	Modern Physics Lab Credits: 1 (0+3) Coreq: PHYS 202 Laboratory course accompanying PHYS 202. Experiments in Modern Physics involving data collection and reporting, and error analysis.
PHYS 218	Vector Calculus Credits: 3 (3+0) Prereq: MATH 102 This course covers vector calculus and its applications. The course aims to explain the techniques of vector calculus and their applications in classical mechanics and electrodynamics. The course discusses topics such as Vector Algebra; Vector Calculus; Line, Surface, and Volume Integrals; Gradient, Divergence, and Curl; Potential Theory; Helmholtz Theorems; Laplace and Poisson Equations; Integral Theorems; and Curvilinear Coordinates. Tensors, index notation, dual vectors, Levi Civita tensor, and applications.
PHYS 308	Electrodynamics II Credits: 3 (3+0) Prereq: PHYS 208 In this course we will introduce to the students some advanced topics of classical electromagnetism. The student will continue to learn the fundamental principles of electrodynamics as well as its applications. The lecture course will cover classical electrodynamics on an advanced level. It introduces the concepts and applications of electromagnetic wave propagation in various media. Wave guides with Cartesian and cylindrical symmetries will be studied. The potential formulation of the solution to Maxwell's equations will be discussed, together with retarded potentials, Jefimenko's equations, and Lienard-Wiechert potentials. The course will also cover electric and magnetic dipole radiation, with some common applications. Relativistic electrodynamics will also be covered, introducing the field tensor and the relativistic potentials.

Courses	Description
PHYS 311	Thermal and Statistical Physics Credits: 3 (3+0) Prereq: PHYS 201 - Boltzmann transport equation. Statistical physics permits us to predict the macroscopic properties of a many-body system by studying the statistics of the behavior of its individual constituents. In the course we develop the machinery needed to link microscopic model of many particle system with measurable quantities. The topics to be covered are: - Thermodynamic review. - An air table simulation for a 2D gas - Distribution functions and mean values. - Manual sorting and counting in 2D and 3D. - Density of states. - Microstate, Macrostate, and dominant Macrostate. - Distinguishable particles and Maxwell-Boltzmann distribution. - Velocity distribution function. - Statistical interpretation of entropy. - Partition function and thermodynamic properties of a system. - A spin ½ solid, adiabatic demagnetization - Localized harmonic oscillators - Distribution in groups. Identical particles. - Counting microstates for Fermions and for Bosons.. - Dilute gases, the three distributions (Fermi-Dirac) (Bose-Einstein) (Maxwell-Boltzmann). - Maxwell-Boltzmann gases, Fermi-Dirac gases, Bose-Einstein gases. - Phase transitions. - Boltzmann transport equation.
PHYS 316	Mathematical Physics I Credits: 3 (3+0) Mathematical methods of particular interest in physics, astronomy, and atmospheric science, including Fourier analysis, special functions, and Green's function.
PHYS 323	Quantum Mechanics I Credits: 3 (3+0) Prereq: PHYS 202 The theory of quantum mechanics is treated using the Schrodinger equation for the square well, harmonic oscillator and hydrogen atom. It also covers angular momentum, tunneling, spin, quantization and matter waves.
PHYS 326	Mathematical Physics II Credits: 3 (3+0) Prereq: PHYS 346 AND MATH 201 AND MATH 202 The course will have two parallel components, one component is the analytical methods of solving the problems of mathematical physics, i.e., differential equations, linear algebra, eigenvalue problems etc. and a numerical component which will teach the students numerical and computational techniques of solving these problems. The numerical part will act like laboratory for the different problems which arise in the analytical part.This will include introducing the students to the different numerical algorithms of solving mathematical problems plus the symbolic mathematical computation programs like Mathematica and MatLab. By the end of this course, the student should be able to apply the numerical techniques he learned to tackle any mathematical problem which doesn't have an analytical solution. This includes problems in electrodynamics, quantum mechanics, statistical mechanics etc.

Courses	Description
PHYS 327	Observational Astrophysics Laboratory Credits: 2 (0+6) Prereq: PHYS 205 The astronomy laboratory provides students with practical experience in basic observational and computational aspects of astronomical data collection and analysis through a set of experiments that cover the core principles in astronomy and astrophysics. The laboratory provides practical utilization of statistical concepts including measurement precision, propagation of errors, and systematic uncertainties that are put into practice in astronomical context.
PHYS 331	Stellar Structure and Evolution Credits: 3 (3+0) Prereq: PHYS 205 This course covers the basics of main sequence stellar theory, with simple descriptions of star formation and end states.
PHYS 346	Mathematical Physics I Credits: 3 (3+0) Prereq: MATH 202 Mathematical methods of particular interest in physics, astronomy, and atmospheric science, including Fourier analysis, special functions, and Green's functions.
PHYS 348	Quantum Mechanics II Credits: 3 (3+0) Prereq: PHYS 323 This course is a continuation of Advanced Quantum Mechanics I, including Eigen functions, perturbation and scattering theory, and introduction to Quantum Field Theory.
PHYS 356	Mathematical Physics II Credits: 4 (4+0) Prereq: MATH 201 Note: This course code was previuosly PHYS 326 The course will have two parallel components, one component is the analytical meth- ods of solving the problems of mathematical physics, i.e., differential equations, linear algebra, eigenvalue problems etc. and a numerical component which will teach the students numerical and computational techniques of solving these problems. The numerical part will act like laboratory for the different problems which arise in the analytical part.This will include introducing the students to the different numerical algorithms of solving mathematical problems plus the symbolic mathematical computation programs like Mathematica and MatLab. By the end of this course, the student should be able to apply the numerical techniques he learned to tackle any mathematical problem which doesn't have an analytical solution. This includes problems in electrodynamics, quantum mechanics, statistical mechanics etc.

Courses	Description
PHYS 364	Biological Physics Credits: 3 (3+0) Prereq: BIOL 102 AND (CHEM 202 OR PHYS 201) This course presents the physical basis underlying the structure, dynamics and function of biological molecules, and the intermolecular interactions that form the basis for life. Topics include biophysical properties of proteins, nucleic acids and lipids and their relationship to function, intermolecular interactions, ion channels, and experimental and computational methods for the study of biophysics.
PHYS 399	Internship Credits: 2 (2+0) Pass/Fail External training in a national or international industry or research institution on any experimental, computational, or theoretical physics related project.
PHYS 405	Cosmology Credits: 3 (3+0) Prereq: PHYS 205 Topics in this course will include cosmological observations, Friedmann models, the early universe and interface with particle physics, inflation and seed fluctuations, the hot big bang, the cosmic microwave background, dark matter dynamics and large scale structure, and semi-analytical models of the 'gastrophysics' of galaxy formation and their confrontation with observations.
PHYS 416	Galactic & Extragalactic Astrophysics Credits: 3 (3+0) Prereq: PHYS 205 This course covers the basic content and phenomenological description of galaxies and how it is inferred from experimental observations, including classification of galaxies, stellar content and its kinematics, the spectral and chromatic properties, sizes and luminosity functions of galaxies, the physics and ecology of the interstellar medium and its probing via spectroscopic observations, rotation curves and dark matter, and gravitational lensing.
PHYS 420	The Solar System Credits: 3 (3+0) Prereq: PHYS 205 This course describes the origins and history of the sun and solar system, and gives a geological description of planets, their atmospheres and satellites, as well as asteroids and comets.

Courses	Description
PHYS 422	Astrophysical Fluid Dynamics Credits: 3 (3+0) This course is an introduction to fluid dynamics. It introduces the necessary concepts and laws of fluid dynamics necessary to understand a wide range of astronomical phenomena, from stellar structure to supernovae blast wave, to accretion discs. The course will cover the effects of gravitational field on a give mass distribution, propagation of many kind of waves, such as sound waves and supersonic waves. The course will introduce the student to an advance topic as flow instabilities and flow viscosity.
PHYS 430	Quantum Mechanics III Credits: 3 (3+0) Prereq: PHYS 348 This course will be a sequel to Quantum Mechanics I, II and it will be based on David Griffiths book “Introduction to quantum mechanics”. The relativistic mechanics part can be covered from some other source. The topics to be covered are: (1) Time-independent perturbation theory (2) The variational principle (3) WKB approximation (4) Scattering (5) Dirac equation.
PHYS 431	Quantum Field Theory and Particle Phys Credits: 6 (6+0) Prereq: PHYS 323 The objectives of this course are: (i) Explain the basic formalism of quantum field theory (ii) Teach the students how to make calculations related to high energy particle physics using Feynman diagrams The topics to be covered are: (1) Photons and the Electromagnetic Field (2) Lagrangian Field Theory (3) The KleinGordon Field (4) The Dirac Field (5) Photons: Covariant Theory (6) The S-Matrix Expansion (7) Feynman Diagrams and Rules in QED (8) QED Processes in Lowest Order (9) Gauge Theory of Weak Interactions (10) Spontaneous Symmetry Breaking (11) The Standard Electroweak Theory
PHYS 432	Advanced Dynamics Credits: 3 (3+0) Prereq: PHYS 101 This course includes Hamiltonian/Lagrangian representation of classical mechanics; stability of trajectories and the transition to chaos in Hamiltonian systems; qualitative dynamics and phase space structure; limit cycles, bifurcations and chaos in dissipative systems; and indicators of stability and chaos.
PHYS 438	Compact Objects & High Energy Astrophysics Credits: 3 (3+0) Prereq: PHYS 205 This course covers the physics of neutron stars, pulsars, black holes and the active centers of galaxies; supernovae and gamma-ray bursts.

Courses	Description
PHYS 450	Computational Physics Credits: 3 (3+0) Prereq: CSCI 101 This course covers the computational methods of special interest in physics, astronomy and atmospheric science.
PHYS 453	Gravity & General Relativity Credits: 3 (3+0) This course covers gravity and general relativity; dealing with spacetime; core principles of general relativity; and experimental evidence regarding the theory.
PHYS 455	Mathematical Physics III Credits: 3 (3+0) Prereq: PHYS 316 This is a continuation of PHYS 346, covering calculus of variations, integral equations, topology and group theory.
PHYS 498	Senior Project I Credits: 1 (0+3) This course will enable our students to carry out a research project. They will learn how to apply their knowledge of physics and the scientific methods to do a specific small scientific project.
PHYS 499	Senior Project II Credits: 2 (0+6) Prereq: PHYS 498 This course will enable our students to carry out a research project. They will learn how to apply their knowledge of physics and the scientific methods to do a specific small scientific project.
SCH 201	World Literature Credits: 2 (2+0) This course aims at enhancing student's ability to: -relate the experience of reading world literature to everyday life. -analyze and respond to literary texts in different forms and from different countries and cultures. -demonstrate an informed personal response appropriately and effectively. -appraise different ways in which writers achieve their effects. -perceive literature's contribution to aesthetic, imaginative and intellectual growth. -assess the contribution of literature to an understanding of areas of human concern. -discuss local prejudices and enlarge sympathies with different peoples. -discover the rules and techniques of adaptation from literature to film.

Courses	Description
SCH 202	Music Aesthetics Credits: 2 (2+0) Music Appreciation is a survey course providing the student an approach to perceptive listening in order to heighten student appreciation of music. The course is intended to provide a rudimentary knowledge of various musical structures, forms, and styles, a survey of the history of western music, and a few representative works of its principal composers. It aims also to provide students with basic information about Music Theory, to know the meaning of the various symbols in music notation.
SCH 206	Introduction to Visual Arts Credits: 2 (2+0) This course is designed to enrich the students' knowledge of visual arts, and to understand the role of art in past and present traditions and cultures, as well as the contributions of modern visual artists and their aesthetic and cultural influences. Motivating and inspiring the students by comprehending the creation process, through displaying and analyzing world masterpieces, and understanding the context of which a work of art is created. Moreover, the way art was connected to religion, politics, or in modern and contemporary art to self expression. Also gives a brief introduction to the connection between art and science.
SCH 207	Analytical Philosophy Credits: 2 (2+0) This course aims to provide a general view on a wide range of philosophical topics in 20th century Analytic philosophy. The aim is to read, think, discuss and contemplate on one of the most important schools of contemporary philosophy.
SCH 232	Introduction to Psychology Credits: 2 (2+0) The aim of this course is; first to know about one own self, second to be familiar with psychological concepts, theories, processes and operations that take place within us and how these processes affect our behaviors. We live in a world that is always changing with circumstances differ each second; we need to be prepared for these changes. This could be achieved by getting to know our abilities, capabilities, skills, what we inherited and how we are affected by both environments; the inside and the outside. By the end we get to think critically about how we can benefit from what we have, develop it and make the best of it. This course will introduce you to psychology, you will study psychology as a science, our behavior and it's relation to neuroscience, sensation, perception, our conscious state, how we learn, memories and be motivated, understand our problems and stressors, the differences between being normal and being abnormal, how we can be disordered and give us ways to treat and manage our disturbances all of this to acquire better self –understanding and better understanding of others' behavior. It also help us analyzing our past, life our present and plan and have positive anticipation of our future.

Courses	Description
SCH 233	Engineering Economical Analysis Credits: 3 (3+0) This course aims at providing students with essential concepts of Engineering Economics. Topics covered include: Making Economic Decisions, Engineering Costs and Cost Estimating, Interest and Equivalence, More Interest Formula, Present Worth Analysis, Rate of Return Analysis, Inflation and Price Change.
SCH 234	History and Philosophy of Science Credits: 3 (3+0) This course aims to provide the student at Zewail city with a holistic view of Science, as supreme system of knowledge distinguished by its logic and methodology, likewise as an essential constituent of the human civilization and its development. It is comprehensive consciousness of the phenomenon of Science in order to achieve an integrated scientific mentality, realizing that Science is not only a professional career, but also an attitude, standpoint and glorious mission. Philosophy aims, primarily, at shaping minds through critical reflection to reach conceptual clarity. Philosophy of science is no exception. So it helps the student to gain clear conceptions of the epistemological foundations of science such as: empiricism, method, testability and falsifiability, hypothesis, theory and theorem, deduction, axiomatization, necessity of mathematics…... etc. The course approaches also the Paradigm which deals with science as practice that has its cultural and social dimensions, i.e. Science as human endeavor has its history. So, emphasis will be given to the great impact and considerable outcome of the revolution of relativity and quantum during the 20th century and afterwards; meanwhile the course covers the history of science from its inceptions and the ancient oriental civilizations, to the Greek and Alexandrian sciences, then sciences in the Arab Islamic civilization and how they paved the way to the revolution of modern science in 17th century, and the further developments in modern and contemporary ages. This historical approach helps one to understand the course of human civilization. Finally, this interesting journey across philosophy and history gives the student deep insight to the nature of progress as characteristic of scientific knowledge, and how to promote it.
SCH 235	The Creative Mind Credits: 3 (3+0) This course aims to: First, introduce main topics and concepts in creativity, mental health and well-being based on integration of recent scientific research from various disciplines as Neuroscience, Psychology and Philosophy. Topics covered include but aren't limited to the intertwining relation between mental health and Resilience, Change, Creativity, Morality and Social Interactions. Second, based on scientific findings, the course will cover some practical aspects and techniques that boost creativity, well-being and enhance mental health. Participants will have the chance to assess their thoughts and values about well-being and creativity.

Courses	Description
SCH 258	Arabic Literature Credits: 2 (2+0) الهدف من تدريس ذلك المحتوى هو مساعدة الطلبة على الوعي باللحظة التاريخية التي عاصروها والتي يعيشونها الآن، وأن يربطوا بين النص الأدبي وبين واقعهم المعاش. وسيلتنا لمعرفة التاريخ هي قراءة الانتاج الأدبي والثقافي لتلك المرحلة، وهو الأمر الذي يستدعي القراءة المتأملة للنصوص والمواد المصورة والمسموعة، وبعض الكتابات النقدية التي تساعد الطلبة على الاستمتاع بالنص وفهمه.
SCH 260	Philosophical Thinking Credits: 2 (2+0) This course has two key, interrelated and mutually reinforcing purposes. The first is to develop thinking skills. The second is to be familiar with key Philosophical concepts, ideas, schools of thought and key influencers on Philosophy. We live in a society that mass produces information. Not all of it is true or well-grounded in fact. The key challenge in an information age is to know how to judge the quality of the information, opinions, and arguments that we are exposed to on a daily basis. This includes the ideas, arguments and assertions that we see, hear or read in the news, in coursework, on the job and in all human relations. Critical thinking is a foundational skill for of the University of Science and Technology at Zewail City curriculum. It is not an end in itself, but a first step towards creative thinking and problem solving. The ability to think critically and solve problems is survival skill in the knowledge age. This course will introduce you to the major fields in the philosophical tradition. In particular, you will study the major fields, problems, theories, and personalities of philosophy through the biographies and writings of leading thinkers.
SPC 303	Remote Sensing & Instrumentation Credits: 2 (2+0) Prereq: PHYS 102 AND MATH 202 The course introduces the principles of remote sensing, including electromagnetic radiation, remote sensing platforms and sensors, acquisition, processing and analysis of data and imaging, with applications for earth and space observation. Langmuir probes, Magnetometers, E-field double probes, Tophat particle detectors, Mass spectrometers, Resonance probes, Interferometers, Ionosondes