Code	Description
BIOL 101	Biology I Credits: 3 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 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 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 Coreq: BIOL 102 Laboratory concurrent with BIOL 102. Experiments include bacterial transformation, plasmid extraction, and gel electrophoresis.
BMS 201	General Microbiology Credits: 3 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 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.
BMS 203	Principles of Genetics Credits: 3 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.

Code	Description
BMS 204	Biochemistry Credits: 3 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 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 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 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 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.
BMS 214	Biochemistry Lab Credits: 1 Coreq: BMS 204 This laboratory course introduces students to standard biochemicaltechniques in the context of research projects. Examples of techniques to beincluded in research include protein purification, enzyme assays, enzymekinetics (Km determination), enzymatic proteolysis, and chromatography.
BMS 215	Human Physiology Lab Credits: 1 Coreq: BMS 205 Human Physiology laboratory, the lab component of Human Physiology. Thecourse introduces human physiology, structure and function of humantissues in an integrated hands-on approach. Laboratory exercises cover awide range of topics, including classic experiments on nervous system,muscles, respiration, cardiac vascular physiology, and exercise physiology.

Code	Description
BMS 301	Molecular Biology Credits: 3 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 302	Functional Genomics and System Biology Credits: 3 Prereq: BMS 202 AND BMS 203 AND BMS 204 This course discusses how genes function, regulate, and interact with each other. Students will learn the effect of genome regulation on cellular processes and how genes and their products interact to form complex systems.
BMS 303	Experimental Design and Data Analysis Credits: 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 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.
BMS 311	Molecular Biology Lab Credits: 1 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 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.

Code	Description
BMS 320	Introduction to Bioinform and Prog Languag Credits: 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 Prereq: BIOL 102 AND MATH 102 The course provides a practical programming for students who have somebackground and programming experience. The course will also be offered inthe summer as intensive hands-on continued programming practice.Fundamental scientific algorithms, analytical skills, simulation, optimization,and modern programming language will be practiced. Some programmingskills and biology knowledge are required.
BMS 322	Structural Biology Credits: 3 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 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 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.

Code	Description
BMS 325	Clinical Sciences Credits: 3 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 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.
BMS 327	Neurobiology and Practicum Credits: 3 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 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 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 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.

Code	Description
BMS 332	Drug Discovery and Development Credits: 3 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 Coreq: BMS 333L Prereq: BMS 204 AND MATH 201 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 333L	Drug Design & Computational Chem Lab Credits: 1 Coreq: BMS 333 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 Coreq: BMS 339 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.

Code	Description
BMS 335	Advanced Microbiology and Practicum Credits: 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 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 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 Coreq: BMS 334 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 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.
BMS 343	Drug Design and Computational Chemistry Lab Credits: 1 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.

Code	Description
BMS 344	Human Embryology Credits: 3 Prereq: BIOL 102 This course provides comprehensive understanding of embryologicaldevelopment using human body systems by following systematic approachto the body system. The course will focus on anatomy based approach andsome comparative molecular approach. Topics include fertilization,implantation, in vitro fertilization, embryonic stem cell, gastrulation, andorganogenesis.
BMS 349	Principles of Pharmacology and Toxicology Laboratory Credits: 1 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 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.
BMS 399	Internship (For BIOMEDICAL SCIENCES PROGRAM) Credits: 2 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 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 401 D	DDD Senior Project I Credits: 2 The Senior Project provides fifth year Drug Design and Development students at UST students the opportunity to experience first-hand the academic experience of conducting a research project from beginning to end. The capstone project allows the students to explore scientific inquiry, perform literature search, learn research techniques, and be mentored on one-to-one basis by a faculty who is experienced in their area of research. Completion of a senior project requires that students write a comprehensive thesis under the mentorship of their professors. Successful defense of the thesis before a committee of specialized Professors in the field of study excluding the supervising professor is required for graduation.

Code	Description
BMS 402	Senior Project II Credits: 3 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 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 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.
BMS 406	Molecular Modeling and Targeted Drug Design Credits: 3 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 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 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.

Code	Description
BMS 416	Molecular Modeling and Targeted Drug Design lab Credits: 1 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.
BMS 422	Algorithmic Foundations of Comp Biology Credits: 3 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 423	Integrative Biology Credits: 3 Prereq: BMS 202 This is an advanced bio physiology course that covers integrated Biosystems and feedback, comparative biology, modern drug design and discovery and physiological genomics.
BMS 425	Protein Structure and Function Credits: 3 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 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 Coreq: BMS 428L 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.

Code	Description
BMS 428 L	Pathology Lab Credits: 1 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 429	Molecular Immunology Credits: 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.
BMS 430	Advanced Strategies in Organic Synthesis Credits: 3 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 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 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 This course will discuss the national and international regulations for registration of new drugs.
BMS 438	Human Pathophysiology Credits: 3 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.

Code	Description
BMS 444	Metagenomics Credits: 3 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 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 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 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 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.
BMS 456	Forensic Biology Credits: 3 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.

Code	Description
BMS 457	Clinical Nutrition Credits: 3 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 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 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 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 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.
BMS 463	Vaccines Credits: 3 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 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.

Code	Description
BMS 467	Bacteriophages as Antibacterial Agent Credits: 3 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 468	Bioorganic & Natural Products Chemistry Credits: 3 This course introduces modern bioorganic and natural products chemistry. Topics will include classes of natural products, biosynthesis of natural products, methods of extraction, molecular recognition, and small molecule-biomolecule interactions.
BMS 469	Targeted Metabolism & Redox Biology Credits: 3 Metabolism plays pivotal roles in normal physiology as well as in a broad range of pathologies. This course extensively covers metabolism with emphasis on mitochondrial function. Until very recently, mitochondrial biology was focused on the mechanisms to generate ATP but more recently the role of mitochondria in redox signaling is increasingly recognized. The course will discuss modern concepts in bioenergetics and redox modulations of cellular functions. Various interventional strategies targeting mitochondria and cellular redox homeostasis in pathological conditions will be introduced.
BMS 470	Animal Models of Diseases Credits: 3 The course introduces scientific, ethical, and legal aspects of the use of animals in biomedical research. Categories of animal models to be discussed in this course include induced (i.e. pharmacologic), spontaneous (i.e. genetic or mutant), and genetically modified models. Examples of animal species will include nematodes, rodents, fish, and primates. Disease models including pathologic cardiovascular, neurologic, and psychological disorders will be discussed.
BMS 471	Clinical Trials Design, Administration and Management Credits: 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 472	Pharmaceutics Credits: 4 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.

Code	Description
BMS 473	Foundations of Computational and Systems Biology Credits: 3 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.
BMS 474	Genomics and Data Sciences Credits: 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 474	Genomics and Data Sciences Credits: 3 Prereq: MATH 101 AND MATH 102 AND MATH 201 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 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 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 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.

Code	Description
BMS 500 A	Directed Research Field Study Credits: 3 This course is a three-credit hour for biomedical science students in the DDD concentration who are engaged in off campus activities related to the DDD. Examples on internship include working in the industry, working with scientists in national or international institutions, and working in pharmaceutical companies, in the factories or the R&D sector. The 3-hour credit for the internship is equivalent of a 3 days / week for three months of full time work. Prior approval of the program director in required. The course is pass/fail only.
BMS 500 B	Directed Research Field Study Credits: 3 This course is a three-credit hour for biomedical science students in the DDD concentration who are engaged in off campus activities related to the DDD. Examples on internship include working in the industry, working with scientists in national or international institutions, and working in pharmaceutical companies, in the factories or the R&D sector. The 3-hour credit for the internship is equivalent of a 3 days / week for three months of full time work. Prior approval of the program director in required. The course is pass/fail only.
BMS 500 C	Directed Research Field Study Credits: 3 This course is a three-credit hour for biomedical science students in the DDD concentration who are engaged in off campus activities related to the DDD. Examples on internship include working in the industry, working with scientists in national or international institutions, and working in pharmaceutical companies, in the factories or the R&D sector. The 3-hour credit for the internship is equivalent of a 3 days / week for three months of full time work. Prior approval of the program director in required. The course is pass/fail only.
BMS 500 D	Directed Research Field Study Credits: 3 This course is a three-credit hour for biomedical science students in the DDD concentration who are engaged in off campus activities related to the DDD. Examples on internship include working in the industry, working with scientists in national or international institutions, and working in pharmaceutical companies, in the factories or the R&D sector. The 3-hour credit for the internship is equivalent of a 3 days / week for three months of full time work. Prior approval of the program director in required. The course is pass/fail only.
BMS 501	Senior Project II Credits: 3 The 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 502	Senior Project III Credits: 3 The student will continue to work on and finalize the project initiated in Senior Project II. Students will present their thesis project at the graduation seminar orally or in a poster session.
BMS 503	Genome Stability & Drug Development Credits: 3 Prereq: BMS 203 AND BMS 204 AND BMS 301 The course will reflect on the current knowledge of genome stability in identifying new drug targets. It will cover the concept of siRNA screening to identify new drug targets.

Code	Description
BMS 504	Targeting DNA Repair in Person Medicine Credits: 3 The course will cover current and putative DNA repair drug targets. It will introduce and discuss the concept of synthetic lethality in drug discovery and genetic basis of personalized medicine.
BMS 506	Molecular Modeling and Targeted Drug Des Credits: 4 Prereq: PHYS 101 AND CHEM 202 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.
CHEM 101	Chemistry I Credits: 3 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.
CHEM 102	Chemistry II Credits: 3 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 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 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.

Code	Description
CHEM 201	Organic Chemistry Credits: 3 Coreq: CHEM 211 Prereq: CHEM 102 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.
CHEM 202	Analytical & Physical Chemistry Credits: 3 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 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 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 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.

Code	Description
CIE 202	Fundamentals of Computer Programming Credits: 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 any of the two programming approaches.
CIE 205	Data Structures and Algorithm Analysis Credits: 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 206	Database Management System Credits: 3 Prereq: CIE 202 The overall aim of the course is to know the basic concepts of database systems. To design and practice creating database systems using the entity-relationship model. To learn functional dependencies and practice relational model normalization. To learn and practice using SQL for relational databases programming
CIE 212	Introduction to Electronics Credits: 3 Prereq: ENGR 210 OR NANENG 203 This course introduces students to the basic components of electronics: diodes, transistors, and their applications. It explains the semiconductor physics (Fermi Level, Band Gap, Doping), PN junction, diodes, BJT & MOSFET transistors and some of their common applications like rectifiers and amplifiers. The course will integrate demonstrations and laboratory examples with lectures on electronics foundations. Throughout the course we will use simulation programs for analysis, design, and understanding the operation of electronic devices. Practical experience in design, analysis, and troubleshooting will be covered.
CIE 227	Signals and Systems Credits: 3 Prereq: MATH 201 This course covers the fundamentals of signal and system analysis, focusing on representations of discrete-time (DT) and continuous-time (CT) signals. The course introduces the Fourier series representation for periodic signals and the Fourier transform method for CT and DT signals. The course builds upon the representations of linear, time-invariant systems to analyze frequency domain and time domain representation of systems. Applications are drawn broadly from engineering and physics, focusing on communications, and signal processing.

Code	Description
CIE 238	Electromagnetic Fields & Waves I Credits: 3 Prereq: PHYS 102 AND MATH 102 This course covers the fundamentals of Electromagnetic Fields and waves. The course introduces the electromagnetic model. The course starts by reviewing the math tools required to understand the course, such as vector calculus and orthogonal coordinate systems. Then it introduces fundamental electrostatic quantities and laws, discussing several methods to solve electrostatic problems such as image method and Laplace and Poisson's equations. After that steady state current problems are introduced and magnetostatic fundamental quantities and laws are discussed. Magnetostatic problems and their solutions are presented. Throughout the course the student is presented by Maxwell's equations, constitutive relations and boundary conditions, in different media.
CIE 239	Digital Design and Computer Architecture Credits: 3 This course focuses primarily on the fundamentals of digital design. The core concepts are studied at first, including data representation, binary operations, Boolean algebra, and logic simplification. Next, the design and analysis of combinational and sequential circuits is discussed, including adders, flip-flops, registers, and counters. Also, the topic of hardware description languages is gradually introduced in a learning-by-doing fashion along with a brief introduction to FPGAs. In addition, the course briefly introduces the basics of computer architecture, including the functions and design of microprocessors. To enhance the learning experience, the practical element of the course includes several hands-on labs and a term project.
CIE 301	Advanced Electric Circuits Credits: 3 Prereq: MATH 202 AND (ENGR 210 OR ENGR 201 OR NANENG 203) This course covers the formal methods of electrical circuit analysis and relevant network theorems will be covered. This includes an in-depth study of state-equation formulations and methods of obtaining them from a circuit's graph. Extensive use of the Laplace Transform for the analysis of networks will be made and it is expected that a student will have the mathematical background related to Laplace Transform techniques. The second part of the course will be devoted to the fundamentals of frequency selective circuits, network synthesis, filter approximations and frequency transformations. Different methods for passive and active filter synthesis. Computer techniques for analyzing and designing electrical circuits, using Spice as exemplary tools, will be used throughout the course. Laboratory sessions and a final group design project will provide a means of applying theoretical concepts and computer tools to solve practical problems and create useful circuit designs.
CIE 302	Operating Systems Credits: 3 Prereq: CIE 205 This course explores the field of computer operating systems, emphasizing basic operating systems (OS) concepts and design principles. While stressing the fundamental principles behind them, the idea is to learn not only what operating systems are and how they work today, but also why they are designed the way they are and how they are likely to evolve in the future. This course will cover fundamental OS material such as scheduling and synchronization, threads, memory management, file system, protection, and security. Topics: •Threads & Processes •Concurrency & Synchronization •Scheduling •Virtual Memory •I/O •Disks, File systems •Protection & Security •Virtual machines

Code	Description
CIE 318	Control Systems Credits: 3 Prereq: CIE 227 This course introduces the analysis and design of continuous-time and discrete-time feedback control systems. Topics include the properties and advantages of feedback systems, time-domain and frequency-domain performance measures, stability, PID control, the root locus method, frequency-domain design, and an introduction to state space methods.
CIE 320	Analog Electronics Credits: 3 Prereq: CIE 212 OR (ENGR 201 AND SPC 327) This course covers the design, construction, and debugging of analog electronic circuits. The main contents are: Design and analysis of multistage analog amplifiers. Study of differential amplifiers, current mirrors, and gain stages. Frequency response of cascaded amplifiers and gain-bandwidth considerations. Concepts of feedback, stability and frequency compensation
CIE 325	Signals and Systems Credits: 3 Prereq: MATH 101 AND MATH 201 This course covers the fundamentals of signal and system analysis, focusing on representations of discrete-time (DT) and continuous-time (CT) signals. The course introduces the Fourier series representation for periodic signals and the Fourier transform method for CT and DT signals. The course builds upon the representations of linear, time-invariant systems to analyze frequency domain and time domain representation of systems. Applications are drawn broadly from engineering and physics, focusing on communications, and signal processing.
CIE 327	Probability and Stochastic Processes Credits: 3 Prereq: CIE 227 OR SPC 318 This course introduces the theory and applications of probability and stochastic processes. It provides also an understanding of the mathematical techniques relating to random processes in the areas of signal processing, and communication. Topics include: introduction to probability, random variables and joint random variables, applications to random variables, introduction to stochastic processes, stochastic processes through linear systems, applications to stochastic processes.
CIE 328	Electromagnetic Fields and Waves I Credits: 3 Prereq: PHYS 201 AND (PEU 228 OR PEU 218) This course covers the fundamentals of Electromagnetic Fields and waves. The course introduces the electromagnetic model. The course starts by reviewing the math tools required to understand the course. Then it introduces fundamental electrostatic quantities and laws, discussing several methods to solve electrostatic problems such as image method and Laplace and Poisson's equations. After that steady state current problems are introduced and magnetostatic fundamental quantities and laws are discussed. Magnetostatic problems and their solutions are presented. The course ends by introducing the time varying fields and Maxwell's equations, wave equations and time harmonic fields. Throughout the course the student is presented by Maxwell's equations, constitutive relations and boundary conditions, in different media.

Code	Description
CIE 337	Communications Theory and Systems Credits: 3 Prereq: CIE 327 The course introduces the concept of information measurement through Shannon's information theory. The course also introduces technical concepts, principles, models, management, and foundational logic of information and communication systems such as coding, error correction, channel noise, distortion, communication protocols, and communication standards. The course examines history, current trends, and future of ICT. Review of global ICT standards and regulations.
CIE 338	Electromagnetic Fields and Waves II Credits: 3 Prereq: CIE 328 AND MATH 302 This course covers the fundamentals of Electromagnetic waves. The course starts by discussing plane electromagnetic waves in lossless and lossy media, introducing the electromagnetic power and pointing vector and exploring the wave incidence on plane boundaries. Then the course presents electromagnetic waves applications: Transmission Lines, Wave Guides, Cavity Resonators, and Antennas.
CIE 339	Digital Design and Computer Architecture Credits: 3 This course emphasizes elementary digital electronics and interfaces. Topics include gates and Boolean algebra, Karnaugh maps, flip flops, registers, counters and memories, digital components, microprocessor functions and architecture, instruction sets, D/A and A/D converters, and waveshaping
CIE 402	Antennas Engineering Credits: 3 Prereq: CIE 338 This course explores the theory and practice of antenna engineering, including a range of popular antenna types, applications and electromagnetic properties from basic to state-of-the-art. Study a wide spectrum of frequencies from 300 kHz to 550 GHz, with primary emphasis in the MF, HF, VHF, UHF and microwave regions. Examine communications, radar, commercial and military applications. Discuss related topics, such as radomes, antenna materials, computer modeling of antennas, antenna noise and antenna measurement techniques.
CIE 405	Electric Machines Credits: 3 Prereq: CIE 301 This course begins by covering the fundamental theory of power converters and electrical machines, including energy storage and conversion; force and emf production; coupled circuit analysis of systems with both electrical and mechanical inputs; the electromechanical theory (magnetic systems, torque and force generation, multi-phase analysis); AC machines; and control mechanisms. The course also covers applications to specific control systems, including those being used in renewable energy systems.
CIE 406	Computer Networks Credits: 3 Prereq: CSCI 101 AND CIE 428 This Course is an introduction to the design and analysis of computer communication networks. Topics include application layer protocols, Internet protocols, network interfaces, local and wide area networks, wireless networks, bridging and routing, and current topics. Analysis and comparison between the OSI model and Ethernet for computer networks are introduced.

Code	Description
CIE 408	Embedded Systems Credits: 3 Prereq: CIE 439 AND CIE 302 In this course the fundamentals of embedded system hardware and firmware design will be explored. Issues such as embedded processor selection, hardware/firmware partitioning, glue logic, embedded code debugging and development, firmware architecture, firmware design, and firmware debugging will be discussed. Other topics may be covered.
CIE 416	Satellite Communications System Credits: 3 Prereq: CIE 437 This course provides an in-depth introduction to geostationary Earth orbit (GEO) satellites and their use in broadcasting services, as well as low Earth orbit (LEO) satellites and their use in telecommunications, covering practical existing satellite networks such as IRRIDIUM, Globalstar and Starlink. The course will cover also link budget calculations and multiple access techniques used in satellite systems, based on relevant standards. In addition, the course includes topics related to interference in satellite systems and the calculation of the carrier to interference ratio for various types of interference. Moreover, the course studies the practices of planning satellite networks. For LEO telecommunication satellite systems, the course covers the topics of inter-satellite communication links, handoff, Doppler effect, spotbeams, Doppler-based multiple access and design considerations for satellite clusters regarding the numbers of satellites and orbits in such clusters.
CIE 417	Machine Learning Credits: 3 Prereq: CIE 205 AND (CIE 327 OR MATH 301) Machine learning is one of the most powerful tools that is used for data-driven decision making. Topics covered include: training and evaluating machine learning models, model selection, regression, classification, clustering, and dimensionality reduction. Selected applications in data mining, predictive analytics, and pattern recognition.
CIE 418	Communications Circuits Credits: 3 Prereq: CIE 320 AND CIE 301 This course is an introduction to concepts associated with the wireless transmission and reception of analog modulated signals. It provides sufficient background in theory, devices, and circuits employed in radio communication systems, which enables the students to design, build and test basic communication circuitry. In particular, this course introduces fundamental principles of wireless RF communications, AM, FM, and PM modulation, demodulation and spectra, and frequency shifting and mixing. Practical linear and nonlinear circuits for a heterodyne radio receiver are studied, including RF/IF amplifiers, matching networks, oscillators, mixers, modulators, and demodulators.
CIE 425	Information Theory and Coding Credits: 3 Prereq: CIE 327 This course covers fundamentals of information theory and coding, including entropy, average mutual information, channel capacity, block codes and convolutional codes. Topics covered also include asymptotic equipartition property, entropy rates of a stochastic process, data compression, channel capacity, differential entropy, and the Gaussian channel.

Code	Description
CIE 427	Big Data Analytics Credits: 3 Prereq: CIE 206 AND CIE 417 The course is designed to give the students in-depth knowledge of the Big Data framework using Hadoop and Spark. They will learn the principles of HDFS, YARN, and MapReduce. They will learn to use Pig and Hive to process and analyze large datasets stored in the HDFS and to use Sqoop and Flume for data ingestion. They will be introduced to HBase, a distributed column-oriented database to use when require real-time read/write random access to very large datasets. They will learn real-time data processing using Spark, understanding parallel processing in Spark, and using Spark RDD optimization techniques and SparkML.
CIE 428	Digital and Wireless Communications Credits: 3 Prereq: CIE 431 This course will cover channel models: fading channels, the Rayleigh fading model, channel characteristics (Doppler spread, delay spread, coherence), multipath. Error exponent, lower bound on the capacity of the channel, sphere packing bound on the error exponent. SISO Gaussian channel: capacity with and without fading, ergodic capacity, outage and outage capacity, diversity in communication over fading channels. MIMO communication: diversity gain, multiplexing gain (degrees of freedom), diversity-multiplexing tradeoff. Multicarrier modulation and OFDM: water-filling over parallel Gaussian channels. DS-SS and CDMA: spreading codes, interference and ISI rejection, rake receiver.
CIE 430	Sensors and Instrumentation Credits: 3 Prereq: CIE 212 General measurement systems; static and dynamic characteristics, loading effects, signals and noise; sensing elements, resistive, inductive, electromagnetic, thermoelectric, elastic, piezo-electric, electromechanical, optical etc.; signal conditioning elements, D.C. and A.C. bridges, compensation by linearization, feedback, operational amplifiers, modulation/ demodulation; signal processing elements; examples of measurement systems such motion, pressure, level, temperature, etc.
CIE 431	Communications Theory and Systems Credits: 3 Prereq: CIE 325 The course introduces the concept of information measurement through Shannon's information theory. The course also introduces technical concepts, principles, models, management, and foundational logic of information and communication systems such as coding, error correction, channel noise, distortion, communication protocols, and communication standards. The course examines history, current trends, and future of ICT. Review of global ICT standards and regulations.
CIE 437	Digital and Wireless Communications Credits: 3 Prereq: CIE 337 Digital and Wireless communications course is an in-depth senior level Communications course for undergraduate students. This course covers signal space representation of signals and Gram-schmidt orthogonalization procedure. It also covers digital passband shift keying systems, including Amplitude Shift Keying, Phase Shift Keying, Quadrature Amplitude Modulation and Frequency Shift Keying. The course also studies the calculation of error probabilities for various digital communication systems as well as union bounds. In this course, the characteristics of wireless communication channels and the concept of multipath fading as well as statistical descriptions of such channels are also covered.

Code	Description
CIE 438	RF and Microwave Engineering Credits: 3 Prereq: CIE 338 This course introduces the design and analysis of active and passive radio frequency and microwave circuits. It prepares? the students for careers in RF and Microwave Engineering; and for working on projects related to antennas and propagation, RF electronics, and optical communication systems. Topics include introduction to microwave systems; microwave network analysis; and impedance matching and tuning. After that the course discusses microwave passive and active devices.
CIE 439	Computer Architecture and Assembly Language Credits: 3 Prereq: CIE 239 The objective of this course is to explain how computers are designed and how they work. Students are introduced to modern computer principles using a typical processor. They learn how efficient memory systems are designed to work closely with the processor, and how input/output (I/O) systems bring the processor and memory together with a wide range of devices. The course emphasizes system-level issues and understanding program performance. Topics include Harvard and Von Neumann microprocessors architectures, instruction sets, X86 and ARM assembly language, internal data representation, computer arithmetic, processor datapath and control, memory hierarchy, I/O devices and interconnects, CISC and RISC architectures, and an introduction to DSP architecture and GPUs.
CIE 440	Digital Control Systems Credits: 3 Prereq: CIE 318 Introduction to computer control systems; Sampled data systems, Z-transform and its properties, Inverse Z-transform; Modeling of dynamic digital systems, Time domain ARMA model, Z-Domain Digital Transfer functions, Closed loop performance and stability; Digital PID controller design; Digital State Space models, Properties of the State Space models; State feedback controller, Pole placement digital control, and Linear Quadratic Regulator.
CIE 442	Digital Signal Processing Credits: 3 Prereq: CIE 227 This course begins with a discussion of the analysis and representation of discrete-time signal systems, including discrete-time convolution, difference equations, the z-transform, and the discrete-time Fourier transform. Emphasis is placed on the similarities and distinctions between discrete-time. The course proceeds to cover digital network and nonrecursive (finite impulse response) digital filters. Digital Signal Processing concludes with digital filter design and a discussion of the fast Fourier transform algorithm for computation of the discrete Fourier transform
CIE 447	Computer Networks Credits: 3 Prereq: CIE 327 This Course is an introduction to the design and analysis of computer communication networks. Topics include application layer protocols, Internet protocols, network interfaces, local and wide area networks, wireless networks, bridging and routing, and current topics. Analysis and comparison between the OSI model and Ethernet for computer networks are introduced.

Code	Description
CIE 450	Robotics: Transformations, Kinematics, and Dynamics Credits: 3 Prereq: CIE 318 Introduction, history, types and applications of robots; Manipulation using single and multi-robots; Rigid body motion, Rigid body transformations, Homogeneous representation; Velocity of a rigid body, Manipulator kinematics, and Forward kinematics; Manipulator workspace, General solutions to inverse kinematics problems, End-effector velocity and forces; Robot dynamics and control, Lagrange's equations, Dynamics of a two-link planar robot; Redundant and parallel manipulators; Tools for robotics analysis and simulation.
CIE 458	Fundamentals of Artificial Intelligence Credits: 3 Prereq: CIE 205 AND (CIE 327 OR MATH 301) The course addresses key concepts underlying intelligent systems, which are increasingly deployed in consumer products and online services. Topics include problem solving, state-space representation, heuristic search techniques, game playing, constraint satisfaction problems, Markov decision process, and reasoning under uncertainty. These concepts will be examined in the design of intelligent agents in the context of several applications.
CIE 460	Software Engineering Fundamentals Credits: 3 Prereq: CIE 205 AND CIE 206 This course covers the fundamentals of software engineering, including understanding system requirements, finding appropriate engineering compromises, effective methods of design, coding, and testing, team software development, and the application of engineering tools. The course will combine a strong technical focus with a capstone project providing the opportunity to practice engineering knowledge, skills, and practices in a realistic development setting with a real client.
CIE 461	Automata and Compiler Design Credits: 3 Prereq: CIE 302 The purpose of this course is to acquaint the student with an overview of the theoretical foundations of computer science from the perspective offormal languages and to introduce them to the principles and practices in the design of compilers. The course covers formal language, regular Expressions, Finite Automata and conversion of regular expressions to Finite Automata.Students study applications of Finite Automata to lexical analysis. The course includes the study of context Free grammars and parsing as well as the semantics such as Syntax directed translation, Intermediate code, translation of simple statements and control flow statements.Topics such as symbol table, storage organization, storage allocation strategies, code optimization principal and optimization techniques are also discussed in the course. Other topics are also covered in the course such as machine dependent code generation, object code forms, generic code generation algorithm and the DAG representation for Blocks.
CIE 464	Computer Graphics Credits: 3 Prereq: CIE 205 This course provides introduction to computer graphics algorithms, software and hardware. Topics include: ray tracing, the graphics pipeline, transformations, texture mapping, shadows, sampling, global illumination, splines, animation and color.

Code	Description
CIE 470	Introduction to Quantum Computation and Quantum Information Credits: 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.
CIE 478	Advanced Wireless Communication Systems Credits: 3 Prereq: CIE 437 In this senior-level undergraduate communications course, the students are introduced to the advanced concepts of wireless communications. This course covers multicarrier modulation systems, Shannon capacity, water-filling algorithm. The course also covers wideband communications systems such as direct sequence spread spectrum and frequency hopping spread spectrum. The generation of pseudo-noise sequences using linear feedback shift registers is also covered. Multiple access techniques are studied, including code division multiple access and its application in 3G mobile systems. Other multiple access techniques used in wireless communication systems are also studied. The course also introduces the concept of orthogonal division modulation and its application in 4G mobile systems. Finally, the course covers the concepts of diversity and equalization to address the impairments of wireless communication channels.
CIE 502	Propagation and Channel Modeling Credits: 3 Prereq: CIE 402 This course discusses radiowave propgation and channel modeling for wireless indoor/outdoor/V2V applications. The courses covers topics such as Radio Wave Propagation for the Wireless Channel, Shadowing and Multipath, Path-Loss, Channel Models, MIMO Channels, Antenna-Channel Interaction Characterization, System-Specific Propagation Channels (indoors/outdoors/V2V...), Channel Measurement Techniques, Channel Estimation,Statistical Inference and Model Selection, and Future Developments in Wireless Communication Channels
CIE 506	Bioinformatics for Engineers Credits: 3 Prereq: BIOL 102 AND CIE 417 AND (CIE 327 OR MATH 301) The role of biological research has been transformed significantly due to the vast amount of data produced in genomics related research. The aim of this course is to introduce the students to the recent research field of bioinformatics. The topics covers in this course include the areas of computer science that play an important role in bioinformatics such as software, data mining, high-performance computing, mathematical models and infrastructure for high-throughput automated biological experiments. Other topics include existing methods for analyzing genomes, sequences and protein structures. The course provides hands-on approach to the field of bioinformatics.

Code	Description
CIE 510	Wireless Sensor Networks and IoT Credits: 3 Prereq: CIE 437 AND CIE 447 In this elective course, the students will be introduced to the concept of the Internet of Things (IoT). The course starts with introducing wireless sensor networks (WSN) as a key player in IoT. The basics and applications of wireless sensor networks are presented. The course studies the wireless communication technologies suitable for WSN. Medium access control protocols as well as routing protocols for WSN are covered. The course also covers the network management models for WSN, as well as performance and traffic management. In addition, the course will introduce the most common operating systems used for WSN and IoT applications.
CIE 514	Visualization Credits: 3 Prereq: CIE 464 This course provides an overview about the state of the art in information visualization. It teaches the process of producing effective visualizations that take the needs of users into account. Among other topics, the course covers:Data analysis algorithms that enable extraction of patterns and trends in dataMajor temporal, geospatial, topical, and network visualization techniquesDiscussions of systems that drive research and development.
CIE 524	Mobile Communications Technologies Credits: 3 Prereq: CIE 437 OR CIE 428 In this course, students will apply the concepts of digital communications as well as the characteristics of wireless communications on mobile communication systems. The course introduces the cellular concept, frequency reuse and channel allocation techniques. The course also covers mobility management issues, including the various types of handover. The course studies interference in cellular systems, methods to mitigate it and its effects on the system capacity. Students will learn the concepts of trunking and grade-of-service. In this course, students will also learn about the various multiple access techniques and their effect of the system capacity. In addition, the course covers system architectures for second, third and fourth generation mobile communication systems, and the requirements of each of these generations as well as standard systems that fulfill such requirements. By the end of the course, students will learn about the key enabling technologies of the fifth generation systems and proposed methods in literature to reach the requirements of the standardization bodies.
CIE 528	Mechatronics Engineering Credits: 3 Prereq: CIE 450 This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, and 3D graphic simulation; Control design, actuators, and sensors; Multi-robot systems; Data communication and wireless networking; Task modeling, human-machine interface, and embedded software. Students will design and build working robotic systems with multiple sensors, actuators, mechanisms and computer systems connected with a data communication bus.

Code	Description
CIE 530	Cognitive Radio Systems Credits: 3 Prereq: CIE 437 This course introduces the students to the concept of spectrum sharing and its use in cognitive systems. The course covers the concept of cognitive radio, the reasons it evolved and the methods it is applied. The course includes the general structure of cognitive systems. It then details the types of spectrum sensing and their techniques. This includes the calculations of missed detection and false alarm probabilities. The course then covers the topic of spectrum management. The course also covers the aspects of game theory that are used in spectrum management in cognitive radio. In addition, the course includes the design of prototype cognitive radios using USRPs.
CIE 538	Electromagnetic Remote Sensing: Engineering Principles and Techniques Credits: 3 Prereq: CIE 442 AND CIE 338 This course covers the physical principles involved in remote sensing of Earth's environment and their implementation in engineering systems. The topics covered include: the fundamentals of electromagnetic wave propagation, scattering by matter, effects of propagation media, passive and active sensing systems, remote sensing platforms, data processing, and systems integration. Concepts important for the design and analysis of remote sensing systems will also be covered
CIE 539	Advanced Computer Architecture Credits: 3 Prereq: CIE 439 Fundamentals of computer design; quantifying cost and performance; instruction set architecture; program behaviour and measurement of instruction set use; processor datapaths and control; pipelining, handling pipeline hazards; memory hierarchies and performance; I/O devices
CIE 547	Cloud Computing Technology Credits: 3 Prereq: CIE 302 AND CIE 447 This course provides a foundation for cloud computing infrastructure and modern data centers. It has a theoretical and practical component and hands-on activity on the various cloud services. It introduces the students to the concepts of virtualization in computing, storage, and networking and the popular hypervisors. The different service models, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) are also introduced. The course also addresses the economics and pricing models of cloud computing and security challenges related to the cloud. The course introduces the students to Cloud-native applications, containers, and serverless computing. Moreover, the popular cloud computing systems and the various cloud services offering like Storage, Infrastructure, Compute, and Data are discussed. The course has hands-on cloud programming and a capstone project.
CIE 552	Computer Vision Credits: 3 Prereq: CIE 417 This course provides an introduction to the field of computer vision.Some of the topics covered in the class are: Image and Camera Fundamentals, Fourier Transform & Convolution, Image enhancement, Image Segmentation, Image Feature Extraction, Object recognition, Stereo-vision, Motion analysis, and latest topics in computer vision.

Code	Description
CIE 553	Natural Language Processing Credits: 3 Prereq: CIE 417 This course provides an introduction to the field of Natural Language Processing.Some of the topics covered in the class are Text Similarity, Part of Speech Tagging, Parsing, Semantics, Question Answering, Sentiment Analysis, and Text Summarization.The course includes programming assignments in Python.
CIE 554	Computer Arithmetic Credits: 3 Prereq: CIE 205 Arithmetic is the science of handling numbers and operating on them. This course is about the arithmetic done on computers. To fulfill its purpose, there is a need to describe the computer representations of the different numbers that humans use and the implementation of the basic mathematical operations such as addition, subtraction, multiplication and division. These operations can be implemented in software or in hardware. The focus of this class is to introduce the hardware aspects of computer arithmetic. The enhancements to improve the usual performance metrics (speed, area, and power) are discussed and the students are expected to use them in their projects.
CIE 555	Neural Networks and Deep Learning Credits: 3 Prereq: CIE 417 This course provides an intoduction to deep Learning, how to build efficient neural networks, and how to apply deep learning to applications. Topics covered in this course include convolutional networks, RNNs, LSTM,GAN, Adam, Dropout, and more. Students will be able to build, train and apply fully connected deep neural networks. They will study the key parameters in a neural network's architecture and learn how to implement efficient neural networks. They will work on case studies from autonomous driving, image generation, natural language processing, and more. They will master the theory and practice the ideas.
CIE 556	Speech Analysis, synthesis, and recognition Credits: 3 Prereq: CIE 417 AND CIE 442 This course provides an introduction to speech analysis, synthesis and recognition. The course introduces the production of human speech, vocal tract, the hearing system, the units of speech, methods of analysis for speech signals, speech recognition technology, and computerized speech synthesis. It provides a basic understanding of multidimensional techniques for speech representation and classification methods. Students will learn to express the speech signal in terms of its time domain and frequency domain. They will learn to derive expressions for simple features used in speech classification applications.Topics include Introduction to speech processing, time-frequency analysis, spectral analysis, speech Modeling , Linear Predictive Analysis, pitch Extraction, Human Auditory System, Speech Enhancement, Clustering and Gaussian Mixture models, Speaker Recognition, Hidden Markov models & Neural networks, and speaker and speech recognition.

Code	Description
CIE 558	Robot and Machine Vision Credits: 3 Prereq: CIE 552 AND CIE 442 This course addresses the industrial use of vision for automatic inspection, process control and robot guidance. The course addresses the usage of computer vision technique to increase the robot's ability to physically affect the environment. It involves controlling the motion of a robot by using the feedback of the robot's position as detected by a vision sensor. The course teaches how to use and select the hardware components of a machine vision system, and implement machine vision tasks and inspections using Arduino or equivalent system. The students will apply their knowledge of computer vision to create a vision system to program a robotic arm to perform a simple, visual task.
CIE 564	Parallel and Distributed Computing Credits: 3 Prereq: CIE 439 AND CIE 205 This course covers a broad range of topics related to parallel and distributed computing, including parallel and distributed architectures and systems, parallel and distributed programming paradigms, parallel algorithms, and scientific and other applications of parallel and distributed computing.
CIE 574	Distributed Systems Credits: 3 Prereq: CIE 447 AND CIE 564 The course addresses the main principles underlying distributed systems: processes, communication, naming, synchronization, consistency, fault tolerance, and security. The course covers the building blocks for a study of distributed systems, and addressing the characteristics and the challenges that must be addressed in their design: scalability, heterogeneity, security and failure handling. The course also covers issues and solutions related to the design and the implementation of distributed applications. Students will be familiar with some of the main paradigms in distributed systems: object-based systems, file systems, web-based and coordination-based systems. Students will be able to design and develop distributed systems and applications.
CIE 581	Information Security and Encryption Credits: 3 Prereq: CIE 327 This course introduces the fundamentals of information security, with a focus on modern practices that are used in protecting the information at rest and in transit. The concept of security services is first discussed. Then, the course discusses selected topics in information security, including encryption, access control mechanisms, IoT security, network security, physical security, security management and risk assessment. The practical element of the course includes several lab activities, research discussions and a final research report.
CIE 582	Cryptography Credits: 3 Prereq: MATH 308 AND CIE 327 This course provides a foundation of applied cryptography, enabling the students to grasp its importance in the field of information security. Topics include steganography, block and stream ciphers, secret-key encryption, public-key encryption, cryptographic hash functions, message authentication codes, digital signatures, certificates and authentication protocols, cryptanalysis techniques, and key management. Also, the course covers principles of number theory, necessary for the study of cryptographic algorithms and cryptanalysis. The practical element of the course includes several lab activities and a final project.

Code	Description
CIE 591	Selected Topics in Networks and Communications Systems Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 592	Selected Topics in Electromagnetics and Remote Sensing Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 593	Selected Topics in Artificial Intelligence and Big Data Analytics Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 594	Selected Topics in High Performance Computing and Visualization Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 595	Selected topics in Robotics Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 597	Selected topics in Communications and Information Engineering Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
CIE 598	Senior Design Project I Credits: 1 Students must undertake an independent major senior design project during the last two terms of their program. The purpose of the project is to demonstrate students' abilities to practice in their chosen area of expertise, using knowledge gained from their academic and industrial training experiences. The first part of the project will include problem identification, generation and selection of solutions and time management. Incorporation of technical and economic issues in the solution for the project will be required. Requirements include: proposal, progress report, and a final report containing recommendations for part two of the project.
CIE 599	Senior Design Project II Credits: 3 Prereq: CIE 598 A continuation of CIE 598. The final design of the major senior design project proposed in CIE 598 will be undertaken. The purpose of this phase of the project is to carry out a detailed technical design of the solution proposed in CIE 598. Requirements of this part of the two-term project include a final report. Students will present their thesis project at the graduation seminar orally or in a poster session.

Code	Description
CSCI 101	Introduction to Computer Science Credits: 2 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.
EBE 359	Bioprocess Engineering Credits: 3 Prereq: ENV 220 AND ENV 207 Principles of biochemistry and microbiology, kinetics of Enzymatic reactions and microbial growth, are reviewed and applied to batch and continuous cell growth kinetics, biomass and product formation in cell culture and nutrient utilization, and bioreactors. Additional topics include introduction to activated sludge process kinetics, nitrification and denitrification systems, basics of anaerobic suspended culture systems, microbiology of wastewater treatment.
EBE 401	Control Systems Credits: 3 Prereq: MATH 202 This course studies dynamic systems encountered in a variety of Renewable Energy and Power Plants systems. It will look at the modelling of such systems and the response of these systems to inputs, initial conditions and disturbances. It is of particular interest to analyse systems obtained as interconnections (e.g., feedback) of two or more other systems. In addition, the design of control systems that ensure desirable properties (e.g., stability, performance) of the interconnection with a given dynamic system using different design techniques will be studied.
EBE 411	Thermal Solar Energy Credits: 3 Prereq: ENGR 207 AND ENV 346 AND (ENGR 332 OR ENGR 205) This course provides a comprehensive overview of Thermal Solar Energy fundamentals and its different application for heating, steam production and power generation. Different solar concentration technologies and equipment regarding the collectors, receivers and the working fluid will be addressed. Lectures will cover commercial and emerging Thermal Solar Energy technologies and cross-cutting themes, including conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis.
EBE 450	Unit Operations Lab Credits: 1 Coreq: ENV 425 The students will perform lab experiments on different unit operations available in ZC's labs such as adsorption, reaction, distillation, particle separation, absorption, sedimentation, water treatment, etc.

Code	Description
EBE 480	Separation Processes Credits: 2 Prereq: ENV 425 OR ENV 436 This course covers the general principles of separation by equilibrium and rate processes. An introduction to the principles and applications of diffusional separation processes involving gas-liquid, liquid-liquid and solid-liquid systems in equilibrium-stage and continuous-contact operations. Topics include staged cascades and applications to distillation, absorption, adsorption, and membrane processes. Throughout emphasis is placed on problem solving and illustrative worked examples.
EBE 505	Industrial Bio-Processes Credits: 3 Prereq: (ENV 359 OR EBE 359) The course aims to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food, bioenergy etc. The course introduces bioreactors, its types, operation methods and provides an experimental demonstration of the same. Strategies to obtain higher yields, design of the reactors and production of biofuels from microbes are thoroughly explained. The course discusses the existing bioprocess applications such as cheese making, antibiotics and vaccines etc. Major bottlenecks for the operation of biochemical industries will be discussed. This course provides students with an up-to-date knowledge of upstream and downstream processing technology.
EBE 522	Fuel Cells and Battery Technology Credits: 3 Prereq: ENV 207 AND (EBE 203 OR CHEM 202) By the end of the course, the students will be able to1. Understand the basic elements of electrochemistry as needed for the course2. Learn the design and analysis of fuel cells using thermodynamics and electrochemistry3. Understand the performance and design characteristics and operating issues for various fuel cells4. Calculate the fuel consumption and expected power output for a typical PEMFC and SOFC5. Explain how batteries work from a thermodynamic and transport viewpoints6. Do a mathematical simulation of a fuel cell in MATLAB and COMSOL7. Account for different batteries and fuel cells with advanced knowledge about their performance8. account for the relationship between battery performance and materials properties
EBE 524	Energy and Bio-Process Engineering Lab Credits: 1 Prereq: EBE 359 OR ENV 359 This course includes lab experiments that illustrates many of the concepts learned throughout the program's course of studies. Examples of the experiments to be performed by the students are fermentation, absorption, and energy storage and conversion.
EBE 530	Process Design and Simulation Credits: 3 Prereq: ENV 346 AND ENV 436 The course covers the principals and elements of process design and simulation, including flow sheeting, process equipment selection, piping & instrumentation, Plant layout and site selection. The course also involves the application of the course elements using process design simulators.

Code	Description
EBE 550	Process Dynamics and Control Credits: 2 Prereq: MATH 202 AND ENV 207 This course introduces dynamic processes and the engineering tasks of process operations and control. Subject covers modeling the static and dynamic behavior of processes; control strategies; design of feedback, feedforward, and other control structures; and applications to process equipment. It introduces students to the mathematical theory, modern practice and industrial technology of process control, combining theoretical and computational approaches in order to illustrate how dynamic mass and heat balances govern the response of unit operations and plants to setpoint changes and external disturbances.
EBE 597	Selected topics in Energy & Bioprocess Engineering Credits: 3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
EBE 598	Senior Design Project I Credits: 1 Students must undertake an independent Energy and Bioprocess Engineering design project during the last two terms of their program. The purpose of the project is to demonstrate students' abilities to practice in their chosen area of expertise, using knowledge gained from their academic and employment experiences. The first part of the project will include problem identification, generation and selection of solutions and time management. Incorporation of technical, ecological, social, political and economic issues in the solution for the project will be required. Requirements include: proposal, progress report, and a final report containing recommendations for part two of the project.
EBE 599	Senior Design Project II Credits: 3 Prereq: EBE 598 The final design of the major Energy and Bioprocess Engineering project proposed in EBE 598 will be undertaken. The purpose of this phase of the project is to carry out a detailed technical design of the solution proposed in EBE 598. Requirements of this part of the two-term project include a final report.
ENG 101	English for Science Credits: 3 This course introduces students to the use of English in technical reading and writing. Passages describing basic Science and Engineering concepts are used to illustrate sentence patterns and grammatical structures commonly used to express scientific concepts, such as definition, classification, causation, induction and deduction and quantification, how to report results and describe experimental protocols. The development of critical thinking and overall communication skills are emphasized.
ENGL 101	English for Science Credits: 3 This course introduces students to the use of English in technical reading and writing. Passages describing basic Science and Engineering concepts are used to illustrate sentence patterns and grammatical structures commonly used to express scientific concepts, such as definition, classification, causation, induction and deduction and quantification, how to report results and describe experimental protocols. The development of critical thinking and overall communication skills are emphasized.

Code	Description
ENGL 151	Scientific Writing Credits: 2 Prereq: ENG 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.
ENGL 152	Effective Speaking and Composition Credits: 2 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 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.
ENGL 201	Rhetoric & Composition Credits: 3 A course that introduces the meaning and strategies of rhetoric which aids students in knowing, comprehending, and evaluating different types of spoken and written arguments. This entails developing the analytical skill and deeper insight to analyze and develop solid arguments while addressing a variety of audiences. During the semester, students will practice critical thinking, reading, and writing skills; 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 points of view. English 101 students will further demonstrate an understanding of the audience, purpose, voice, tone and genre that constitute a rhetorical situation.

Code	Description
ENGL 202	Advanced Scientific Writing Credits: 3 Prereq: ENGL 201 OR ENGL 101 to express their research orientations, experiments, and findings effectively.
ENGL 203	Public Speaking Credits: 3 Prereq: ENGL 101 OR ENGL 202 The course aims at enhancing students' public speaking skills paying special attention to public speaking ethics and audience awareness. This course builds upon what students learned in 101 in terms of argumentation and persuasion. It is the final step after enhancing their scientific writing skills to hone their speaking skills in both scientific and non-scientific communities. Having this course prior to their graduation will prepare them for various public speaking events such as speeches, conference presentations, and lectures.
ENGR 102	Introduction to Engineering Design Credits: 2 Introduction to profession teamwork and effective functional meetings. Problem solving procedure: problem definition, generation of solutions, decision analysis methodology, solution implementation, assessment of implementation. Engineering design process. Computer modeling and heuristics for problem solving. Hands-on real life and team–based engineering design project: customer requirements, conceptual design, prototyping, functional testing, preparation of operational manual. Communicating design outcomes. Organization of the work and design notebook. Reverse engineering and design projects. Principle of project commercialization.
ENGR 201	Circuits & Electronics Credits: 3 Prereq: PHYS 102 AND MATH 102 The course introduces the components of a lumped electrical circuits and the laws and theories used for circuit analysis. Both DC, transient and AC steady state analyses will be covered for passive circuits. Active circuits will be analyzed only in DC. The course will use CAD tools such as Spice to enhance the practical capabilities of the student.
ENGR 205	Thermodynamics for Engineers Credits: 3 Prereq: CHEM 101 AND PHYS 101 Thermodynamics is concerned with the study of heat and work, and the transfer of energy from one form to another in physical and chemical transformation. The main topics are The first law and basic concepts, volumetric properties of pure fluids, Heat effects, the second law of thermodynamics, Thermodynamics properties of fluids, Applications of thermodynamics to flow processes, and Cycles.
ENGR 207	Fluid Mechanics Credits: 3 Prereq: MATH 201 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.
ENGR 207N	Fluid Mechanics Credits: 3 Prereq: MATH 201 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.

Code	Description
ENGR 209N	Structural Mechanics Credits: 3 Prereq: MATH 201 AND ((PHYS 100 OR MATH 100) AND (PHYS 101 OR MATH 101)) in materials of elementary structures due to the axial and bending loading.
ENGR 210	Electric Circuits Credits: 3 Prereq: PHYS 102 This course covers the fundamentals of Electric Circuits analysis. The course introduces the techniques used to analyze circuits of different lumped elements and circuit blocks. The course starts first by introducing several electric circuit elements, including regular and dependent sources. Then it discusses how to analyze simple and complex resistive circuits through different techniques. After that Operational Amplifiers and energy storage elements (capacitors and inductors) are introduced. Sinusoidal sources are introduced and analyzed using phasors through different analysis methods. AC circuits Power calculations and Balanced Three-Phase Circuits are explained. The course ends by discussing frequency selective circuits that has wide applications
ENGR 218	Thermofluids Credits: 2 Coreq: MATH 202 Prereq: MATH 201 AND PHYS 201 This course covers a review of the fundamental thermodynamic concepts, and is followed by the second law. Next are applications of thermodynamics to engineering systems (e.g. propulsion and power cycles, thermo chemistry), and an introduction to microfluidics and Liquid manipulation on the microscale, Electro-osmotic flow, Pressure driven flow, Laminar flow in rectangular microchannels, pumping on the microscale, secondary flows in microchannels).
ENGR 219	Introduction to Structural Mechanics Credits: 2 Coreq: MATH 201 Prereq: PHYS 101 This course is intended to introduce the student to the fundamentals of staticequilibrium of rigid and elastic bodies as well as the concepts of equivalentsystems of forces and moments. Then, it introduces the concepts of stressesin materials of elementary structures due to the axial and bending loading.
ENGR 221	Engineering Drawing Credits: 2 This course is intended to introduce the student to the fundamentals of engineering design process and graphical communications tools used by engineers. It introduces the concepts of engineering graphics and visualization including lettering, line types, freehand sketching, and use of instruments, orthographic projection, dimensioning, pictorial drawings, sectional views and the use of Computer-Aided-Drafting as a design tool.
ENGR 346	Heat Transfer Credits: 3 Prereq: ENGR 205 AND MATH 202 This course covers the basic principles of heat fluxes, in the forms of conduction, convection, and radiation of heat. Specific topics include forced convection in laminar and turbulent flows; mass transfer at low rates; evaporation; and thermal radiation. Problems and examples will emphasize modeling of complex systems drawn from environmental and Renewable Energy applications such as water and waste management heat exchange and energy storage systems.

Code	Description
ENGR 347N	Heat Transfer and Thermodynamics Credits: 3 Prereq: MATH 202 AND CHEM 102 This course covers the basic principles of thermodynamics and heat transfer. In Thermodynamics, the main topics are The first law and basic concepts, volumetric properties of pure fluids, Heat effects, the second law of thermodynamics, Thermodynamics properties of fluids, Applications of thermodynamics to flow processes, and Cycles.Heat Transfer and Thermodynamics In Heat Transfer, basic principles of heat fluxes, in the forms of conduction, convection, and radiation of heat. Specific topics include forced convection in laminar and turbulent flows; mass transfer at low rates; evaporation; and thermal radiation. Problems and examples will emphasize modeling of complex systems drawn from environmental and Renewable Energy applications such as water and waste management heat exchange and energy storage systems.
ENGR 444	Industrial Training Credits: 2 The main objective of industrial training is to enable engineering students a real life engineering work place to earn practice skills. It is planned in summer after the students complete their third year. For a period of 120 working hours the students receive training from industrial companies, research institutions, consultancy offices, government ministries, and NGO or foreign research institute related to their field of specialization. The student, supervised by the training organization, has to submit at the end a technical report to his/her Program. At present it is a 2 credits course and is graded “PASS” or “NOT PASS”. The industrial training program is coordinated by the Industrial Liaison Office.
ENGR/SCI 304	Scientific Ethics & Safety Credits: 3 The course will cover ethical, social, environmental, and safety issues surrounding important scientific advances, including genetically modified organisms, animal cloning, nanotechnology, weapons of mass destruction, and stem cells. It will focus on intensive discussions to develop the powers of reasoning and judgment. The second part of the course will cover biosafety and how scientists should handle biological and chemical waste, in relation to national and international biosafety regulations.
ENV 203	Environmental Chemistry Credits: 3 Prereq: CHEM 201 This course covers topics in Analytical Chemistry with applications to the Environment: Units, significant figures and data analysis, Classification of pollution parameters, analytical chemistry and quantitative analysis, instrumental analysis, gravimetric analysis, basic methods of analysis of water and wastewater. Laboratory work on water and wastewater analysis. Water and wastewater sampling, transportation and protection, total suspended matter, pH, hardness, dissolved oxygen, BOD, COD, Nitrogen, Phosphorus, oil and grease analysis.
ENV 207	Material & Energy Balances Credits: 3 Prereq: ENGR 205 OR PHYS 201 This course covers the fundamental principles and applications of the conservation of mass and energy and develops the skills needed to apply these principles to engineering problems. It includes methods of formulating and analyzing mass and energy balances in unit operations with the goal of minimizing waste and assessing material and environmental impact.

Code	Description
ENV 213	Environmental Chemistry Lab Credits: 1 This course is designed to introduce you to common procedures for analyzing environmental samples. Students will learn how to analyze water for dissolved oxygen, pH, conductivity, turbidity, heavy metals, COD, BOD etc. The techniques include wet methods, such as titrations and extractions, and instrumental methods, such as spectroscopy and chromatography.
ENV 220	Environmental Microbiology Credits: 3 Coreq: ENV 221 Prereq: BIOL 101 This course is designed to provide students with a conceptual and experimental background in environmental microbiology. It is specifically designed for students to be able to comprehend general concepts, methods, techniques, and applications related to the roles of diverse microorganisms in natural and industrial environments. Lectures are not only focused on the structure of prokaryotic microorganisms but will also emphasize microbial metabolism and growth, community dynamics, water and soil microbiology, waste water and solid waste microbiology, fermentation technology and the use of microorganisms in biodegradation and bioremediation.
ENV 221	Environmental Microbiology Lab Credits: 1 Coreq: ENV 220 This lab course is concurrent with ENV 220. 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.
ENV 301	Environmental Laws, Policies, and Economics Credits: 3 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.
ENV 303	Environmental Chemistry Credits: 3 Prereq: CHEM 201 This course covers topics in Analytical Chemistry with applications to the Environment: Units, significant figures and data analysis, Classification of pollution parameters, analytical chemistry and quantitative analysis, instrumental analysis, gravimetric analysis, basic methods of analysis of water and wastewater. Laboratory work on water and wastewater analysis. Water and wastewater sampling, transportation and protection, total suspended matter, pH, hardness, dissolved oxygen, BOD, COD, Nitrogen, Phosphorus, oil and grease analysis.

Code	Description
ENV 319	Environmental Climatology Credits: 3 Prereq: CHEM 102 AND PHYS 101 The course gives an introduction to physical climatology in order to better understand climate variations in the past, present, and future. Focus is on the physical principles governing the global energy budget, the role of the circulation of the atmosphere and seas, and interactions between the different components of the climate system. The course will investigate the physical mechanisms important for climate related to changes in land surface properties (vegetation, etc), atmospheric composition (gas and particles), clouds or orbital parameters. In addition, different methods for investigating natural climate variability and possible effects of anthropogenic climate change will be discussed.
ENV 324	Ecology Credits: 3 Prereq: BIOL 101 AND CHEM 102 Principles governing the behavior of ecosystems. A systems approach is used to describe the interplay between environment and species. A focus on desert, river, oceanic and urban ecosystems as appropriate to the Middle East region. Principles of human interaction with the ecosystem and sustainability are introduced towards the end of the course.
ENV 330	Phase Equilibria for Engineers Credits: 3 Prereq: ENGR 205 Phase equilibria is concerned with review of basic thermodynamics, development of the laws of thermodynamics into working equations, fundamental property relations, residual properties, vapor-liquid equilibrium of ideal and non-ideal systems, Equations of state, activity coefficient models, chemical reaction equilibrium and solid-liquid and solid-vapor adsorption equilibria.
ENV 346	Heat Transfer Credits: 3 Prereq: MATH 202 AND (ENGR 332 OR ENGR 205) This course covers the basic principles of heat fluxes, in the forms of conduction, convection, and radiation of heat. Specific topics include forced convection in laminar and turbulent flows; mass transfer at low rates; evaporation; and thermal radiation. Problems and examples will emphasize modeling of complex systems drawn from environmental and Renewable Energy applications such as water and waste management heat exchange and energy storage systems.
ENV 348	Aquatic Environments Credits: 3 Prereq: CHEM 102 AND BIOL 101 This course will provide a broad overview of the physical, chemical, geological, and biological aspects of freshwater and marine systems. Human perspectives will focus on the conservation and exploitation of the resources found within and below lakes, rivers and oceans Marine protected areas of Egypt will be covered.
ENV 350	Hydraulic Engineering Credits: 3 Prereq: ENGR 207 Sources and distribution of water, analysis of water and sewer systems, open channel flow, wastewater and storm water management, hydraulic structures, wells and dewatering systems, pumps and lift stations.

Code	Description
ENV 356	Soil & Water Chemistry Credits: 3 Prereq: BMS 201 AND CHEM 201 AND (PEU 207 OR PEU 315) This course covers interactions between soil solids, precipitates and solution phases. The course discusses the principles of soil chemistry, including inorganic and organic soil components; complex equilibria in soil solutions; solubility of various mineral phases; sorption of ions and organic compounds to soil and sediment materials; complex formation of metals in natural systems; and redox processes. Applications to environmental risk assessment; environmental monitoring; plant nutrition; and desert and coastal soils are emphasized.
ENV 357	Reactions Engineering Credits: 3 Prereq: ENV 207 Review of stoichiometry and chemical kinetics. Homogeneous reactors: isothermal operation; batch; semi-batch; continuous tank; plug flow reactor design. CSTRs in series; plug flow reactor with recycle. Multiple reactions in reactor networks. Temperature effects in adiabatic and non-isothermal reactors. Yield, selectivity and optimal operation of reactors. Heterogeneous catalysisand effectiveness factors in two-phase reactors.
ENV 359	Bioprocess Engineering Credits: 3 Prereq: ENV 220 AND ENV 207 Principles of biochemistry and microbiology, kinetics of Enzymatic reactions and microbial growth, are reviewed and applied to batch and continuous cell growth kinetics, biomass and product formation in cell culture and nutrient utilization, and bioreactors. Additional topics include introduction to activated sludge process kinetics, nitrification and denitrification systems, basics of anaerobic suspended culture systems, microbiology of wastewater treatment.
ENV 406	Surface & Groundwater Water Hydrology Credits: 3 Prereq: ENGR 207 This course involves an advanced treatment of physico-chemical and biological processes when water interacts with the earth. Quantitative treatments of the flow of water through permeable, saturated media, heterogeneity of flow, and equations used to describe flow dynamics will be discussed. Procedures for planning and managing a site, site characterization and the technical aspects of field investigative methods will be covered.
ENV 415	Water and Wastewater Treatment Lab Credits: 1 Prereq: ENV 420 AND ENV 422 This laboratory course provides and refreshes the basic knowledge of process technology, water chemistry and microbiology involved in water and wastewater treatment. Students will be trained practically on various process technologies. They will study mass balance analysis, reactor models, mixing in reactors, kinetics, mathematical description of chemical and biological reactions in reactors. The course aims to build practical skills for application in various cases of water and wastewater engineering.

Code	Description
ENV 420	Water Treatment Engineering Credits: 3 Prereq: ENV 303 AND ENV 350 The course provides theoretical background and practical expertise in the field of surface and ground water treatment. The topics include water demand and water resources options, surface and ground water characteristics, design of water intake, treatment units and processes such as coagulation, flocculation, clarification, filtration, adsorption, disinfection and oxidation.
ENV 422	Wastewater Treatment Engineering Credits: 3 Prereq: ENV 359 AND ENV 303 The course topics include characterization of wastewater (quantity and quality) originating from population, industry, rainfall and infiltration; physical, chemical, and biological processes necessary for designing , operating , controlling and managing wastewater treatment plants; and the principles of process selection to meet the required effluent discharge requirements in a cost-effective manner.
ENV 423	Municipal Solid Waste Management Credits: 3 Prereq: ENV 207 Solid wastes are the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted. The main topics are Municipal Solid Waste Management; Generation and Characteristics of Waste, Health and Environmental Effects; Waste Collection, Storage and Transport. Record Keeping, Control, Inventory and Monitoring, Implementing Collection and Transfer System, Case Study-Waste Storage, Collection and Transport, Waste Disposal - Key issues and features, Sanitary Landfill, Waste Processing Techniques.
ENV 425	Mass Transfer Operations Credits: 3 Prereq: ENGR 346 AND ENV 330 This course studies selected important topics for environmental and energy and bioprocess engineering such as Mass transfer theory and mechanisms, absorption and stripping, hydrodynamics in absorption column will be considered, flash and distillation, extraction, supercritical extraction, membrane separation. Students will learn a quantitative framework to design different processes related to environmental and renewable energy systems.
ENV 427	Hazardous Waste Management Credits: 2 Prereq: ENV 207 This class provides an overview of treatment and disposal of municipal and industrial waste, including design and economic analysis. Topics include Regulatory Aspects, Resource Conservation and Recovery Overview , Classification and Characterization of Hazardous Waste, Hazardous Waste Facility Operation, Generators of Hazardous Waste, Fate and Transport of Contaminants in the Subsurface, Toxicology and Quantitative Risk Assessment , Pollution Prevention and Waste Minimization, Landfill Disposal, Financial Assurance Requirement, Physio-Chemical and Biological Treatment Processes, Stabilization and Solidification, Thermal Treatment and Disposal Methods, Management of Medical Waste and case studies.

Code	Description
ENV 434	Safety & Risk Analysis Credits: 3 Prereq: MATH 301 AND ENV 425 This course provides a study of the fundamentals of process safety. It includes toxicology, industrial hygiene, source models, fires and explosions, relief systems, hazard identification, risk assessment, accident investigations, and process safety management.
ENV 457	Environmental Impact Assessment Credits: 3 Prereq: ENV 301 The course is intended to present the students with up-to-date information on the principles of Environmental Impact Assessment and its application at different levels and in different projects. The course is designed to be practical in nature. For this purpose, the course is divided in the EIA principles, case studies with an on-hand application and computer application in the EIA studies. The students will be able at the end of the course to apply the EIA concepts on real life cases. During the course students will do exercises on how to carry out an EIA study and write up an EIA report. The course main objectives are to have the student familiar with EIA Principles, know and apply computer applications used in EIA studies, and present and make a case study.
ENV 458	Energy from Biomass and Waste Credits: 3 Prereq: ENV 359 The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. It will also introduce fundamental principles and practical applications of biomass to renewable energy processes, including anaerobic digestion of agricultural and industrial wastes for biogas and hydrogen production, bioethanol production from starch and lignocellulosic materials, biodiesel production from plant oils, and thermos conversion of biomass and waste materials for renewable energy production. It is intended to help the young scientific professionals to keep their knowledge upgraded with the current thoughts and newer technology options along with their advances in the field of the utilization of different types of wastes for energy production.
ENV 465	Environmental Project Management Credits: 3 The course covers Frameworks of Project management; Quantitative Methods of project Management; Project Scope Management; Project Time Management; Project Cost Management; Project Quality Management; Project Human Resources Management; Project Communications Management; Project Risk Management; Project Procurement Management; Project Integration Management; Professional Responsibility.

Code	Description
ENV 470	Air Quality & Pollution Engineering Credits: 3 Prereq: ENV 319 AND ENV 207 Introduction to Air Pollution Control. Types of Air Pollution control equipment. Aerodynamics and fluid resistance to particle motion. Particle and gas separation techniques (Gravity, momentum, Centrifugal Separators, filters, scrubbers, electrostatic precipitators' absorbers, etc.). Design principles of air pollution control equipment. Industrial applications. Air pollution control in urban environment". Cost and design of control systems. Regulations, legal and economic aspects.Sources, behavior, and fate of gaseous and particulate air pollutants. Principles of meteorology and atmospheric diffusion in relation to modeling pollutant transport and dispersion. Design of air pollution control equipment for removal of gases and particles from air streams. Unit operations examined include cyclones, electrostatic precipitators, fabric filters, wet scrubbers, incinerators, biofiltration, adsorbers, and absorbers. In the laboratory section, students will develop an air permit, and complete projects using dispersion modeling and air pollution engineering software.
ENV 480	Urban Water Systems Design Credits: 3 Prereq: ENV 406 AND ENV 420 Planning, design, hydraulic analysis, operation, and maintenance of water transport and distribution systems, wastewater collection systems, and stormwater drainage systems. Introduction to hydraulic design of pump stations. Transient analysis and protection methods for pipelines. This course introduces students to the use of professional software packages for hydraulic analysis and design of urban water systems to plan, design, analyze and simulate water transport and distribution systems, wastewater collection systems, stormwater drainage systems, and pump stations.
ENV 506	Water Desalination Credits: 3 Prereq: ENV 346 AND ENV 420 The course provides conceptual understanding, theory and design of different desalination processes including single effect evaporator, mechanical vapor compression, multiple-effect evaporators, multistage flash desalination process, electro-dialysis and reverse osmosis process. Course topics include design and operation of water intake, pre- and post-treatment, reject brine management, and scale formation processes.
ENV 510	Process Analysis and Simulation Credits: 3 Prereq: ENV 425 The aim of this course is to illustrate the use of process simulation as a tool for the analysis and the conceptual design of chemical processes. It will focus on the integration, dynamic analysis, cost evaluation, and conceptual design of reaction and separation operations. Students will learn how to use process simulators to perform calculations in a fast way in order to focus in the analysis of the obtained information and on other relevant aspects such as safety, green engineering, economic profitability, and the factors that make the systematic solutions of engineering problems more competitive. It aims to practice the use of process simulation as a tool for the analysis and the conceptual design of chemical processes. Students will apply what they learned and perform simulations of entire chemical and environmental processes using different simulation software.

Code	Description
ENV 512	Green Economy Credits: 2 This course focuses on an economy that results in reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment. Topics include: Rationale, Concepts and Principles; Enabling Conditions for Advancing a Green Economy; Sectors and Strategies; Developing a Balanced and Inclusive Green Economy, International Developments and Support to Advance a Green Economy.
ENV 514	Soil & Environmental Physics Credits: 3 Prereq: ENV 406 The course is intended to provide with the theoretical and practical basis for understanding and quantifying physical and hydrological properties of soils. The course focuses on hydro-physical processes taking place near the Earth's surface emphasizing mass and energy exchange, and transport processes in saturated and partially-saturated soils at multiple scales. Coupling with the atmosphere and the role of plants in the hydrological cycle will be discussed. Students will gain hands-on experience with modern measurement methods and analytical tools for hydrological data collection and interpretation during the laboratory sessions.
ENV 518	Introd to Environmental Systems Analysis Credits: 3 Prereq: ENV 508 AND ENV 207 AND MATH 202 This course is organized around a set of large-scale environmental engineering system problems. The problems are used to study and practice the use of quantitative tools for the planning or management of these systems. The problems relate to the provision of safe drinking water, desalination, irrigation, transportation infrastructure, energy/power provision, sewage treatment, and solid waste management. A systems treatment of the physical project/infrastructure provides a starting point, the “system” is then expanded to include the physical environment, and social and economic context. Common tools in environmental systems analysis are used, including environmental economics; mass and energy balances; benefit-cost and risk analysis; and sustainability.
ENV 519	Introduction to Integrated Water Resources Management Credits: 3 Prereq: ENV 406 This course introduces the concept of Integrated Water Resources Management (IWRM). The course discusses the following topics: definition of management functions and decision making processes in IWRM; tools for water resources management; water and irrigation management at the watershed level (water policy and governance aspects; operation of irrigation at the main-distribution-system scale (irrigation system distribution components, irrigation scheduling); operation of irrigation at the on-farm scale (identification of soil types and their soil-water holding capacity, definition of crop evapotranspiration rates and determination of crop and irrigation water requirements, soil-water balance and yield response to water); irrigation water use efficiency at different scales; introduction to water economics (water values, basic functions and characteristics of water markets, unit costs of water and cost recovery in water utilities, role of the public and private sectors in water supply; water pricing in agriculture, urban water pricing and regulation); basics of water policy and legislation; water institutions and administration; transboundary water management and international water law

Code	Description
ENV 520	Separation Processes Credits: 3 Prereq: ENV 425 OR ENV 436 This course covers the general principles of separation by equilibrium and rate processes. An introduction to the principles and applications of diffusional separation processes involving gas-liquid, liquid-liquid and solid-liquid systems in equilibrium-stage and continuous-contact operations. Topics include staged cascades and applications to distillation, absorption, adsorption, and membrane processes. Throughout emphasis is placed on problem solving and illustrative worked examples.
ENV 522	Industrial Bio-Processes Credits: 3 Prereq: ENV 359 The course aims to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food, bioenergy etc. The course introduces bioreactors, its types, operation methods and provides an experimental demonstration of the same. Strategies to obtain higher yields, design of the reactors and production of biofuels from microbes are thoroughly explained. The course discusses the existing bioprocess applications such as cheese making, antibiotics and vaccines etc. Major bottlenecks for the operation of biochemical industries will be discussed. This course provides students with an up-to-date knowledge of upstream and downstream processing technology.
ENV 523	Transport and Fate of Chemicals in the Environment Credits: 3 Prereq: ENV 406 AND ENV 470 This course is designed to give students an understanding of processes that govern the behavior of both hazardous and naturally-occurring substances in the environment. The subject includes aspects of intermedia transport, surface and groundwater hydrology, air pollution modeling, degradation processes, human exposure pathways, and monitoring. This course involves the training of students to model and simulate the transport and fate of chemicals in the environment including surface water, ground water, air and soil. The students will write their own programming code and will use software package to simulate real chemicals transport processes.
ENV 524	Life Cycle Assessment Credits: 3 The course includes lectures and a group project. Lectures will cover the following areas: LCA in relation to other environmental systems analysis tools, Methodology for the different phases of an LCA (goal definition and scoping, inventory analysis, impact assessment and interpretation), Methodology for simplified LCA, LCA software tools and databases. Critical review of an LCA study, Application areas of LCA and limitations.
ENV 527	Appropriate Technology Credits: 1 This course is designed to train students to develop judgments as to when to choose high technology versus traditional solutions to engineering problems, how to most effectively implement technological innovation within a traditional environment and how to combine novel and traditional technologies to obtain enhanced performance with minimal social or environmental disruption. Classroom lectures will focus on case studies drawn from around the world. To be taken concurrently with the first semester senior project.

Code	Description
ENV 528	Pollution Sampling, Analysis and Monitoring Credits: 3 Prereq: ENV 203 OR ENV 303 Topics covered in this course include: sampling requirements for pollutants from various sources, concentration techniques, theory and practice of advanced analytical techniques for detailed chemical analysis of samples, on-line methods of analysis for air, exhaust gases and water, methods for suspended particulate matter, different methods for evaluating environmental impact of pollution made by mechanical sources, measuring the emissions of internal combustion engines, boilers and furnaces, filters, industrial waste water. Special emphasis is on measuring the emissions of industries like textile, printing, ceramics, aluminum, steel, brick, etc.
ENV 530	Urban Development & Environmental Planning Credits: 3 The course covers basic principles in Urban planning with an emphasis on environmental sustainability in the context of a developed or developing economy. Topics include land and water utilization, transport, infrastructure planning, waste and recycling, and impacts on local and global environments. A systems approach integrating the physical, urban and social environment is emphasized. Means of incorporating environmental regulations and risk management into planning approaches are covered.
ENV 538	Soil and Groundwater Contamination Survey and Remediation Credits: 3 Prereq: ENV 406 This course will introduce the theory and application of the soil and groundwater remediation technique to student. The contents are divided two parts. First section begins with the nature of soil, groundwater and pollutants, then introduce the mechanism of chemical fate and transport in the underground. Second part introduces the principles, application and design for remediation techniques.
ENV 555	Coastal Environmental Management Credits: 3 Prereq: ENV 319 AND ENV 350 This course covers water waves, surf zone hydrodynamics, tides in oceans and estuaries, storm surges, estuarine mixing, basic sediment transport, coastal morphodynamics, and coastal groundwater dynamics.
ENV 556	Soil & Water Chemistry Credits: 3 Prereq: ENV 220 AND CHEM 201 This course covers interactions between soil solids, precipitates and solution phases. The course discusses the principles of soil chemistry, including inorganic and organic soil components; complex equilibria in soil solutions; solubility of various mineral phases; sorption of ions and organic compounds to soil and sediment materials; complex formation of metals in natural systems; and redox processes. Applications to environmental risk assessment; environmental monitoring; plant nutrition; and desert and coastal soils are emphasized.

Code	Description
ENV 558	Energy from Biomass and Waste Credits: 3 Prereq: ENV 359 The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. It will also introduce fundamental principles and practical applications of biomass to renewable energy processes, including anaerobic digestion of agricultural and industrial wastes for biogas and hydrogen production, bioethanol production from starch and lignocellulosic materials, biodiesel production from plant oils, and thermos conversion of biomass and waste materials for renewable energy production. It is intended to help the young scientific professionals to keep their knowledge upgraded with the current thoughts and newer technology options along with their advances in the field of the utilization of different types of wastes for energy production.
ENV 559	Remote Sensing for the Environment Credits: 3 Prereq: PHYS 102 AND MATH 202 The course covers the principles of remote sensing, general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for environmental engineering practices. Data collection from airborne and satellite platforms will be emphasized. Photographic and non-photographic sensing methodologies will be covered as well as manual and computer assisted data analysis techniques for site investigations and examination of ground conditions.
ENV 597	Selected topics in Environmental Eng. Credits: 3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
ENV 598	Senior Design Project I Credits: 1 Students must undertake an independent Environmental Engineering design project during the last two terms of their program. The purpose of the project is to demonstrate students' abilities to practise in an Environmental Engineering capacity in their chosen area of expertise, using knowledge gained from their academic and employment experiences. The first part of the project will include problem identification, generation and selection of solutions and time management. Incorporation of technical, ecological, social, political and economic issues in the solution for the project will be required. A basic requirement of the proposed solution is that it must be compatible with the principles of sustainability. Requirements include: proposal, progress report, and a final report containing recommendations for part two of the project.
ENV 599	Senior Design Project II Credits: 3 Prereq: ENV 598 The final design of the major Environmental Engineering project proposed in ENV 598 will be undertaken. The purpose of this phase of the project is to carry out a detailed technical design of the solution proposed in ENV 598. Requirements of this part of the two-term project include a final report.
HIS 302	Egyptian History Credits: 2 The students will learn about Egyptian history, including the Pharaonic, Ptolemaic , Coptic, Arabic, and Islamic periods

Code	Description
HIS 304	Arab World History Credits: 2 The historical origins of the modern Middle East, its culture(s), languages, religions, and influential concepts such as "Arabism", are traced through an exploration of pre-Islamic civilizations in Egypt, Mesopotamia, and Arabia, Greek, Roman and Persian influences, the rise of Islam, the Caliphates, colonialism and contemporary events. The role of science in the region's history is an important subtheme. While Arab civilization is a major theme, the roots of several minority languages, ethnicities, and religions in the region will also be explored.
Math 101	Calculus I Credits: 3 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 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 Prereq: MATH 102 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.
MATH 202	Ordinary Differential Equations Credits: 3 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 203	Introduction to Discrete Mathematics Credits: 1 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

Code	Description
MATH 301	Probability and Statistics Credits: 3 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 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.
MATH 306	Numerical Analysis Credits: 3 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.

Code	Description
MATH 306N	Numerical Analysis Credits: 3 Prereq: MATH 202 AND MATH 102 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 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 403	Introduction to Real Analysis and Topology Credits: 3 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.
MATH 404	Linear and Non-linear Programming Credits: 3 Prereq: MATH 102 The goal of this course is to help the student develop efficient algorithms to solve linear and nonlinear optimization problems especially convex optimization. The course explores the optimality conditions, duality and sensitivity analysis, algorithms include simplex methods, gradient and conjugate gradient methods, Newton and Quasi-Newton methods and interior-point methods.

Code	Description
MATSCI 201	Fundamentals of Materials Science and Engineering Credits: 3 Prereq: CHEM 102 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 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 214	Inorganic chemistry lab Credits: 1 Coreq: MATSCI 204 Familiarize with examples of inorganic complexes with focus on the synthetic techniques, characterization and the study of the physical and chemical properties of these complexes.
MATSCI 255	Introduction to Nanomaterials Synthesis Credits: 2 Prereq: CHEM 102 This course is an experimental introduction to synthesis of nanomaterials. It includes topics such as nanoparticles synthesis, self-assembly, photoresist-like material synthesis, nanotubes, basic battery technology,...
MATSCI 301	Catalysis Credits: 3 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.
MATSCI 302	Solid State Physics Credits: 3 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.

Code	Description
MATSCI 303	Macromolecular Chemistry Credits: 3 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 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 305	Quantum Chemistry Credits: 3 Prereq: CHEM 202 AND PHYS 202 AND MATH 202 Introduction to principles of reaction kinetics, laws of thermodynamics, Schrodinger model of the hydrogen atom, quantum well and quantized oscillator, spectral analysis and modeling.
MATSCI 307	Introduction to scientific computing Credits: 3 Prereq: CHEM 201 Introduction to the various methods of computational chemistry including Quantum/Molecular mechanics (QM/MM). Familiarize with different methods of quantum chemical calculations such as Semi-empirical and Density Functional Theory (DFT).Different types of molecular mechanical force fields in materials simulation. Methods of Molecular dynamics simulations using Quantum/Molecular mechanical calculations
MATSCI 308	Computational modeling Credits: 3 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 317	Introduction to scientific computing lab Credits: 1 Coreq: MATSCI 307 Familiarize with various methods of quantum and molecular mechanical calculations. In the labs, the students will apply the different methods of computational calculations to study the functionalized materials. Gaussian 16 and Quantum Eespresso will be used to perform the quantum chemical calculations. For molecular mechanical calculations, AMBER software will be used.

Code	Description
MATSCI 318	Computational modeling lab Credits: 1 Coreq: MATSCI 308 Familiarize with different modeling software like Gaussview, Avogadro and VESTA. The students will learn basic commands of Linux operating system and use High performance Computer (HPC) to perform their calculations.The calculations will be carried out using computational software like Gaussian16 and QuantumEespresso to predict the single point energy, geometrical structure and spectroscopic data of materials. In addition, the computational calculations will be employed in different applied fields such asprediction of reaction pathways, performing conformational analysis and comparison of anticorrosion inhibition efficacy of organicmolecules.
MATSCI 399	Internship (For MATERIALS SCIENCE PROGRAM) Credits: 2 Pass/FailAn 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.
MATSCI 402	Advanced computational methods Credits: 3 Prereq: MATSCI 308 The course will focus on the advanced methods of computational modeling. In the course, the student will familiarize with The Born-Oppenheimer Approximation and differentmethods like Hartree-Fock Approximation (HF), Density Functional Theory (DFT), Møller-Plesset Perturbation Theory (MP), Coupled Cluster Theory (CC) and Frozen Core Approximation. The course will also cover the different types of basis setswhich used in the computational calculations.
MATSCI 403	Thin films and surface science Credits: 3 Prereq: CHEM 201 AND PHYS 202 Introduction to different methods for thin film synthesis and characterization including: chemical vapor deposition, atomic layer deposition, layer by layer synthesis, oriented thin films synthesis, perovskite materials for solar energy, methods of spin coating and lithography. Also, an orientation into clean room techniques, membrane characteristics and gas separation principles.
MATSCI 404	Modeling of biological molecules Credits: 3 Prereq: CHEM 201 Discussing computational methods used for simulation of biological molecules with focus on DNA and protein folding, small molecule binding to biological hosts.
MATSCI 405	Advanced organic chemistry Credits: 3 Prereq: CHEM 201 Introduction to functional group identification and transformation, and polymers synthesis. Also, advanced level analysis of organic compounds using mass spectrometry, NMR spectroscopy, FTIR spectroscopy and UV-vis spectroscopy.
MATSCI 406	Modeling of carbon materials and semiconductors Credits: 3 Discussing computational methods used for simulation of carbon-based structures such as: fullerenes, CNT, graphene and materials with semiconducting properties.

Code	Description
MATSCI 407	Functional composites Credits: 3 Prereq: CHEM 102 Introduction to new methods for synthesis of composite materials, characterization techniques and applications. The relationship between structure and function of composites will also be discussed.
MATSCI 408	Magnetic and electrical properties of materials Credits: 3 Prereq: MATSCI 302 Introduction to the concepts of electronic energy bands and transports applied to metals, semiconductors, and insulators. The behavior of electronic and optical devices including p-n junctions, MOS-capacitors, MOSFETs, optical waveguides, quantum-well lasers, light amplifiers, and metallo-dielectric light guides. Emphasis is on relationships between structure and physical properties.Fundamentals of magnetism, magnetic materials, and magnetic nanostructures and their myriad of applications in nanotechnology, sensing, energy and related areas will also be discussed.
MATSCI 409	Materials for energy Credits: 3 Prereq: CHEM 101 Introduction to novel materials for energy applications with focus on energy conversion, batteries, supercapacitors and photochemical catalysis.
MATSCI 412	Advanced computational methods lab Credits: 1 Coreq: MATSCI 402 Testing and comparison betweenvarious computational methods performance in materials modeling using different software packages. Familiarize with the different levels of calculation inside Density Functional Theory (DFT)and Møller-Plesset Perturbation Theory (MP). Performing Benchmarking calculations using Coupled Cluster theory.
MATSCI 416	Materials Science Capstone research project Credits: 1 A research project related to industrial challenge and conducted throughout the semester.
MATSCI 417	Composite materials lab Credits: 1 Introduction to new methods for synthesis of composite materials, characterization techniques and applications.
MATSCI 418	Materials Science Capstone research project Credits: 1 A research project related to industrial challenge and conducted throughout the semester.
MATSCI 420	Fuel Cells and Battery Technology changed to Selected topics in advanced materials Credits: 3 Prereq: CHEM 202 AND PHYS 202 This course offers a comprehensive study in fuel cells and batteries by offering an up-to-date knowledge concerning “the fundamental knowledge of fuel cells and batteries”, “fuel cell types“, “charge and mass transport processes in fuel cells and batteries “, “analysis and characterization of fuel cells and batteries “, “fuel cell membranes“, “fuel cell catalysts“, “fuel cell electrodes“, “low and high temperature fuel cells“, “the current challenges of fuel cells and batteries industry“, along with the specific techniques of batteries. The topics will also include in-situ and ex-situ characterization techniques, potential-power curves, frequency response analyses, fuel cell modeling and system integration. For each topic, the fundamental knowledge will be exemplified with applications issued from industrial developments and/or current research activities.

Code	Description
MATSCI 422	Instrumental analysis Credits: 3 Prereq: CHEM 202 AND PHYS 202 Introduction to various analytical techniques including: electron microscopy (such as: SEM, TEM, STEM, and AFM), surface analysis techniques including XRF, EDX, XPS and single crystal and powder X-ray diffraction.
MATSCI 423	Research methods Credits: 3 Prereq: CHEM 102 AND PHYS 102 This course introduces the students to the different available electronic resources and databases that are essential in performing proper literature survey in materials science.
MATSCI 425	Main group and transition metals chemistry Credits: 3 Prereq: CHEM 202 Introduction to the principles of main group (s and p block) element and transition metal chemistry with an emphasis on synthesis, structure, bonding, and reaction mechanisms.
MATSCI 430	Solid State Chemistry Credits: 3 Prereq: CHEM 202 This course describes structure and composition of commonly utilized minerals like Zeolites and silicates. The topics covered also include many of recently discovered and utilized solid-state materials like metal-organic materials, covalent-organic frameworks, hydrogen-bonded structures and coordination polymers. In addition, crystal engineering principles and novel solid-state syntheses strategies will be discussed.
MATSCI 480	Self-assembled Systems Credits: 3 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.
NANENG 201	C/C++ Programming Language Credits: 3 This course starts with basic C language fundamentals, then introduces the student to object-oriented programming through a study of the concepts of program specification and design, algorithm development, and coding and testing using a modern software development environment. Students learn how to write programs in an object-oriented high-level programming language. Topics covered include fundamentals of algorithms, flowcharts, problem solving, programming concepts, classes and methods, control structures, arrays, and strings. Throughout the semester, problem solving skills will be stressed and applied to solving computing problems. Weekly laboratory experiments will provide hands-on experience in topics covered in this course. The class is taught in a computer lab.

Code	Description
NANENG 203	Electric Circuits Credits: 3 Prereq: PHYS 102 AND MATH 102 Introduction to theory, analysis and design of electric circuits. Voltage, current, power, energy, resistance, capacitance, inductance. Kirchhoff's laws node analysis, mesh analysis, Thevenin's theorem, Norton's theorem, steady state and transient analysis, AC, DC, phasors and Introduction to the concept of impulse response and frequency analysis using the Laplace transform, and introduction to 3-phase circuits.
NANENG 204	Digital Logic Design Credits: 2 This module introduces the concepts of the design and implementation of digital circuits. The students will be introduced to different numbering systems as well as logic gates family. The Boolean Algebra will also introduced to simplify logic circuit design. Analysis and Synthesis of Combinational Circuit, Sequential Circuits, Registers and Counters, Sequential Circuits with Programmable Logic Devices.Laboratory experiments will be used to reinforce the theoretical concepts discussed in lectures. The lab experiments will involve the design and implementation of digital circuits. Emphasis is on the use computer aided tools in the design, simulation, and testing of digital circuits.
NANENG 245	Introduction to Discrete Mathematics Credits: 1 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
NANENG 301	Micro/Nano Fabrication Techniques Credits: 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.
NANENG 305	Physics Of Semiconductors Credits: 3 Prereq: PHYS 202 AND MATH 202 The course will apply fundamental solid-state physics concepts to a specific material class, namely semiconductors, to identify its electronic properties. The course starts by reviewing quantum mechanical concepts, followed by Kronig-Penny model and band theory, energy gaps, and effective mass. This is followed by Fermi-Dirac and Maxwell-Boltzmann carrier statistics, density of states, Fermi level and doping, and electron-hole concentrations calculations. Basic conduction mechanisms such as drift-diffusion equation, mobility, conductivity, generation-recombination, lifetime, excess carriers injection, thermionic emission and metal-semiconductor contacts are discussed.

Code	Description
NANENG 307	Physics of Electronic Materials Credits: 3 Prereq: NANENG 305 This Course gives an overview of the physics of the electronic material. Why the electronic materials behave the way they do? It takes you in journey starting from the basic structure and building block, bonding and navigate through the thermal, electrical, dielectric and magnetic properties of the materials with a review on the different theory that illustrates these properties and phenomenon.
NANENG 308	Solid State Devices Credits: 3 Prereq: NANENG 305 This course covers crystal structures, band gap theory, ionic equilibrium theory, fundamentals of carrier transport, compound semiconductors III-V. This course will make special emphasis on the properties of various types of junctions (p-n junctions, heterojunctions, metal-semiconductor junctions) leading to various electronic devices such as field effect transistors (FETs), metal oxide-semiconductor FETS (MOSFETs), high electron mobility transistors (HEMTs), etc. Short Channel effects and nanoscale phenomena will be emphasized throughout the course and their impact on device modeling in analog and digital circuits.
NANENG 312	C/C++ Programming Lab Credits: 1 Prereq: CSCI 101 AND MATH 306 This course introduces the student to object-oriented programming through a study of the concepts of program specification and design, algorithm development, and coding and testing using a modern software development environment. Students learn how to write programs in an object-oriented high-level programming language. Topics covered include fundamentals of algorithms, flowcharts, problem solving, programming concepts, classes and methods, control structures, arrays, and strings. Throughout the semester, problem solving skills will be stressed and applied to solving computing problems. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.
NANENG 322	Electronic Circuit Design Credits: 3 Prereq: ENGR 201 OR NANENG 203 The course first starts by explaining the basic operation of basic devices such as diodes, BJTs and FETs, from a simplified point of view. Basic DC and load-line analysis of these devices is explained, followed by AC analysis and small circuit models. This course covers basic building blocks in electronic systems, such as amplifiers, current mirrors, digital switches and inverters. Application of basic circuit theory to analyze these simple sub-systems is implemented

Code	Description
NANENG 331	Electromagnetics Credits: 3 Prereq: PHYS 201 AND MATH 202 This course covers electromagnetic forces and fields and their sources. Maxwell's equation in vacuum: The integral and differential forms; boundary and continuity conditions; static and dynamic problems; plane waves; the quasistatic field equations.Electro-quasistatics: Potential; Poisson's and Laplace's equations; the superposition integrals; boundary value problems in Cartesian, cylindrical and spherical coordinates; electro-mechanical systems and equivalent circuits; numerical solutions. Magneto-quasistatics: The vector potential and gauge theory; Biot-Savart superposition integral; boundary value problems; induced fields and potentials; self and mutual induction; magneto-mechanical systems and equivalent circuits. Fields in matter: Conduction and charge relaxation, polarization and magnetization; physical models; field equations and constitutive relations; solution techniques; examples for quasistatic electro- and magneto-mechanical systems. Electromagnetic energy: Pointing's theorem; energy balance in static and quasistatic problems; exchange of mechanical and electromagnetic energy. Electro-dynamics: The sinusoidal steady state and introduction to electromagnetic waves.
NANENG 335	Introduction to Photonics Credits: 3 Prereq: PHYS 201 Course description: Introduction to light interaction with the material, Fresnel equations,Dielectric mirrors, optical waveguiding, optical fibers, light dispersion, control of light polarization.COMSOL® and Lumerical FDTD software are used throughout the course to demonstrate andsimulate different devices.
NANENG 401	MEMS Design and Fabrication Credits: 3 Prereq: NANENG 301 This course introduces nanotechnology engineering students to state-of-the-art micro / Nano fabrication technologies in a combination of theory, simulation, device fabrication and device characterization in modern laboratory facilities. The course covers basic MEMS/NEMS fabrication technologies, various transduction mechanisms such as piezoelectric, thermoelectric, thermionic, piezoresistive, etc. In addition, the theory of operation of few sensors will be covered this will include infrared detectors, radiation sensors, rotation and acceleration sensors, flow sensors, pressure and force sensors, and motion sensors.
NANENG 402	Modern Characterization Techniques Credits: 2 Prereq: CHEM 102 AND PHYS 202 AND MATSCI 201 This course will cover a variety of modern characterization techniques. The techniques covered in this course will include, Optical Microscope Instrumentation, Spectroscopy, SEM, TEM, STEM, and AFM, Elliposmetery, Mechanical Characterization, X-ray and thermal Characterizations

Code	Description
NANENG 410	Real-Time Embedded System & Microcontroller Design Credits: 3 Prereq: NANENG 204 AND NANENG 312 Due to its vital role in almost all application domains, such as ground and air/space vehicles, robots, buildings and even human bodies, as well as telecommunication systems and devices, real-time computing (RTC) has become an essential discipline in the field of computer science and engineering. The new emerging concept of cyber-physical system (CPS) is also rooted at real-time computing.This course is intended to cover principles and foundations (not case studies or applications) of real-time computing, which are based on three attributes: timeliness, reliability/safety, and environmental interface. These three attributes are strongly coupled with each other by a single precious resource, time, which is, in turn, dictated by limited resources, electric energy, space and weight. In this course, students will be exposed to the state-of-art (both analytical and experimental) research and development related to all these three attributes and their interplay.
NANENG 421	Analog Integrated Circuit Design Credits: 3 Prereq: NANENG 322 The subject of this course is the analysis and design of analog CMOS integrated circuits. Simple modelling techniques are used to gain a better understanding of the functions of the circuits. Intuitive design methods, quantitative performance measures and practical circuit limitations are emphasized. Circuit performance is predicted by means of both hand calculations and computer simulations. The course contains a review of device modelling, dc and small signal properties of single- and multi-stage amplifiers, followed by the study of biasing circuits, current mirrors, and active loads, differential pairs and operational amplifiers. Next, frequency response characteristics of amplifiers will be examined.
NANENG 422	ASIC and FPGA Design Credits: 3 Prereq: NANENG 204 This course covers comprehensive theoretical understanding as well as hands-on practical experience of the digital design flow, including the design optimization, hardware description languages (VHDL/Verilog Coding), commercial Field Programmable Gate Arrays (FPGAs) architectures, the physical implementation steps in digital custom Application Specific Integrated Circuits (ASICs) design, as well as synthesis algorithms.Students will earn invaluable experience to professionally work with state-of-the-art design tools for both FPGA and ASIC design flow through several hardware implementation assignments. The implementation platform is Xilinx Spartan 6 board, which will be used throughout the course. Moreover, students will design a ready for-fabrication ASIC tape-out as a final project in this course.
NANENG 424	Photovoltaics and Photonic Devices Credits: 3 Prereq: MATSCI 302 OR NANENG 305 The course is introduction to the principles, design and application of semiconductor photonic devices including photovoltaic, photodiodes, light-emitting diodes, laser diode and optical Fibers. Light interaction with semiconductors, quasi-Fermi levels, and light absorption are discussed. The course identifies the various kinds of semiconductor materials used in photonic devices, different generations of solar cell materials and structures, in addition to basic characterization techniques required for photovoltaic devices and the factors that limit the power conversion efficiency. It also explains the most common specifications of photodiodes, LEDs, and laser diodes.

Code	Description
NANENG 430	Principles of Microwave and Waveguides Credits: 3 Prereq: SPC 312 OR NANENG 331 Review of transmission line and Use of Smith Chart for admittance. Field analysis of different type of metallic waveguides. TEM, TM and TE Waves. Parallel plate and rectangular waveguides. Waveguide modes of a coaxial line. Circular metallic waveguide. Dielectric slab waveguides, surface waves, Stripline, Planar guiding structures: microstrip, coplanar lines etc. Microwave network analysis. Scattering parameters. ABCD matrix. Two-port networks. The course will also cover design of passive microwave elements such as divider, couplers, and filters and will also introduce the design of active transistor amplifier.
NANENG 433	Computer Architecture &Assembly Language Credits: 3 Prereq: NANENG 204 AND NANENG 312 The objective of this course is to explain how computers are designed and how they work. Students are introduced to modern computer principles using a typical processor. They learn how efficient memory systems are designed to work closely with the processor, and how input/output (I/O) systems bring the processor and memory together with a wide range of devices. The course emphasizes system-level issues and understanding program performance. Topics include instructions sets, assembly language, internal data representation, computer arithmetic, processor data path and control, memory hierarchy, I/O devices and interconnects, and an introduction to parallel processing. Parallel architectures will also be explored
NANENG 461	Communications Theory and Systems Credits: 3 Prereq: MATH 301 The course introduces the concept of information measurement through Shannon's information theory. The course also introduces technical concepts, principles, models, management, and foundational logic of information and communication systems such as coding, error correction, channel noise, distortion, communication protocols, and communication standards. The course examines history, current trends, and future of ICT. Review of global ICT standards and regulations.
NANENG 501	Advanced Digital ASIC Design Credits: 3 Prereq: NANENG 422 This course will focus on the Hardware Description Language (HDL): Verilog and VHDL, Professional Verilog Coding for Synthesis, Verification Techniques, FPGA Architectures, Digital System Design with Xilinx FPGAs, ASIC Digital Design Flow (from Verilog to the actual Chip tape-out), Synthesis Algorithms, Power Dissipation, Power Grid and Clock Design, and Fixed-point Simulation Methodology. The course will be around 30% theoritical and 70% hands on on the design tools for the FPGA and the ASIC flows.
NANENG 503	Physical Design and EDA Algorithms Credits: 3 Prereq: NANENG 312 AND NANENG 422 Beginning with a general introduction to VLSI design flow and Electronic Design Automation (EDA) tools, the course mainly focuses on VLSI physical design (layout). It covers partitioning, placement, floor planning, routing (global and detailed), and compaction. We will discuss why and how to partition a design process into sub-problems and will study how to design good algorithms to solve each of those sub-problems. The course will also introduce numerical methods for large scale simulation of electronic analog/mixed signals using SPICE, compact models and matrix solution.

Code	Description
NANENG 511	Nano Photonics Credits: 3 Prereq: NANENG 509 OR NANOSC 413 OR NANENG 335 The course is designed to introduce the latest developments in the newly emerging field of nanophotonics. The students will gain understanding of the fundamental physics governing the interaction between light and nanoscale materials. The students will also be exposed to the various novel optical phenomena observable in the nanoscale and their applications. Specific topics to be discussed will include photonic crystals, plasmonics and metamaterials.
NANENG 512	Applied Digital Control and Drives Credits: 3 Prereq: NANENG 312 AND MATH 202 This course is designed to study the fundamental theory of linear control systems through mathematical analysis and numerical simulation. The topics covered in the course will include a review of mathematical tools, model representations, feedback control system, time response, frequency response, stability, root locus method, control system design, and digital control system.
NANENG 513	Adv. Nanodevices Fabrication Techniques Credits: 3 Prereq: NANENG 301 This course addresses several advanced techniques and fabrication process flows for nanodevices, including the materials used. Topics include Metal/High-k process integration, Atomic Layer Deposition (ALD), metal-organic CVD, advanced optical lithography practices, electron beam lithography, laser annealing, Cu interconnects, high density plasma sources, and amorphous thin film transistors (TFTs) used in LCD displays. Process integration for high voltage/high temperature devices, practical aspects of vacuum equipment and reactor design are discussed. The course will depend heavily on papers and self reading.
NANENG 514	Organic Electronics and Photovoltaics Credits: 3 Prereq: NANENG 301 AND NANENG 305 The course gives an overview of organic electronic and optoelectronic devices. It begins with a review of electronic structure of single organic molecules as a guide to the electronic behaviour of organic aggregates. Various relevant material phenomena are reviewed; including topics from photophysics (absorption and emission of light, excited states, radiative and non-radiative transitions), intermolecular charge transport mechanisms (hopping, disorder), charge injection and transport models, and energy transfer processes. Their applications in light emitting devices, solar cells, thin film transistors, photodetector and imaging photoreceptors, etc. are discussed.
NANENG 515	Adv. MEMS Design &Fabrication Techniques Credits: 3 Prereq: NANENG 401 This course introduces advanced topics in MEMS and fabrication that includes various MEMS applications in indutrial, automotive, biomedical, RF, and optical fields. This includes the design concepts, boundry conditions, and challengs in both design and fabrication. In addition, the course focuses on the challenges of nano-fabrication and NEMS (Nano-Electro-Mechanical-Systems) on the design, fabrication, and characterization levels.

Code	Description
NANENG 520	Advanced Devices Credits: 3 Prereq: NANENG 408 OR NANENG 308 NANENG 520 begins with the review of classical semiconductor physics and devices (e.g., pn -junction diode, MOSFET, and bipolar transistor) learned in the prerequisite courses. Then Bulk MOSFETs and related device structures (e.g., Conventional field-effect transistor (FET) physics and limitations, alternative FET-related structures on silicon bulk and other materials). After that, physics background on Silicon-on-insulator FET technology, Double-gate and FinFETs, Physics of the Multigate MOS System, Junctionless transistors, Different approaches for semiconductor device modeling and simulation. Then the High-Voltage MOSFET Modeling (e.g., EKV-HV DC Model), effect of semiconductor material, device structure, and current injection levels on device performance.
NANENG 522	Advanced RF/Mixed Signal ICs Credits: 3 Prereq: NANENG 421 In this course, you will learn about design of basic building blocks in radio frequency (RF) integrated circuits. RF circuits constitute the basis of modern communication systems. Designing RF circuits requires an in depth knowledge of transistor operation and high frequency analog circuit design concepts. This course will start from the fundamentals of RF microelectronics such as the noise, linearity, matching and move subsequently to basic communication systems. Next, passive devices such as inductors, capacitors for RF designs will be reviewed. After a detailed discussion of noise calculations in analog and RF circuits, the course will analyze the key building blocks in RF circuits, namely low noise amplifiers (LNA), mixers, oscillators, phase locked loops (PLLs), frequency synthesizers, and power amplifiers. Finally, IC and PCB layout considerations for RF circuits which are crucial for high RF performance will be inquired.
NANENG 523	Nanofabrication Vacuum & Equipment Tech Credits: 3 Prereq: NANENG 301 This course focuses on the broad spectrum of processing approaches involved in "top down", "bottom up", and hybrid nanofabrication. The majority of the course details a step-by-step description of the equipment, facilities processes and process flow used in today's device and structure fabrication. Students learn to appreciate processing and manufacturing concerns including safety, process control, contamination, yield, and processing interaction. The students design process flows for micro- and nano-scale systems. In addition, the students will be included in the process of designing such equipment and using vacuum inside these equipment. More hands on are expected in this course including automation of the nano-fabrication equipment as well.
NANENG 524	Testing, Verification and Reliability Credits: 3 Prereq: NANENG 422 Basic theory, techniques for testing digital circuits and systems. Design techniques for fault tolerant and early diagnosable systems. Test generation for combinational and sequential logic circuits, checking experiments. Gate level fault simulation, and its application to diagnosis. Design techniques using static and dynamic redundancy for reliable systems. Design for testability (DFT) including full and partial internal scan and boundary Scan. Memory test, delay test and at speed testing. Built In Self Test (LBIST, MBIST). Reliability basics its relation to accelerated testing.

Code	Description
NANENG 525	Optical MEMS Credits: 3 Prereq: NANENG 430 This course aims at providing students with essential concepts about optical MEMS. Topics covered include: Fabrication and testing concepts for optical MEMS, different optical systems on-chip, chip testing and characterization, optical transducers and sensors, optofluidics, Lab-on-a-chip & µTAS (Micro Total Analysis Systems), advanced topics in coupling between different domains such as optical forces. Several practical experiments for optical systems will be demonstrated.
NANENG 530	Computational Photonics Credits: 3 Prereq: MATH 306 AND NANENG 312 This course covers many of the most popular methods used in modern computational modeling of photonic devices. These methods include transfer matrix method, finite-difference frequency-domain, finite-difference time-domain, beam propagation method, plane wave expansion method, and finite element method. and optimization. The students will demonstrate a rich and deep understanding of computational electromagnetics, including formulation and implementation of several specific methods.
NANENG 533	Mixed Signal and Low Power VLSI Credits: 3 Prereq: NANENG 421 The goal of this course is to provide the students with in-depth study of advanced mixed-signal integrated circuits such as ADCs/DACs, switched-capacitor circuits, variable gain amplifiers, filters, PLL. If time permits, the instructors will provide an overview of analog circuits for biomedical applications, specifically design techniques of neural recording amplifiers for Brain-Computer Interfaces.
NANENG 535	Integrated Nanophotonics Credits: 3 Prereq: NANENG 511 This course introduces the students to the basics of the field of integrated nanophotonics which deals with the physics, technology and simulation of semiconductor optoelectronic devices such as laser diodes and passive photonic components such as directional coupler and optical waveguide. Assuming a general science undergraduate level background, the course begins with a recap of essential semiconductor (to this course) physics, followed by the study of interaction of photons with matter at bulk and quantum scales leading to realization of a variety of designs and configurations for semiconductor photon sources, modulators, amplifiers and detector. Additionally, the course emphasis on the theory and simulation of the propagation of light in passive structured dielectric devices.
NANENG 540	Microfluidics and Biochips Credits: 3 Prereq: BIOL 101 AND NANENG 301 AND (ENGR 218 OR ENGR 207N OR ENGR 207) Introduction to Microfluidics: Advantages of microfluidics, Types of microfluidic platforms, different applications. Particle manipulation on the microscale: Electrophoresis, Dielectrophoresis, Magnetophoresis, Optical tweezers. Microfabrication Technology: micromachining of silicon and polymeric chips, fabrication techniques. Components of Microfluidic Devices: miniaturized Systems, actuators, pumps, valves, micro-mixers, sensors, readout circuits, microfluidic chamber. Biodetection Techniques: optical, impedance, Flow Cytometry and Cell Sorting. Lab-on-CMOS (Biochips): advantages, parts, fabrication, applications and packaging.

Code	Description
NANENG 597	Selected topics in Nanotechnology Eng. Credits: 3 Selected coverage of topics specializing in different fields in nanotechnology and nanoscience e.g., modern quantum devices, spin-devices, junctionless devices, tunneling based device, predictive technology models. Printed electronics and their applications in solar cells, photovoltaics, lab-on-chip and other applications, biosensors.
NANENG 598	Senior Design Project I Credits: 1 The course will provide students with the opportunity to conduct a design project. They will be taught how to plan and execute experiments and how to analyze and write the data.
NANENG 599	Senior Design Project II Credits: 3 Prereq: NANENG 598 The student 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.
NANOSC 301	Spectroscopy of Nanomaterials Credits: 3 Prereq: PHYS 202 AND NANOSC 303 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 Coreq: NANOSC 312 Prereq: CHEM 102 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.

Code	Description
NANOSC 303	Quantum Mechanics Credits: 3 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 304	Emerging Nanomaterials Credits: 3 Prereq: CHEM 201 The course covers the development, characterizations and recent potential applications of a wide range of emerging nanomaterials including; graphene, fullerene, carbon nano-tubes, carbon nanofibers, polymeric nanoparticles, smart hydrogel particles, polymeric nanofibers, quantum dots, and self-assembled systems.
NANOSC 305	Synthesis/Fabrication of Nanomaterials Credits: 3 Coreq: NANOSC 315 Prereq: CHEM 201 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 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.

Code	Description
NANOSC 307	Nanosciences Research Lab Rotations Credits: 1 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 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 Prereq: CHEM 202 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 312	Modern Characterization Techniques Lab I Credits: 1 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.
NANOSC 313	Advanced Characterization Techniques Credits: 3 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 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.

Code	Description
NANOSC 322	Chemistry & Physics of Nanomaterials Credits: 3 Prereq: BMS 202 AND 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.
NANOSC 392	Introduction to Nanochemistry Credits: 3 Prereq: CHEM 202 AND BMS 339 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 Pass/FailAn 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 Prereq: NANOSC 305 This course defines the importance of the emerging science of Nanotoxicology,the importance of nanoparticle characterization in toxicity testing of nanomaterials, andthe physicochemical characteristics of various nanoparticles that mediate their toxicity.The course also focuses on toxicokinetics (ADME) and toxicodynamics ofnanostructures, as well their adverse impacts on various organs and systems inside thebody. 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 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.
NANOSC 403	Special Topics in Nanomedicine Credits: 3 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.

Code	Description
NANOSC 404	Principles of Pharmacology Credits: 3 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 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.
NANOSC 406	Nanomat for Reg Med Tissue Engin Credits: 3 Prereq: NANOSC 302 AND 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.

Code	Description
NANOSC 407	Special Topics in Bio-Nanotechnology Credits: 3 Prereq: NANOSC 305 AND BIOL 102 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 408	Synthetic Biology Credits: 3 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 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.
NANOSC 411	Bio-Nanotechnology Lab Credits: 1 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: 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.

Code	Description
NANOSC 413	Photonics & Laser Physics Credits: 3 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 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.
NANOSC 416	Modeling of Nano Materials Credits: 3 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 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 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.

Code	Description
NANOSC 421	Nanostructured Mat & Nanosc Thin Film Credits: 3 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 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.
NANOSC 425	Quantum Theory for Nanoscale Systems Credits: 3 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 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 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 428	Biological Nanomaterials Credits: 3 Prereq: NANOSC 304 AND BIOL 102 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.

Code	Description
NANOSC 431	Nanobiology Credits: 3 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.
NANOSC 433	Nano- & Biophotonics Credits: 3 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 497	Nanoscience Capstone Research Project C Nanoscience Capstone Research Project I Credits: 4 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.
NANOSC 498	Nanoscience Capstone Research Project Nanoscience Capstone Research Project II Credits: 3 Part 2 of NANSC 499 course for Nano Medicine students:This 6 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: 3 This 6 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.
PEU 204	Analytical Mechanics I Credits: 3 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.
PEU 205	Introduction to Astronomy Credits: 3 Prereq: PHYS 101 This course introduces students to the basic observational and theoretical methods, techniques and technical language of astronomy.

Code	Description
PEU 207	Earth & Atmospheric Sciences Credits: 3 This course covers the physics and chemistry of the Earth and its atmosphere. General principles of geology, including vulcanism, erosion processes, rock formation, classification and identification, along with geophysical flows in the atmosphere, transport and turbulence in the atmosphere, thermodynamic and chemical descriptions of gases, water vapor, lifting and convection, and applications to air pollution.
PEU 210	Advanced Electromagnetism Credits: 3 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.
PEU 218	Vector Calculus Credits: 3 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.
PEU 223	Rock and Minerals Credits: 3 This course covers the composition of the earth crust, definition of a rock and rocktypes. Definition of mineral –crystals and Crystallographic properties of minerals.Topics include: Genesis of minerals, physical and chemical properties of minerals,genesis and occurrence of minerals in nature, and classification of minerals.Systematic mineralogy and Crystallography: crystal morphology, crystal symmetry,crystal form, crystal aggregate, intercepted parameters and indices.
PEU 228	Vector Calculus Credits: 2 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.

Code	Description
PEU 304	Electrodynamics I Credits: 3 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.
PEU 308	Electrodynamics II Credits: 3 Prereq: PEU 304 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.
PEU 311	Thermal and Statistical Physics Credits: 3 Prereq: PHYS 201 - Boltzmann transport equation.Statistical physics permits us to predict the macroscopic properties of a many-body systemby 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.
PEU 315	Geophysics Credits: 3 Prereq: PEU 207 Gravitational description of Earth and its gravitational field, geomagnetism, seismology, geologic time and dating methods, experimental methods in geophysics, plate tectonics and seafloor spreading, oceanography, and applications, including oil exploration.

Code	Description
PEU 316	Mathematical Physics I Credits: 3 Mathematical methods of particular interest in physics, astronomy, and atmospheric science, including Fourier analysis, special functions, and Green's function.
PEU 323	Quantum Mechanics I Credits: 3 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.
PEU 326	Mathematical Physics II Credits: 3 Prereq: PEU 346 AND MATH 201 AND MATH 202 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.
PEU 327	Astronomy Laboratory Credits: 2 Prereq: PEU 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.
PEU 329	Earth & Atmospheric Sciences II Credits: 3 Prereq: PEU 207 This course covers the thermodynamics and hydrostatics of the atmosphere and introduces the methods of description and quantitative analysis used in meteorology. The governing equations of atmospheric flow from first principles and application to middle latitude and tropical meteorology are derived.
PEU 331	Stellar Structure Credits: 3 Prereq: PEU 205 This course covers the basics of main sequence stellar theory, with simple descriptions of star formation and end states.
PEU 340	Atmospheric Sciences Lab Credits: 2 This is a lab course involving a series of experiments in atmospheric physics

Code	Description
PEU 346	Mathematical Physics I Credits: 3 Prereq: MATH 202 Mathematical methods of particular interest in physics, astronomy, and atmospheric science, including Fourier analysis, special functions, and Green's functions.
PEU 348	Quantum Mechanics II Credits: 3 Prereq: PEU 323 This course is a continuation of Advanced Quantum Mechanics I, including Eigen functions, perturbation and scattering theory, and introduction to Quantum Field Theory.
PEU 356	Mathematical Physics II Credits: 4 Prereq: MATH 201 Note: This course code was previuosly PEU 326The 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.
PEU 364	Biological Physics Credits: 3 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.
PEU 399	Internship (For PHYSICS OF EARTH AND UNIVERSE PROGRAM) Credits: 2 Pass/FailExternal training in a national or international industry or research institution on any experimental, computational, or theoretical physics related project.
PEU 404	Senior Project Credits: 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.
PEU 405	Cosmology Credits: 3 Prereq: PEU 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.

Code	Description
PEU 407	Climatology & Climate Change Credits: 3 Prereq: PEU 207 This course covers the basic principles of climate and weather systems, forces contributing to the formation of local climate and local and global weather patterns, weather forecasting and applications to man-made and natural climate change.
PEU 412	Oceanography Credits: 3 Prereq: PEU 207 This course covers the structure, geography and physiography of the ocean basins, surface and subsurface circulation of ocean waters, and geophysics of the ocean basins, including volcanism, plate tectonics and sea floor spreading, interactions with the atmosphere and climate, hurricanes, monsoons, El Niño-La Niña oscillation, waves and tides, marine ecology, pollution and applications to climate change.
PEU 416	Galactic & Extragalactic Astronomy Credits: 3 Prereq: PEU 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.
PEU 420	The Solar System Credits: 3 Prereq: PEU 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.
PEU 422	Astrophysical Fluid Dynamics Credits: 3 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.
PEU 430	Quantum Mechanics III Credits: 3 Prereq: PEU 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.

Code	Description
PEU 431	Quantum Field Theory and Particle Phys Credits: 6 Prereq: PEU 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 usingFeynman diagramsThe 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
PEU 432	Advanced Dynamics Credits: 3 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.
PEU 438	Compact Objects & High Energy Astrophys Credits: 3 Prereq: PEU 205 This course covers the physics of neutron stars, pulsars, black holes and the active centers of galaxies; supernovae and gamma-ray bursts.
PEU 450	Computational Physics Credits: 3 Prereq: CSCI 101 This course covers the computational methods of special interest in physics, astronomy and atmospheric science.
PEU 453	Gravity & General Relativity Credits: 3 This course covers gravity and general relativity; dealing with spacetime; core principles of general relativity; and experimental evidence regarding the theory.
PEU 455	Mathematical Physics III Credits: 3 Prereq: PEU 316 This is a continuation of PEU 346, covering calculus of variations, integral equations, topology and group theory.
PHIL 101	Philosophical Thinking Credits: 3 This course introduces students to the concepts of logical thinking and the scientific method. Students will learn the process of thinking, decision making, logical operations and problem solving from psychological and philosophical perspectives.

Code	Description
PHIL 301	History & Philosophy of Science Credits: 2 This course introduces students to the logical and empirical foundations of modern science in philosophy. A range of philosophical positions regarding the role of empirical observation, controlled experiments, mathematics and symbolic logic will be considered, starting from classical Greece continuing to medieval Islamic thinkers and to modern day theories such as those of Popper and Kuhn. Contemporary debates regarding the relationships between gender, culture, economics and science will be analyzed with respect to underlying philosophical and epistemological assumptions. Participatory course activities will aim to develop critical thinking skills. The course focuses on logical reasoning and critical thinking. Students will learn how to assess arguments and think critically.
PHYS 101	Introduction to Classical Mechanics Credits: 3 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.
PHYS 102	Introduction to Electromagnetism Credits: 3 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 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 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 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.

Code	Description
PHYS 202	Modern Physics Credits: 3 Coreq: PHYS 212 Prereq: PHYS 201 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.
PHYS 211	Thermo, Wave Motion and Optics Lab Credits: 1 Coreq: PHYS 201 Laboratory course accompanying PHYS 201. Experiments in thermodynamics, waves, optics and fluid mechanics involving data collection and reporting, and error analysis.
PHYS 212	Modern Physics Lab Credits: 1 Coreq: PHYS 202 Laboratory course accompanying PHYS 202. Experiments in Modern Physics involving data collection and reporting, and error analysis.
REE 201	Renewable Energy Systems Credits: 2 In this course, students will learn about the operation and performance of a series of renewable energy technologies, including grid-connected wind turbines, photovoltaic systems, and solar hot water systems. A selection of such systems will be used to introduce students to energy engineering calculations and the availability of renewable energy sources. Emphasis will be placed on selecting and evaluating renewable energy equipment for given applications and integrating renewable energy sources into production, distribution and end-use systems.
REE 202	Mechanics of Materials Credits: 3 Prereq: MATH 102 AND PHYS 101 This course introduces the concepts of stresses in materials of elementary structures due to the axial, twisting, sheering, and bending loading.
REE 208	Engineering Dynamics Credits: 3 Prereq: MATH 102 AND PHYS 101 Basics of engineering dynamics. Kinematics of motion using vectors. Motion of projectiles. Kinetics: Newton's laws of motion. Momentum, Work and Energy conservation principles. Angular momentum and the motion of rigid bodies in the plane
REE 222	Introduction to Manufacturing Processes Credits: 3 The course introduces the major Production methods that include: Metal Casting, Metal Forming, Metal Joining Processes, Machining and Machine Tool Operations, Principles and applications of nontraditional machining, Metrology and Inspection, Powder Metallurgy, processing Polymers and Composites.

Code	Description
REE 302	Machine Design Credits: 3 Prereq: REE 202 AND MATSCI 201 AND REE 222 Introduction to Conceptual Design: design considerations, uncertainty, and reliability.Materials in design: material selection process, material failure limits. Loading andstress analysis, stiffness, and stress concentration. Fatigue failure of ductile and brittlematerials. Analysis of combined loading: Goodman diagram. Design of machineelements: shaft design, bearings.
REE 307	Fluid Mechanics II Credits: 3 Prereq: ENGR 207 An introduction to viscous flow in internal and external geometry. The course starts by a discussion of laminar and turbulent flows. This is followed by a review of viscous flow in pipes including the losses in valves and connections. This sets the stage for an analysis of pipe networks. This is followed by an introduction to unsteady flow in conduits. The derivation of Navier-Stokes equation and applying it to simple flows will be studied. Finally, the different type of boundary layer and their evolution will be studied. Finally, optimal estimation is considered to cover cases where noise or other reasons necessitate estimating the system states.
REE 308	Mechanical Vibrations Credits: 3 Prereq: REE 208 This course will introduce the student to the concepts of mechanical vibration applied to single degree of freedom systems, multiple degree of freedom systems and continuous structures including bars, beams, cables, and shafts. Then the student will be introduced to the concepts of vibration damping and control.
REE 309	Renewable Energy Systems Credits: 3 In this course, students will learn about the operation and performance of a series of renewable energy technologies, including grid-connected wind turbines, photovoltaic systems, and solar hot water systems. A selection of such systems will be used to introduce students to energy engineering calculations and the availability of renewable energy sources. Emphasis will be placed on selecting and evaluating renewable energy equipment for given applications and integrating renewable energy sources into production, distribution and end-use systems.
REE 310	Control Systems Credits: 3 Prereq: MATH 202 This course studies dynamic systems encountered in a variety of Renewable Energy and Power Plants systems. It will look at the modelling of such systems and the response of these systems to inputs, initial conditions and disturbances. It is of particular interest to analyse systems obtained as interconnections (e.g., feedback) of two or more other systems. In addition, the design of control systems that ensure desirable properties (e.g., stability, performance) of the interconnection with a given dynamic system using different design techniques will be studied.

Code	Description
REE 311	Electric Machines Credits: 3 Prereq: ENGR 201 AND MATH 202 This course begins by covering the fundamental theory of power converters and electrical machines, including energy storage and conversion; force and emf production; coupled circuit analysis of systems with both electrical and mechanical inputs; the electromechanical theory (magnetic systems, torque and force generation, multi-phase analysis); AC machines; and control mechanisms. The course also covers applications to specific control systems, including those being used in renewable energy systems.
REE 312	Machine Design II Credits: 3 Prereq: REE 302 Introduction to geometric dimensioning and tolerance specification, Design ofmachine elements: joints and fasteners, welded joints, gears, Clutches, brakes,couplings, flexible machine elements. Case study.
REE 322	Advanced Circuits Design Credits: 3 Prereq: ENGR 201 AND MATH 202 This course is based on deep understanding of aspects in active analog filter design students are equipped with the knowledge and skills to design, and to be in a good position to undertake further self-study as required. This course is conducted with theoretical study and design project practice. It covers the theory and design of active and passive analog filters including the followings: Fundamental concepts in circuit theory: network functions, characteristic frequencies; Types of filter: lowpass, bandpass, etc; Review of operational amplifiers; Design of first and second order filters using operational amplifiers; Cascade design; Typical filters: Butterworth, Chebyshev, etc; Frequency transformations in design; Sensitivity, etc.
REE 405	Electric Machines Credits: 3 Prereq: ENGR 201 AND MATH 202 This course begins by covering the fundamental theory of power converters and electrical machines, including energy storage and conversion; force and emf production; coupled circuit analysis of systems with both electrical and mechanical inputs; the electromechanical theory (magnetic systems, torque and force generation, multi-phase analysis); AC machines; and control mechanisms. The course also covers applications to specific control systems, including those being used in renewable energy systems.
REE 406	Advanced Thermodynamics Credits: 3 Prereq: ENGR 205 The course introduces advanced concepts and applications of engineering thermodynamics. The course starts by a general review on the first law and second law of thermodynamics as well as entropy. This is followed by exergy and second law analysis and the relation to real-life processes. Then, thermodynamic cycles (gas power cycles, vapor and combined cycles and refrigeration cycles) with practical considerations are discussed in details. Psychrometry and gas mixture engineering will be then studied leading to a study of chemical reactions of hydrocarbon fuels, first law analysis of reacting systems (including the analysis of enthalpy of formation), heat of reaction (including the study of adiabatic flame temperature).

Code	Description
REE 407	Aerodynamics Credits: 3 Prereq: REE 307 This course extends fluid mechanic concepts from Unified Engineering to the aerodynamic performance of wings and bodies in sub/supersonic regimes. Generally it four components: subsonic potential flows, including source/vortex panel methods; viscous flows, including laminar and turbulent boundary layers; aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/interacting boundary layer methods; and supersonic and hypersonic airfoil theory.
REE 409	Advanced Control Systems Credits: 3 Prereq: REE 310 This course will teach fundamentals of control design and analysis using state-space methods. This includes both the practical and theoretical aspects of the topic. We will introduce the design of feedback control systems as applied to a variety of systems. Topics include the properties and advantages of feedback systems. By the end of the course, you should be able to design controllers using state-space methods and evaluate whether these controllers are robust to some types of modeling errors and nonlinearities.
REE 411	Power Electronics Credits: 3 Prereq: REE 322 The course will demonstrate the basics of power semiconductor devices including: Principle of operation - Characteristics and modeling of power diodes, IGBTs, and power MOSFETs. The course will also cover the analysis of Phase controlled converters, DC/DC converters, single phase and three phase inverters. The analysis of these converters will include circuit analysis, circuit simulation, continuous mode of operation, dynamic modeling, and controller design for closed loop operation. Applications in power systems and renewable energy fields will be demonstrated.
REE 415	Power Plant Technology Credits: 3 Prereq: REE 406 This course provides a comprehensive overview of power plant fundamentals and the challenges and advantages of major electrical power generation unit types. A review of the principles of thermodynamics as well as the theory and design of fossil, nuclear, hydro, solar, and wind generation systems and related equipment will be addressed. Maintenance and operational requirements and special concerns involved in each type of generation are addressed. Options for future generation systems and the related advantageous choices each holds for future sources of electricity for Egypt will be studied. Research reports on the subject matter and sub-topics related to power generation are required of participants in this course.
REE 419	Power Systems Credits: 3 Prereq: REE 411 This course is an introduction to urban, suburban and rural electrical distribution systems, and the analysis of power flow in circuits and large systems. Topics will include power system control, power system stability, distribution transformers, estimation of load, load characteristics, groundings, earthing of distribution transformer, earthing resistance, earthing practice in L.V. networks, power factor, and fundamentals of illumination engineering.

Code	Description
REE 420	Power Electronics Credits: 3 Prereq: REE 322 The course will demonstrate the basics of power semiconductor devices including: Principle of operation - Characteristics and modeling of power diodes, IGBTs, and power MOSFETs. The course will also cover the analysis of Phase controlled converters, DC/DC converters, single phase and three phase inverters. The analysis of these converters will include circuit analysis, circuit simulation, continuous mode of operation, dynamic modeling, and controller design for closed loop operation. Applications in power systems and renewable energy fields will be demonstrated.
REE 421	System Engineering Credits: 2 System engineering is an interdisciplinary approach to the successful realisation of engineering systems. Systems engineering approaches the system design as whole composed of interacting parts. The design problem is successively decomposed to its basic components and the relation between these components is optimised to maximise system preformance through its lifetime. System engineering considers the complete range of processes involved in engineering systems from design through, operations, cost and schedule, performance, training and support, test, manufacturing, and disposal. This course provides an introduction to system engineering approaches using a structured approach. The course offers a wide overall view of all system engineering topics then focuses more narrowly on the project planning and management process. The student will be able at the end of the course to use system thinking effectively in conceiving and planning engineering projects.
REE 422	Optics and Photonics Credits: 3 Prereq: PHYS 102 AND MATH 202 The course provides introductory lectures on fundamental optical principles and phenomena, as well as photonic devices and systems. Fundamental principles will be accompanied by practical and contemporary examples. Students will develop the necessary mathematical skills regarding light interaction with different categories of material, optical wave-guides, polarization and optical components which are used in different systems to generate, modulate and detect light.
REE 428	Energy Storage Credits: 3 Prereq: REE 309 The hydrogen economy has been proposed as an alternative to hydrocarbons as the main source of energy for economic and societal needs. This course explores the vision and principles behind the concept of the hydrogen economy and the technologies that are being applied or proposed to produce and store hydrogen, including fuel cells, types of rechargeable batteries, lithium-ion battery technology, and methods of chemical and physical storage.

Code	Description
REE 430	Rotor Aerodynamics Credits: 3 Prereq: REE 407 The course considers the design of wind turbine rotors. The main emphasis will be on horizontal axis wind turbines. Extension of the theory to other types of machines such as tidal generators and vertical axis wind turbines will be briefly discussed. The course covers basic aerodynamic theory including blade element momentum theory and its corrections. The course also covers the calculation of blade loads, and the preliminary sizing of the blade structure. The modelling of wind resources using statistical methods is addressed at multiple time and length scales. The students are able by the end of the course to analyse wind turbine rotors and predict their torque and power characteristics and their structural integrity.
REE 466	Machine Design Credits: 3 Prereq: ENGR 221 Introduction to Conceptual Design: design considerations, uncertainty, and reliability.Materials in design: material selection process, material failure limits. Loading andstress analysis, stiffness, and stress concentration. Fatigue failure of ductile and brittlematerials. Analysis of combined loading: Goodman diagram. Design of machineelements: shaft design, bearings.
REE 470	Computer-Aided Design and Engineering Credits: 3 Prereq: REE 312 This course allow the student to have hands on experience on computer aided design (CAD) for mechanical engineering applications, it employs commercial software such as solidWorks, ANSYS, COMSOL, for developing 3D models, professional mechanical drawings. The student will also learn to utilize finite element analysis and computational fluid dynamics techniques to analyze design performance and drive design enhancements.
REE 501	Sustainable Energy Development Credits: 2 This class assesses current and potential future energy systems, covering resources, extraction, conversion, and end-use technologies, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner. Instructors and guest lecturers will examine various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in different countries. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology system proposals in the context of engineering, political, social, economic, and environmental goals. Students taking the graduate version, Sustainable Energy, complete additional assignments.
REE 503	Renewable Energy Law and Economics Credits: 2 Prereq: REE 534 OR EBE 411 In response to depleting natural resources and heightened environmental awareness, many countries are now seeking to redefine their energy mix. Several energy sources are available: coal and oil, natural gas, and a variety of renewable energy sources such as solar and wind and biomass. The selection and achievement of the energy mix that best meets core energy-related concerns: reliability, security, affordability, fairness, and sustainability poses complex not only technical but also legal and economic questions. This course introduces the students to questions of legal regulation of the energy market and to the art and science of evaluating various energy generation proposals from a realistic, market, point of view.

Code	Description
REE 506	Carbon Dioxide Sequestration Credits: 2 Prereq: PEU 311 OR ENV 346 This course covers the technologies used for carbon dioxide disposal and the engineering issues concerned with their implementation, as well as the resultant economic and environmental impacts. It also covers the physical and chemical properties of carbon dioxide and carbon containing materials; fluid and non-aqueous phase equilibria; hydrates; and compressor design and operation. The course introduces students to the natural carbon cycle and the effects of human intervention within the context of present and future carbon management strategies. The course also discusses how plants can be used to sequester carbon.
REE 515	Thermal Solar Energy Credits: 3 Prereq: REE 415 This course provides a comprehensive overview of Thermal Solar Energy fundamentals and its different application for heating, steam production and power generation. Different solar concentration technologies and equipment regarding the collectors, receivers and the working fluid will be addressed. Lectures will cover commercial and emerging Thermal Solar Energy technologies and cross-cutting themes, including conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis.
REE 517	Renewable Resources Management Credits: 2 Prereq: REE 322 This course focuses on the management of soil, water, plants, and animals as renewable natural resources in an integrated ecosystem context; and practices used to protect water, wood, forage, wildlife and other renewable resources and to mitigate the adverse impacts of energy and land-use on the environment. The course introduces sustainable practices in forestry and agriculture as sources for bioenergy carriers.
REE 520	Wind Energy Credits: 2 Prereq: MATH 202 AND ENV 346 This course introduces the basic science behind the meteorology of wind; extraction of energy from wind, and physical wind modeling. In addition, the course covers the design and development of wind plants, with emphasis on wind turbine aerodynamics and design, and applications to wind farm and wind energy grids.
REE 521	Smart Grid Credits: 3 Prereq: REE 419 This course will introduce the main aspects of integrating renewable power plants into power systems. The challenges facing the increase of the renewables penetration level in the power system will be covered including for example the frequency and voltage stability. The students will be exposed to the grid code requirements for renewable power integration established by system operators to maintain the acceptable operation of the power system. The course will also introduce the concepts of distributed generation and smart micro-grids to demonstrate the challenges facing the operation and control of such systems. Finally, the electrical design of renewable power plants and the needed studies to show grid code compliance will be demonstrated.

Code	Description
REE 522	Geothermal Energy Credits: 2 Prereq: PEU 207 This course starts with the structure and composition of the earth and how heat is transferred, generated and stored naturally. It also introduces plate tectonic theory. The course then covers the layout, design and operation of geothermal systems, including heat pumps and ground source heat systems; pond and lake-based systems; ground heat exchanger configurations; building heating and cooling loads; soil thermal conductivity; pressure drop calculations; pump, and fluid selection; and air and debris purging.
REE 523	Dynamics and Control of Renew Power Gen Credits: 2 Prereq: REE 419 AND REE 406 In this course the fundamentals of the different renewable power generation technologies will be demonstrated. The course will cover the commercially available technologies for wind power and solar power. The focus will be put on the dynamics and control of such systems to demonstrate the interaction between the different components of the generator system. One major building block in these systems is the voltage source converter and therefore emphasis will be put on the modeling, dynamics and control of such a power electronics based system. This course can be considered as the application of the fundamentals taught in the electric machines course (REE405) and the power electronics course (REE420) for renewable power generation.”
REE 524	Hydroelectric, Tidal and Wave Energy Credits: 2 Prereq: ENV 346 This course covers water hydraulics and principles of fluid statics, the hydrologic cycle and hydrodynamics as applied to hydropower generation. The conservation of energy principle is used to establish the conditions that need to be considered in the selection of a hydropower generation system. Analysis of hydraulic head, flow rates and power; river discharge and flow duration curves; turbine selection and efficiency; and planning and design issues are also covered.
REE 525	Geothermal Energy Credits: 2 Prereq: REE 410 AND ENGR 207 This course starts with the structure and composition of the earth and how heat is transferred, generated and stored naturally. Plate tectonic theory is introduced. The course then covers the layout, design and operation of geothermal systems, including heat pumps and ground source heat systems, pond and lake-based systems, ground heat exchanger configurations, building heating and cooling loads, soil thermal conductivity, pressure drop calculations, pump, and fluid selection and air and debris purging.
REE 526	Bio-Fuels & Bio Mass Credits: 2 Prereq: BIOL 102 AND (PHYS 201 OR CHEM 202) This course covers the chemistry and biochemistry of various forms of biofuel technologies, such as biomass, biodiesel, biomethane, bioethanol and biohydrogen; bioenergy systems; direct biomass combustion and co-firing; gasification and pyrolysis; wood biomass energy; grass energy; and algae biofuel. The course also assesses the sustainability, and environmental and economic impact of each form.

Code	Description
REE 528	Propane, Natural Gas & Bio Gas Credits: 2 Prereq: REE 301 The course covers the principles and problems involved in the mining, transport, conversion and storage of natural gas and propane as energy sources.
REE 530	Nuclear Energy Credits: 2 Prereq: PHYS 202 AND CHEM 202 This course is intended to understand the engineering design of nuclear power plants using the basic principles of reactor physics, thermodynamics, fluid flow and heat transfer. Lectures will include the following: Reactor designs, Thermal analysis of nuclear fuel, Reactor coolant flow and heat transfer, Power conversion cycles, Nuclear safety and Reactor dynamic behavior.
REE 532	Photovoltaic Systems Credits: 3 Prereq: REE 422 In this course, students learn about the fundamentals of photoelectric conversion: charge excitation, conduction, separation, and collection. Lectures cover commercial and emerging photovoltaic technologies and cross-cutting themes, including conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis. Some of the course will also be devoted to discussing photovoltaic technology evolution in the context of markets, policies, society, and environment.
REE 534	Electric Power Generation, Distribution and Utilization Credits: 2 Prereq: REE 406 This course is an introduction to urban, suburban and rural electrical distribution systems, and the analysis of power flow in circuits and large systems. Topics will include power system control, power system stability, distribution transformers, estimation of load, load characteristics, groundings, earthing of distribution transformer, earthing resistance, earthing practice in L.V. networks, power factor, and fundamentals of illumination engineering.
REE 540	Renewable Energy Economic Analysis and Feasibility Study Credits: 2 Prereq: REE 309 This course prepares students for the systematic evaluation of the costs and benefits associated with proposed technical projects. Concepts include the “time value of money” and the methods of discounted cash flow; engineering costs and cost estimates; interest and equivalence; present worth, cash flow, and rate of return analysis; uncertainty in future events; depreciation; inflation; and replacement analysis.
REE 543	Energy Conservation & Efficiency Credits: 2 Prereq: REE 534 AND REE 411 OR EBE 411 This course provides students with a foundation level of understanding of electrical energy use and losses, introduces the tools required for electrical energy analysis and management, and presents case studies of latest industry practice in energy efficiency improvements. This course also focuses on providing state-of-the-art knowledge of energy efficiency management strategies and technology options for improving electrical energy utilization in the residential, commercial and industrial sectors where special attention is given to process optimization, energy conservation and waste energy recovery.

Code	Description
REE 555	Turbine Blade Design Credits: 2 Prereq: REE 466 AND SPC 408 The course considers the design of turbine blades. The main emphasis will be on horizontal axis wind turbines. Extension of the theory to other types of machines such as tidal generators and vertical axis wind turbines will be briefly discussed. The design of a turbine blade is a multidisciplinary problem that involves: aerodynamics, structures and materials, and control. Moreover some understanding of the characteristics of wind (in the case of wind turbines), or water currents (in the case of tidal machines) is prerequisite. The course covers basic aerodynamic theory including blade element momentum theory and its corrections. The course also covers the calculation of blade loads, and the preliminary sizing of the blade structure. The modelling of wind resources using statistical methods is addressed at multiple time and length scales. The students are able by the end of the course to analyse wind turbine blades and predict their torque and power characteristics and their structural integrity.
REE 560	Special Topics in Adv Generator Control Credits: 2 In this course the fundamentals of the different renewable power generation technologies will be demonstrated. The course will cover the commercially available technologies for wind power and solar power. The focus will be put on the dynamics and control of such systems to demonstrate the interaction between the different components of the generator system. One major building block in these systems is the voltage source converter and therefore emphasis will be put on the modeling, dynamics and control of such a power electronics based system. This course can be considered as the application of the fundamentals taught in the electric machines course (REE405) and the power electronics course (REE420) for renewable power generation.
REE 561	Special Topics in Adv Thermal Systems Credits: 2 The course introduces fundamental concepts and applications of solar thermal energy conversion. The course starts by a general introduction on solar radiation, solar geometry, irradiance models and meteorological data analyses. Techniques of measuring solar radiation are also included. This is followed by studies and analyses of different types of solar collection systems (non-concentrating and concentrating collectors) and the relation to applications. Finally, some attractive applications are introduced; solar water heating systems, solar cooling and dehumidification systems, solar thermal desalination systems and solar food drying systems.
REE 577	Electric Vehicles Credits: 2 Prereq: REE 419 This course considers the design and control of power converters in electric drive vehicles. The course includes an overview of system architectures and covers system-level dynamic modelling and control using MATLAB/Simulink at levels appropriate to determine requirements and validate the performance of switched-mode power converters in the vehicle system. Analysis, modelling and design of switched-mode power converters in electric-drive vehicle systems are then covered, including battery DC-DC converters, battery management electronics, motor drive inverters and battery chargers.
REE 590	Selected Topics in Renewable Energy Eng Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different

Code	Description
REE 598	Senior Design Project I Credits: 1 Students must undertake an independent Renewable Energy Engineering design or experimental project during the last two terms of their program. The purpose of the project is to demonstrate students' abilities to practise in a Renewable Energy Engineering capacity in their chosen area of expertise, using knowledge gained from their academic and employment experiences. The first part of the project (REE 598) will include problem identification, generation and selection of solutions and time management. Incorporation of technical, social, political and economic issues in the solution for the project will be required. A basic requirement of the proposed solution is that it must be compatible with the principles of sustainability. Requirements include: proposal, progress report, and a final report containing recommendations for part two of the project.
REE 599	Senior Design Project II Credits: 3 Prereq: REE 598 As a continuation of REE 598, the final design of the major Renewable Energy Engineering project proposed in REE 598 will be undertaken. The purpose of this phase of the project is to carry out a detailed technical design of the solution proposed in REE 598. A final report that covers all activities carried out in this two-term project is a must.
SCH 201	World Literature Credits: 2 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.
SCH 202	Music Aesthetics Credits: 2 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 203	Entrepreneurship & Small Busin Mgmt Credits: 3 Prereq: ENGL 201 OR ENGL 101 The course is designed to provide preliminary guidance for entrepreneurs to creating a business plan.
SCH 205	Arabic Creative Writing Credits: 2 The writing class aims at facilitating self expression through creative writing. The class will focus on writing short stories, reading and discussing artistic works in both Arabic and English. Students are expected to submit a collection of short stories by the end of the semester.

Code	Description
SCH 206	Introduction to Visual Arts Credits: 2 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 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 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.
SCH 233	Engineering Economical Analysis Credits: 3 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.

Code	Description
SCH 234	History and Philosophy of Science Credits: 3 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 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.
SCH 244	Leadership & Professionalism Credits: 2 The Leadership and Professionalism Course is an elective credit course intended to introduce Zewail City students to the basics of Leadership. The students get to review the major Leadership Theories, focusing on the Relational Leadership Model. The students are then taken into a journey of exploring self and others. The course, then, tackles some crucial topics in relation to leadership including: effective communication, group dynamics, decision making, problem-solving, conflict resolution and change. Finally, the LAP course helps students understand their role as change agents who can make a difference in the world around them.
SCH 258	Arabic Literature Credits: 2 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.

Code	Description
SCH 260	Philosophical Thinking Credits: 2 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.

Code	Description
SCH 261	Engineering Project Management Credits: 2 This course prepares students for a professional role in the management of engineering projects by providing students with an understanding of both the people-related and technical requirements necessary for the successful management of engineering projects, as well as the organizational and strategic aspects. The course also stresses the processes that are used to produce, process and service engineering-based innovation projects from idea through relevant analyses to launch, relate innovation to improvements in products, processes and competitive advantage and explain how intellectual property is protected and exploited.
SCH 262	Engineering Project Economics Credits: 2 This course aims at providing students with essential concepts of Engineering Project Economics. Topics covered include: Making Economic Decisions, Engineering Costs and Cost Estimating, Interest and Equivalence, Common Interest Formulae, Present Worth Analysis, Rate of Return Analysis, Inflation and Price Change. The course also introduces macro and microeconomic factors that affects small and medium size engineering projects.
SCH 263	Engineering Ethics and Safety Credits: 2 The course will cover ethical, environmental, and safety issues surrounding engineering projects. It will provide a foundation for thinking about and recognizing the ethical, and legal dimensions of a variety of professional settings. We will become familiar with current ethical debates in a range of scientific fields. Topics will include: misconduct in research, conflicts of interest and scientific objectivity, publication and peer review, intellectual property, and ethical decision making.The second part of the course will cover safety issues, risk assessment and how scientists should handle biological and chemical waste, in relation to national and international safety regulation. Students will engage these issues with the help of practical and theoretical tools, apply these tools to case studies, and be challenged to think broadly about the role of scientists in society as well as learn how to critically assess the ethical consequences of science for humankind.
SCH 264	Introduction to Entrepreneurship and Small Business Management Credits: 2 The course is designed to provide preliminary guidance for entrepreneurs to understand business nature, spot business opportunities, conduct market research, make a marketing plan and put pricing strategies of products, work on financial aspects of the business plans, and create business plans.
SCH 265	Geography of Egypt Credits: 2 The purpose of this course is to introduce students to basic geographic concepts as well as topics on both human and physical geography. Students will be able to use research and analytic skills to evaluate and apply theories and methodologies with emphasis on the geography of Egypt. Students will use inductive and deductive logic skills to deconstruct cultural components and historical evolution, as well as gain an understanding of basic earth science concepts.
SCH 266	Sociology Credits: 2 This course introduces the scientific study of human society, culture, and social interactions. Topics include socialization, research methods, diversity and inequality, cooperation and conflict, social change, social institutions, and organizations. Upon completion, students should be able to demonstrate knowledge of sociological concepts as they apply to the interplay among individuals, groups, and societies.

Code	Description
SCH 273	Cognitive Psychology Credits: 2 The aim of this course is; first to know about one own self, second to be familiar with cognitive psychological concepts, theories, processes and operations that take place within us, how these processes affect our behaviours, to expand the student knowledge in cognitive fields which mainly address mental abilities, help understand these abilities and introduce ways to develop them. 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 cognitive psychology, you will study psychology as a science, our behaviour 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' behaviour. It also help us analysing our past, life our present and plan and have positive anticipation of our future.
SCH 277	Positive Psychology Credits: 2 This course aims to study what is right with people and what makes life worth living, the conditions and processes that contribute to the flourishing or optimal functioning of people, groups and institutions and encompasses the study of positive experiences, positive character strengths, positive relationships, and the institutions and practices that facilitate their development. Positive experiences include the mental states of flow and mindfulness and emotions about the present (pleasure, contentment, laughter), past (e.g., nostalgia, satisfaction, pride), and future (e.g., hope, optimism). The distinction among the pleasant life, the good life, and the meaningful life will be drawn. The positive character traits include wisdom, courage, compassion, love, humanity, justice, temperance, self-efficacy, resilience, grit, imagination, creativity, spirituality/transcendence and positive relationships include the factors that enhance meaning and well-being among couples, family, friends, co-workers, and the community.
SCI/ENGR 100	Science & Technology Seminar Credits: 1 The topics of the seminar vary from semester to semester. Students will be exposed to different fields of science, engineering, and technology. Students required to register for SCI 100 either during the Fall or Spring semester.
SCI/ENGR 200	Science & Technology Seminar Credits: 1 Prereq: SCI/ENGR 100 The topics of the seminar vary from semester to semester. Students will be exposed to different fields of science, engineering, and technology. Students required to register for SCI 200 either during the Fall or Spring semester.

Code	Description
SCI/ENGR 300	Science & Technology Seminar Credits: 1 Prereq: SCI/ENGR 200 The topics of the seminar vary from semester to semester. Students will be exposed to different fields of science, engineering, and technology. Students required to register for SCI 300 either during the Fall or Spring semester.
SCI/ENGR 400	Science and Technology Seminar Credits: 1 Prereq: SCI/ENGR 300 The topics of the seminar vary from semester to semester. Students will be exposed to different fields of science, engineering, and technology. Students required to register for SCI 400 either during the Fall or Spring semester.
SCI/ENGR 500	Science & Technology Seminar Credits: 1 Prereq: SCI/ENGR 400 The topics of the seminar vary from semester to semester. Students will be exposed to different fields of science, engineering, and technology. Students required to register for SCI 500 either during the Fall or Spring semester.
SPC 201	Introduction to Aerospace Engineering Credits: 2 This course is intended as an introduction to the topics of Aerospace Engineering and Flight Mechanics. It lays the foundations for understanding the relationship between different aerospace subsystems; aerodynamics, control, structure, and propulsion.
SPC 202	Mechanics of Materials Credits: 3 Prereq: MATH 102 AND PHYS 101 This course introduces the concepts of stresses in materials of elementary structures due to the axial, twisting, sheering, and bending loading.
SPC 218	Dynamics of Particles & Rigid Bodies Credits: 3 Prereq: PHYS 101 AND MATH 102 This course is intended to introduce the student to the fundamentals of dynamics of particles and rigid bodies. In this course the learner will acquire knowledge about kinematics and kinetics using the Newtonian and energy approaches. It serves as a foundation for the dynamics of space vehicles and robotics.
SPC 227	Analog & Digital Electronics Credits: 3 Prereq: ENGR 201 Circuit analysis fundamentals. Analog and digital microelectronic circuits and systems. Operational amplifiers, diodes, BJT, FETs. Frequency response, feedback circuits and amplifiers under large signals. Digital circuits combinational and sequential - Bipolar and MOS families. (includes lab)
SPC 228	Engineering Dynamics Credits: 3 Prereq: MATH 102 AND PHYS 101 Basics of engineering dynamics. Kinematics of motion using vectors. Motion of projectiles. Kinetics: Newton's laws of motion. Momentum, Work and Energy conservation principles. Angular momentum and the motion of rigid bodies in the plane

Code	Description
SPC 303	Remote Sensing & Instrumentation Credits: 2 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
SPC 304	Orbital & Space Flight Mechanics Credits: 2 Prereq: SPC 218 This course covers the fundamentals of astrodynamics, focusing on the two-body orbital initial-value and boundary-value problems with applications to space vehicle navigation and guidance for lunar and planetary missions, including both powered flight and midcourse maneuvers. Other topics include celestial mechanics, Kepler's problem, Lambert's problem, orbit determination, multi-body methods, mission planning, and recursive algorithms for space navigation. Selected applications from the Apollo, Space Shuttle, and Mars exploration programs are also discussed.
SPC 307	Aerodynamics Credits: 3 Prereq: ENGR 207 This course extends fluid mechanic concepts from Unified Engineering to the aerodynamic performance of wings and bodies in sub/supersonic regimes. Generally it four components: subsonic potential flows, including source/vortex panel methods; viscous flows, including laminar and turbulent boundary layers; aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/interacting boundary layer methods; and supersonic and hypersonic airfoil theory.
SPC 308	Supersonic & Hypersonic Fluid Dynamics Credits: 3 Prereq: SPC 307 The course begins with the basics of compressible fluid dynamics, including governing equations, thermodynamic context and characteristic parameters. The next large block of lectures covers quasi-one-dimensional flow, followed by a discussion of disturbances and unsteady flows. The second half of the course comprises gas dynamic discontinuities, including shock waves and detonations, and concludes with another large block dealing with two-dimensional flows, both linear and non-linear
SPC 309	Mechanics of Materials Credits: 3 Prereq: MATH 102 AND PHYS 101 This course introduces the concepts of stresses in materials of elementary structures due to the axial, twisting, sheering, and bending loading.
SPC 316	Aerospace Vehicles Structural Analysis & Design Credits: 3 Prereq: SPC 309 This course introduced intermediate concepts in structural analysis as applied to aerospace vehicles. The use of energy principles to solve structural problems as well as the application of the concepts of the theory of elasticity are introduced. The course will describe techniques used to analyze and design complex cross section of wings and bodies of aerospace vehicles.

Code	Description
SPC 317	Fluid Mechanics II Credits: 3 Prereq: ENGR 207 An introduction to viscous flow in internal and external geometry. The course starts by a discussion of laminar and turbulent flows. This is followed by a review of viscous flow in pipes including the losses in valves and connections. This sets the stage for an analysis of pipe networks. This is followed by an introduction to unsteady flow in conduits. The derivation of Navier-Stokes equation and applying it to simple flows will be studied. Finally, the different type of boundary layer and their evolution will be studied. Finally, optimal estimation is considered to cover cases where noise or other reasons necessitate estimating the system states.
SPC 318	System Modeling & Linear Systems Credits: 3 Prereq: MATH 202 This course introduces the design of feedback control systems as applied to a variety of air and spacecraft systems. Topics include the properties and advantages of feedback systems, time-domain and frequency-domain performance measures, stability and degree of stability, the Root locus method, Nyquist criterion, frequency-domain design, and state space methods.
SPC 328	Classical & Modern Control Credits: 3 Prereq: SPC 318 This course will teach fundamentals of control design and analysis using state-space methods. This includes both the practical and theoretical aspects of the topic. By the end of the course, you should be able to design controllers using state-space methods and evaluate whether these controllers are robust to some types of modeling errors and non-linearities. You will learn to:Design controllers using state-space methods and analyze using classical tools.Understand impact of implementation issues (non-linearity, delay).Indicate the robustness of your control design.Linearize a nonlinear system, and analyze stability.
SPC 338	Sensor Technology Credits: 2 The course provides an introduction to sensors systems and a variety of sensors that are used in engineering practice. The course starts by reviewing electronics for sensors signal conditioning, then the lectures cover the principles and operation of a variety of sensors and sensor architectures, describing the theory of operation, characteristics, limitations, and applications of a selected examples of physical, optical and chemical sensors. Simple sensor processing algorithms and wired and wireless network systems are also introduced
SPC 392	Heat Transfer and Combustion Credits: 3 Prereq: (ENGR 332 OR ENGR 205) AND ENGR 207 Heat Transfer: Introduction, steady heat conduction, thermal boundary layers, external forced convection, internal forced convection, heat radiation, design of heat exchanger, applications, and special problems related to satellite thermal control.Combustion: chemical reactions for hydrocarbon fuels, chemical equilibrium, enthalpy of formation, heat of reaction, adiabatic flame temperature, chemical kinetics.

Code	Description
SPC 406	Advanced Thermodynamics Credits: 3 Prereq: ENGR 205 The course introduces advanced concepts and applications of engineering thermodynamics. The course starts by a general review on the first law and second law of thermodynamics as well as entropy. This is followed by exergy and second law analysis and the relation to real-life processes. Then, thermodynamic cycles (gas power cycles, vapor and combined cycles and refrigeration cycles) with practical considerations are discussed in details. Psychrometry and gas mixture engineering will be then studied leading to a study of chemical reactions of hydrocarbon fuels, first law analysis of reacting systems (including the analysis of enthalpy of formation), heat of reaction (including the study of adiabatic flame temperature).
SPC 407	Aerodynamics Credits: 3 Prereq: REE 307 OR SPC 317 This course extends fluid mechanic concepts from Unified Engineering to the aerodynamic performance of wings and bodies in sub/supersonic regimes. Generally it four components: subsonic potential flows, including source/vortex panel methods; viscous flows, including laminar and turbulent boundary layers; aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/interacting boundary layer methods; and supersonic and hypersonic airfoil theory.
SPC 408	Dynamics of Aerospace Structures Credits: 3 Prereq: SPC 309 This course will introduce the student to the concepts of mechanical vibration applied to single degree of freedom systems, multiple degree of freedom systems and continuous structures including bars, beams, cables, and shafts. Then the student will be introduced to the concepts of vibration damping and control.
SPC 409	Flight Dynamics & Control Credits: 3 Prereq: REE 409 OR SPC 328 This class includes a brief review of applied aerodynamics and modern approaches in aircraft stability and control. Topics covered include static stability and trim; stability derivatives and characteristic longitudinal and lateral-directional motions; and physical effects of the wing, fuselage, and tail on aircraft motion. Control methods and systems are discussed, with emphasis on flight vehicle stabilization by classical and modern control techniques; time and frequency domain analysis of control system performance.
SPC 410	Gas Dynamics Credits: 3 Prereq: ENGR 205 AND ENGR 207 The course begins with the basics of compressible fluid dynamics, including governing equations, thermodynamic context and characteristic parameters. The next large block of lectures covers quasi-one-dimensional flow, followed by a discussion of disturbances and unsteady flows. The second half of the course comprises gas dynamic discontinuities, including shock waves and detonations, and concludes with another large block dealing with two-dimensional flows, both linear and non-linear

Code	Description
SPC 413	Attitude Determination and Control Credits: 2 Prereq: SPC 218 Vector kinematics are applied to translation and rotation of rigid bodies. Newtonian and Lagrangian methods are used to formulate and solve equations of motion. Additional numerical methods are presented for solving rigid body dynamics problems. Examples and problems describe applications to aircraft flight dynamics and spacecraft attitude dynamics.
SPC 415	Thin Walled Sturectures Credits: 3 Prereq: SPC 202 OR SPC 309 OR REE 202 This course introduced intermediate concepts in structural analysis as applied to aerospace vehicles. The use of energy principles to solve structural problems as well as the application of the concepts of the theory of elasticity are introduced. The course will describe techniques used to analyze and design complex cross section of wings and bodies of aerospace vehicles.
SPC 417	Gas Turbine Engines Credits: 3 Prereq: SPC 410 AND (SPC 406 OR REE 406) This course presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations along with requirements and limitations that constrain design choices. Both air-breathing and rocket engines are covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions are presented.
SPC 418	Control Systems Design for Autonomous Vehicles Credits: 2 Prereq: SPC 328 This course covers the fundamentals of autonomous vehicle design and control, whilst enabling the students to specialize in appropriate subject areas via optional modules and an individual research project. The different subject areas include autonomous airborne vehicles, which have numerous existing and potential applications including search and surveillance, mapping crop-spraying, environmental and weather monitoring. Autonomous ground vehicles have very diverse applications such as factory automation and mine clearance. The course will utilize the fundamentals of design of feedback control systems. Properties and advantages of feedback systems. Time-domain and frequency-domain performance measures. Stability and degree of stability. Root locus method, Nyquist criterion, frequency-domain design, and some state space methods. Strong emphasis on the synthesis of full classical and digital controllers, towards full vehicle autonomy. Application to a variety of aerospace systems, hands-on experiments using underwater and airborne robotic systems.
SPC 419	Turbomachinery Credits: 2 Prereq: SPC 308 The course principles are based on a synergized foundations between thermodynamics and fluid mechanics. In the course, the energy transfer mechanisms and theory of operation of the design point analysis and off-design performance are covered. The preliminary designs of compressors and turbines for gas turbine engines are considered with an emphasis on the matching process of their operating conditions.

Code	Description
SPC 424	Spacecraft and Space System Design Credits: 2 This design course focuses on the analysis and design of complex space systems, including mission analysis, space environment interactions, trajectory design, mission geometry, ground system and spacecraft subsystem architecture and design. Particular emphasis will be given to the principle design aspects of communication, power, guidance and navigation, avionics and attitude subsystems. Student teams will be responsible for designing a satellite or space platform from conception to critical design review.
SPC 428	Mechatronics and Robotics Credits: 3 Prereq: SPC 318 This course presents an overview of robotics in practice and research with topics including vision, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors. In course projects, students construct robots that are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students nominally work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. This course will also expose students to some of the contemporary happenings in robotics, which includes current robot lab research, applications, robot contests and robots in the news.
SPC 435	Aerospace Communication Systems Credits: 3 Prereq: CIE 327 The course aims at introducing the students to the fundamentals of telecommunication systems in general, with applicatios from the aerospace industry. Topics covered in this course include: the building blocks of communication systems, various amplitude modulation, frequency modulation and phase modulation techniques. The course also covers the sampling theorem, pulse modulation, uniform and non-uniform quantization, and pulse code modulation. The course also includes an introduction to the general characteristics of communication channels, and their effect on aerospace communications.
SPC 470	Computer-Aided Design and Engineering Credits: 3 Prereq: REE 312 This course allow the student to have hands on experience on computer aided design (CAD) for mechanical engineering applications, it employs commercial software such as solidWorks, ANSYS, COMSOL, for developing 3D models, professional mechanical drawings. The student will also learn to utilize finite element analysis and computational fluid dynamics techniques to analyze design performance and drive design enhancements.
SPC 472	Machine Intelligence Credits: 2 The course will introduce the basic ideas and techniques underlying the design of intelligent computer systems. It focuses on Behavior from Computation and will cover the following areas:Statistical and decision–theoretic modeling paradigm. By the end of this course, you will have built autonomous agents that efficiently make decisions in stochastic and in adversarial settings.Reasoning and Learning. With this additional machinery your agents will be able to draw inferences in uncertain environments and optimize actions for arbitrary reward structures. Your machine learning algorithms will classify handwritten digits and photographs.Applications for a wide variety of artificial intelligence problems. The techniques you learn in this course will serve as the foundation for further study in any application area you choose to pursue.

Code	Description
SPC 491	Jet Propulsion Credits: 3 Prereq: (ENGR 332 OR ENGR 205) AND SPC 308 This course presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations along with requirements and limitations that constrain design choices. Both air-breathing and rocket engines are covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions are presented.
SPC 504	Optimal Control Credits: 2 Prereq: SPC 328 OR REE 409 An introduction to optimal control theory. The course starts by a discussion of calculus of variations. This is followed by a review of variational methods in mechanics (Lagrange equations, Hamilton's equations and the Hamilton-Jacobi equations). This sets the stage for an exposition of optimal control of dynamical systems using dynamic programming and Pontryagin's maximum principle. The primary application will be to linear state space systems for which optimal control indicates the necessity of full state feedback. Finally, optimal estimation is considered to cover cases where noise or other reasons necessitate estimating the system states.
SPC 506	Computational Fluid Dynamics Credits: 2 Prereq: SPC 308 The course is an introductory course to computational fluid dynamics for undergraduate students. Finite difference method will be used to solve different type of Partial Differential Equations (PDEs) that descript different fluid dynamics and heat transfer problems. Several model equations will be considered for finite difference discretization, stability and error analysis. Solution schemes and boundary conditions treatment will be selected based on the PDEs classification. Scalar form of Navier-Stokes (NS) equations will be solved along with two-dimensional incompressible NS equations.
SPC 508	Experimental Aerodynamics Credits: 2 Prereq: SPC 307 The purpose of this course is to introduce the student to different aerodynamic testing strategies along with the measurement techniques for pressure, forces, moments, and velocities associated with low-speed wind tunnel testing. The course prepares the student to plan, design, and conduct experiments then analyze, evaluate, and present experimental data.

Code	Description
SPC 509	Aircraft Conceptual Design Credits: 2 The conceptual design of aircraft focuses on system level analysis and sizing of aircraft to meet stringent mission requirements. This is particularly important given the recent trends towards limiting carbon footprint and noise levels generated by air flight. The design approach works by integrating new technologies and systems with traditional and advanced configurations. The sizing procedure would consider the usual disciplines of aircraft design: materials and structures, control and avionics, propulsion systems and foremost aerodynamic configuration. The course makes airworthiness compliance ensuring designs satisfy the safety requirements of certification authorities- is a central concern in developing the course material. The students will be exposed to a systematic approach of sizing aircraft systems and selecting components based on a combination of airworthiness requirements, detailed system modelling and empirical correlations gleaned from analysis of existing aircraft in the same class. At the conclusion of the course students will be able to specify mission requirements, satisfy airworthiness regulations and come up with a complete baseline concept for an aircraft.
SPC 510	Low Speed Aerodynamics Credits: 2 Prereq: SPC 307 For most practical aerodynamic and hydrodynamic problems, the classical model of a thin viscous boundary layer along the surface, surrounded by a mainly inviscid flow, is the cornerstone of design practice.This approach is particularly useful in the area of low speed aerodynamics where compressibility effects are minimal and the complex phenomena associated with shock waves and their interaction with viscous layers are absent. The success of the approach depends on the ability to solve the inviscid flow efficiently to obtain the pressure distribution over the body which is then impressed upon the viscous layers. The subsequent calculation of the flow in the viscous layers (whether it is laminar or turbulent) would furnish estimates of the skin friction experienced by the body. The interaction between the inviscid flow and the viscous layers is also a source of pressure drag. This course gives a detailed account of the governing equations of low speed flows both in the inviscid flowfield and the viscous layers and develops the numerical schemes needed for their individual solutions and their interaction mechanisms.
SPC 511	Geographical Information Systems Credits: 2 Geographical Information Systems are concerned with the description and manipulation of spatially distributed data. This course introduces the concepts and components of a geographic information system (GIS) and operating a functional GIS through the use of common open source GIS tools. The course will introduce the students to Global Positioning System (GPS) and its use for spatial localization. Students will understand the basic principles of spatial data acquisition and geodatabase design and use. The course introduces applications where spatial analysis and modeling plays a central role such as: agriculture and irrigation, environmental quality assessment and transportation planning.

Code	Description
SPC 512	Digital Control Credits: 2 Prereq: SPC 328 In modern control system controllers are often implemented using digital devices. This is demonstrated by the widespread use of microcontrollers in industrial applications. The use of digital devices requires the introduction of finite sampling of continuous (analogue) signals. Moreover, finite precision and quantization effects need to be considered. In this course, students are introduced to the basic concepts and methods of digital control systems. The course starts by a discussion of discrete time systems and their relation to analogue systems and introduces the z-transform as the corresponding tool to the usual Laplace transform used in continuous system analysis. This is followed by a detailed discussion of the stability of discrete systems using stability tests, root loci and frequency domain criteria. The design of digital systems is connected to standard methods of design in analogue systems. Finally state space models of discrete systems and their controllability and observability are discussed and standard state space controller introduced. Applications to aircraft and space systems are used throughout the course to illustrate the concepts and methods.
SPC 513	Space Applications Law & Policy Credits: 2 This course deals with the international legal aspects of various space applications. In particular, the course examines the international law related to satellite telecommunications, the role therein of various international organizations as well as broadcasting by satellite, navigational services, remote sensing by satellites, space stations, space travel, etc. Certain specific aspects of international law will be discussed as they relate to international technology transfers, military uses of outer space, trade in space products, satellite telecommunications and launch services.
SPC 521	Spacecraft Propulsion Credits: 2 Space Propulsion begins with a review of rocket propulsion fundamentals. The course then proceeds into advanced propulsion concepts, ranging from chemical to electrical engines. Propulsion system selection criteria and mission analysis are introduced. The bulk of the semester is devoted to the physics and engineering of various engine classes, including electrothermal, electrostatic and electro-magnetic. Specific topics include arcjets, ion engines, Hall thrusters and colloid thrusters.
SPC 525	Space Power Systems Credits: 2 Power systems for satellites, space science missions, and planetary and lunar outposts. Photovoltaic, solar-thermal, and nuclear systems, as well as chemical systems for storage. Thermal management of space power systems.
SPC 526	Advanced Materials for Aerospace Struct Credits: 2 Prereq: SPC 316 This course will introduce the students to the modeling of composite materials starting from the micromechanics of materials through the mechanics of plies and the composite plates. Then the student will be introduced to the concepts of smart structures through an introduction to piezoelectric materials, shape memory alloys and magnetorheological fluids.

Code	Description
SPC 527	Advanced Aerospace Structures Credits: 2 Interaction of electromagnetic waves with natural surfaces. Scattering of microwaves, microwave and thermal emission from atmospheres and surfaces, and sensors and associated technology, including sensor design, new observation, techniques, ongoing developments, and data interpretation. (includes lab).
SPC 535	Space Craft Communications Systems Credits: 3 This course covers the design of Spacecraft communication systems and the analysis of communications performance over satellite links. The course covers the major elements of a satellite communications system: spacecraft, radio communications and propagation in the earth's atmosphere, transponders, earth stations, receivers and transmitters, modulation techniques, and error control. Emphasis will be placed on design and analysis of space craft communication systems, with extensive use of block diagrams. There will be a discussion of recent developments in satellite communications covering both geostationary satellite systems (GEO), low earth orbit satellite systems (LEO), and Global Navigation Satellite Systems (GNSS)
SPC 560	Non-Linear Control Credits: 3 The objective of this course, is to present the fundamentals of modern nonlinear control. Classical techniques such as phase plane analysis and the describing function methods are treated, because of their continued practical importance. The scope of the course is quite broad. This is in order to show the multidisciplinary role of nonlinear dynamics and control. In particular, nonlinear control, and Lyapunov stability theory is provided. The objective of the stability analysis is to determine the system behavior without solving the differential, or difference equations modeling the system. In fact, the Lyapunov theory is used as a unifying medium for different types of dynamical systems analyzed. Finally, an introduction to the design of nonlinear control systems design using sliding mode control and nonlinear feedback control will be presented.
SPC 577	Airports and Airlines Credits: 2 The course is intended to familiarize the student with the international aviation system and community. Aviation as an industrial sector requires both pieces of knowledge of the airlines and airport regulations. The course provides an introduction to aviation engineering know-how along with basic management skills of global airlines and airports.
SPC 597	Selected topics in Aerospace Engineering Credits: 1-3 Selected topics of interest of faculty and major students, not covered elsewhere in the curriculum. The course can be repeated for credit more than once on the condition that course topics are different
SPC 598	Senior Design Project I Credits: 1 Students must undertake an independent Aerospace Engineering design project during the last two terms of their program. The purpose of the project is to demonstrate students' abilities to practice in an Aerospace Engineering capacity in their chosen area of expertise, using knowledge gained from their academic and employment experiences. The first part of the project (SPC 501) will include problem identification, generation and selection of solutions and time management. Incorporation of technical, ecological, social, political and economic issues in the solution for the project will be required. Requirements include: proposal, progress report, and a final report containing recommendations for part two of the project.

Code	Description
SPC 599	Senior Design Project II Credits: 3 Prereq: SPC 598 A continuation of SPC 598. The final design of the major Aerospace Engineering project proposed in SPC 598 will be undertaken. The purpose of this phase of the project is to carry out a detailed technical design of the solution proposed in SPC 598. Requirements of this part of the two-term project include a final report