COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

212 Hamilton Hall, MC 2807
1130 Amsterdam Avenue, New York, NY 10027

combinedplan@columbia.edu
undergrad.admissions.columbia.edu/apply/combined-plan

2016-2017 COMBINED PLAN CURRICULUM GUIDE COURSE DESCRIPTIONS

CHEMISTRY

CHEM UN1403-UN1404 General chemistry I and II (lecture): *(Corequisite: MATH UN1101 or the equivalent.)* Topics include stoichiometry, states of matter, nuclear properties, electronic structures of atoms, periodic properties, chemical bonding, molecular geometry, introduction to quantum mechanics and atomic theory, introduction to organic and biological chemistry, solid state and materials science, polymer science and macromolecular structures and coordination chemistry.

CHEM UN1500 General chemistry (laboratory): *(Prerequisite or corequisite: CHEM UN1403 or CHEM UN1404.)* An introduction to basic techniques and practices of modern experimental chemistry, including quantitative procedures and chemical analysis.

CHEM UN2443 Organic chemistry (lecture): *(Prerequisite: CHEM UN1404 or UN1500 or their equivalents.)* The principles of organic chemistry. The structure and reactivity of organic molecules are examined from the standpoint of modern theories of chemistry. Topics include stereochemistry, reactions of organic molecules, mechanisms of organic reactions, syntheses and degradations of organic molecules, and spectroscopic techniques of structure determination.

CHEM UN2493 Organic chemistry (laboratory): (*Prerequisite or corequisite: CHEM UN2443*) Techniques of experimental organic chemistry, with emphasis on understanding fundamental principles underlying the experiments and methodology of solving laboratory problems involving organic molecules.

COMPUTER SCIENCE

COMS W1004 Introduction to Computer Science and Programming in Java: A general introduction to computer science for science and engineering students interested in majoring in computer science or engineering. Covers fundamental concepts of computer science, algorithmic problem-solving capabilities, and introductory Java programming skills. Assumes no prior programming background.

COMS W1005 Introduction to Computer Science and Programming in MATLAB: A general introduction to computer science concepts, algorithmic problem-solving capabilities, and programming skills in MATLAB. Assumes no prior programming background.

COMS W1007 Honors Introduction to Computer Science: *(Prerequisites: AP Computer Science with a grade of 4 or 5 or similar experience.)* An honors-level introduction to computer science, intended primarily for students considering a major in computer science. Computer science as a science of abstraction. Creating models for reasoning about and solving problems. The basic elements of computers and computer programs. Implementing abstractions using data structures and algorithms. Taught in Java.

COMS W3134 Data Structures in Java: *(Prerequisites: COMS W1004 or knowledge of Java)* Data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection. Storage management. Rudiments of the analysis of algorithms. Taught in Java.

COMS W3136 Essential Data Structures with C/C++: *(Prerequisites: COMS W1004, W1005, W1007 or ENGI E1006)* A second programming course intended for nonmajors with at least one semester of introductory programming experience. Basic elements of programming in C and C++, array-based data structures, heaps, linked lists, C programming in UNIX environment, object-oriented programming in C++, trees, graphs, generic programming, hash tables.

COMS W3137 Honors Data Structures and Algorithms: *(Prerequisites: COMS W1004 or W1007; Corequisites: W3203)* An honors introduction to data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection. Storage management. Design and analysis of algorithms. Taught in Java.

COMS W3203 Discrete Mathematics: Introduction to Combinatorics and Graph Theory: *(Prerequisites: Any introductory course in computer programming.)* Logic and formal proofs, sequences and summation, mathematical induction, binomial coefficients, elements of finite probability, recurrence relations, equivalence relations and partial orderings, and topics in graph theory (including isomorphism, traversability, planarity, and colorings).

ENGI E1006 Introduction to Computing for Engineers and Applied Scientists: An interdisciplinary course in computing intended for first year SEAS students. Introduces computational thinking, algorithmic problem solving and Python programming with applications in science and engineering. Assumes no prior programming background.

MATHEMATICS/APPLIED MATHEMATICS

MATH UN1101 Calculus I: Functions, limits, derivatives, introduction to integrals.

MATH UN1102 Calculus II: *(Prerequisite: MATH UN1101 or the equivalent.)* Methods of integration, applications of the integral, Taylor's theorem, infinite series.

MATH UN1201 Calculus III: *(Prerequisite: MATH UN1101 or the equivalent.)* Vectors in dimensions 2 and 3, complex numbers and the complex exponential function with applications to differential equations, Cramer's rule, vector-valued functions of one variable, scalar-valued functions of several variables, partial derivatives, gradients, surfaces, optimization, the method of Lagrange multipliers.

MATH UN1202 Calculus IV: *(Prerequisite: MATH UN1102, MATH UN1201, or the equivalent.)* Multiple integrals, Taylor's formula in several variables, line and surface integrals, calculus of vector fields, Fourier series.

MATH UN2030 Ordinary differential equations: *(Prerequisite: MATH UN1102-MATH UN1201 or the equivalent.)* Special differential equations of order one. Linear differential equations with constant and variable coefficients. Systems of such equations. Transform and series solution techniques. Emphasis on applications.

MATH UN2010 Linear Algebra: *(Prerequisites: MATH UN1201, or the equivalent.)* Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications.

APMA E2101 Introduction to Applied Mathematics *(Prerequisites: MATH UN1201.)* A unified, single-semester introduction to differential equations and linear algebra with emphases on (1) elementary analytical and numerical technique and (2) discovering the analogs on the continuous and discrete sides of the mathematics of linear operators: superposition, diagonalization, fundamental solutions. Concepts are illustrated with applications using the language of engineering, the natural sciences, and the social sciences. Students execute scripts in Mathematica and MATLAB (or the like) to illustrate and visualize course concepts (programming not required).

APMA E3101 Linear Algebra: Matrix algebra, elementary matrices, inverses, rank, determinants. Computational aspects of solving systems of linear equations: existence-uniqueness of solutions, Gaussian elimination, scaling, ill-conditioned systems, iterative techniques. Vector spaces, bases, dimension. Eigenvalue problems, diagonalization, inner products, unitary matrices.

PHYSICS

PHYS UN1401 Introduction to mechanics and thermodynamics: *(Corequisite: MATH UN1101 or the equivalent.)* Fundamental laws of mechanics, kinematics and dynamics, work and energy, rotational dynamics, oscillations, gravitation, fluids, temperature and heat, gas laws, the first and second laws of thermodynamics.

PHYS UN1402 Introduction to electricity, magnetism, and optics: *(Prerequisite: PHYS UN1401. Corequisite: MATH UN1102 or the equivalent.)* Electric fields, direct currents, magnetic fields, alternating currents, electromagnetic waves, polarization, geometrical optics, interference and diffraction.

PHYS UN1403 Introduction to classical and quantum waves: (*Prerequisite: PHYS UN1402. Corequisite: MATH UN1201 or the equivalent.)* Classical waves and the wave equation, Fourier series and integrals, normal modes, wave-particle duality, the uncertainty principle, basic principles of quantum mechanics, energy levels, reflection and transmission coefficients, applications to atomic physics.

PHYS UN1493-4 Introduction to experimental physics: *(Prerequisites: PHYS UN1401 and UN1402.)* Laboratory work associated with the two prerequisite lecture courses. Experiments in mechanics, thermodynamics, electricity, magnetism, optics, wave motion, atomic and nuclear physics.

OTHER COURSES

BIOL UN2005 Introductory Biology I: Biochemistry, Genetics & Molecular Biology: *(Prerequisites: One year of college chemistry, or a strong high school chemistry background.)* Lecture and recitation. Recommended as the introductory biology course for biology and related majors, and for premedical students. Fundamental principles of biochemistry, molecular biology, and genetics.

BIOL UN2006 Introductory Biology II: Cell Biology, Development and Physiology: Exploration of the major discoveries and ideas that have revolutionized the way we view organisms and understand life. The basic concepts of cell biology, anatomy and physiology, genetics, evolution, and ecology will be traced from seminal discoveries to the modern era.

ECON UN1105 Principles of Economics: *(Corequisites: ECON UN1155 recitation section with the same instructor.)* How a market economy determines the relative prices of goods, factors of production, and the allocation of resources and the circumstances under which it does it efficiently. Why such an economy has fluctuations and how they may be controlled.

EEEB UN2001 Environmental Biology I: Elements to Organisms: Introductory biology course for majors in biology or environmental biology, emphasizing the ecological and evolutionary context of modern biology.

EESC UN1011 Earth: Origin, Evolution, Processes Future: What is the nature of our planet and how did it form? This class explores Earth's internal structure, its dynamical character expressed in plate tectonics and earthquakes, and its climate system. It also explores what Earth's future may hold.

EESC UN2100 Earth's Environmental Systems: the Climate System: Origin and development of the atmosphere and oceans, formation of winds, storms and ocean currents, reasons for changes through geologic time. Recent influence of human activity: the ozone hole, global warming, water pollution. Laboratory exploration of topics through demonstrations, experimentation, computer data analysis, and modeling.

EESC UN2200 Earth's Environmental Systems: the Solid Earth System: Exploration of how the solid Earth works, today and in the past, focusing on Earth in the Solar system, continents and oceans, the Earth's history, mountain systems on land and sea, minerals and rocks, weathering and erosion, hydrological cycle and rivers, geochronology, plate tectonics, earthquakes, volcanoes, fossil fuels. Laboratory exploration of topics through examination of rock samples, experimentation, computer data analysis, field exercises, and modeling.

EAEE E2100 A better planet by design: Introduction to design for a sustainable planet. Scientific understanding of the challenges. Innovative technologies for water, energy, food, materials provision. Multi-scale modeling and conceptual framework for understanding environmental, resource, human, ecological and economic impacts and design performance evaluation. Focus on the linkages between planetary, regional and urban water, energy, mineral, food, climate, economic and ecological cycles. Solution strategies for developed and developing country settings.

ELEN E1201 Introduction to electrical engineering: *(Prerequisites: MATH UN1101.)* Basic concepts of electrical engineering. Exploration of selected topics and their application. Electrical variables, circuit laws, nonlinear and linear elements, ideal and real sources, transducers, operational amplifiers in simple circuits, external behavior of diodes and transistors, first order RC and RL circuits. Digital representation of a signal, digital logic gates, flipflops. A lab is an integral part of the course. Required of electrical engineering and computer engineering majors.

ENGL CC1010 University Writing: This course helps undergraduates engage in the conversations that form our intellectual community. By reading and writing about scholarly and popular essays, students learn that writing is a process of continual refinement of ideas. Rather than approaching writing as an innate talent, this course teaches writing as a learned skill. We give special attention to textual analysis, research and revision practices.

ENME E3105 Mechanics: *(Prerequisites: PHYS UN1401, and MATH UN1101-UN1102 and UN1201.)* Elements of statics, dynamics of a particle, systems of particles, and rigid bodies.

IEOR E2261 Introduction to accounting and finance: (*Prerequisite: ECON UN1105.)* This course examines the fundamental concepts of financial accounting and finance, from the perspective of both managers and investors. Topics covered in this course include: principles of accrual accounting; recognizing and recording accounting transactions; preparation and analysis of financial statements, including balance sheets, income statements, cash flow statements, and statements of owners' equity; ratio analysis; pro-forma projections; time value of money (present values, future values and interest/discount rates); inflation; discounted-cash-flow (DCF) project evaluation methods; deterministic and probabilistic measures of risk; capital budgeting. The course is targeted toward students pursuing careers in engineering, economics, finance or business.

IEOR E3658 Probability: (*Prerequisites: Solid knowledge of calculus, including multiple variable integration.*) This is an introductory course to probability theory, and does not assume any prior knowledge of the subject. The course aims to teach students the foundations required to use probability in applications, but the course itself is theoretical in nature. The content and pace of the course is best suited for students (undergraduates) with strong mathematical skills. The course begins with the basic definitions and axioms of probability and then introduces the notions of independence and conditional probability. The majority of the course focuses on random variables, both continuous and discrete, and covers the topics of expectation, variance, conditional distributions, conditional expectation and variance, and moment generating functions. The course ends with the Central Limit Theorem for sums of random variables. The method of instruction consists of lectures, recitations, weekly homework, and in-class exams.

IEOR E4307 Applied Statistical Models in Operations Research: *(Prerequisites: IEOR E3658 or its equivalent is required.)* This course is required for undergraduate students majoring in OR:FE and OR . This class will cover descriptive statistics, central limit theorem, parameter estimation, sufficient statistics, hypothesis testing, regression, logistic regression, goodness of fit tests and its applications to Operations Research models.

SIEO W3600 Introduction to Probability and Statistics (*Prerequisites: Calculus, including multiple variable integration.)* This course is required for undergraduate students majoring in IE, OR:EMS, and OR. This class must be taken during the fourth semester. This course serves as an introduction to both probability theory and statistics as used in engineering and applied science. In probability the course covers random variables, both continuous and discrete, independence, expected values, variance, conditional distributions, conditional expectation and variance, moment generating functions, the strong law of large numbers and the central limit theorem. In statistics it covers the basics of confidence intervals, hypothesis testing and linear regression.

STAT GU4204 Introduction to Statistical Inference *(Prerequisite: STAT GU4203, or the equivalent.)* Calculus-based introduction to the theory of statistics. Useful distributions, law of large numbers and central limit theorem, point estimation, hypothesis testing, confidence intervals maximum likelihood, likelihood ratio tests, nonparametric procedures, theory of least squares and analysis of variance.