COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

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2015-2016 COMBINED PLAN CURRICULUM GUIDE COURSE DESCRIPTIONS

CHEMISTRY

CHEM C1403-C1404 General chemistry: *(Corequisite: MATH V1101 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 C1500 General chemistry laboratory: *(Prerequisite or corequisite: CHEM C1403.)* An introduction to basic techniques and practices of modern experimental chemistry, including quantitative procedures and chemical analysis.

CHEM C3443-C3444 Organic chemistry (lecture): *(Prerequisite: CHEM C1404 or C1500 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 C3493 Organic chemistry (laboratory): (*Prerequisite or corequisite: CHEM C3443-C3444.)* 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.)* An honors-level introduction to 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 Data Structures with C/C++: *(Prerequisites: COMS W1004, W1005, W1007 or ENGI E1006)* A second programming course intended for non-majors 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, and hash tables.

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).

COMS W3210y Scientific Computation: *(Prerequisites: Two terms of calculus.)* Introduction to computation on digital computers. Design and analysis of numerical algorithms. Numerical solution of equations, integration, recurrences, chaos, differential equations. Introduction to Monte Carlo methods. Properties of floating point arithmetic. Applications to weather prediction, computational finance, computational science, and computational engineering.

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 V1101 Calculus I: Functions, limits, derivatives, introduction to integrals.

MATH V1102 Calculus II: *(Prerequisite: Calculus I or the equivalent.)* Methods of integration, applications of the integral, Taylor's theorem, infinite series.

MATH V1201 Calculus III: *(Prerequisite: Calculus II 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 V1202 Calculus IV: *(Prerequisite: Calculus II and III.)* Multiple integrals, Taylor's formula in several variables, line and surface integrals, calculus of vector fields, Fourier series.

MATH V2030 Ordinary differential equations: *(Prerequisite: MATH V1201 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 V2010 Linear Algebra: *(Prerequisites: V1201, or the equivalent.)* Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications.

STAT W1211 – Introduction to Statistics (with calculus): *(Prerequisites: one semester of calculus)* Random variables, probability distributions, pdf, cdf, mean, variance, correlation, conditional distribution, conditional mean and conditional variance, law of iterated expectations, normal, chi-square, F and t distributions, law of large numbers, central limit theorem, parameter estimation, unbiasedness, consistency, efficiency, hypothesis testing, p-value,confidence intervals. maximum likelihood estimation.

APMA E2101 – Introduction To Applied Mathematics *(Prerequisites: Calculus III.)* 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 C1401 Introduction to mechanics and thermodynamics: *(Corequisite: MATH V1101 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 C1402y Introduction to electricity, magnetism, and optics: *(Prerequisite: PHYS C1401. Corequisite: MATH V1102 or the equivalent.)* Electric fields, direct currents, magnetic fields, alternating currents, electromagnetic waves, polarization, geometrical optics, interference and diffraction.

PHYS C1403 Introduction to classical and quantum waves: (*Prerequisite: PHYS C1402. Corequisite: MATH V1201 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 C1493 Introduction to experimental physics: *(Prerequisites: PHYS C1401 and C1402.)* Laboratory work associated with the two prerequisite lecture courses. Experiments in mechanics, thermodynamics, electricity, magnetism, optics, wave motion, atomic and nuclear physics.

PHYS C1494 Introduction to experimental physics: *(Prerequisites: PHYS C1401, C1402)* 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 C2005 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.

ECON W1105 Principles of Economics: 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 W2001 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 V1011 Earth: Origin, Evolution, Processes Future: Students who wish to take only the lectures should register for V1411. What is the nature of our planet and how did it form? From geochemical and geophysical perspectives we explore Earth's internal structure, its dynamical character expressed in plate tectonics, and ask if its future behavior can be known.

EESC V2100 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 V2200 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.

EESC W4001 Advanced General Geology: *(Prerequisites: one term of college-level calculus, physics, and chemistry.)* A concentrated introduction to the solid Earth, its interior and near-surface geology. Intended for students with good backgrounds in the physical sciences but none in geology.

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 V1101.)* 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 C1010 University Writing: This course is designed to help undergraduates read and write essays in order to participate in the academic conversations that form the intellectual community. The course gives special attention to the practices of close reading, rhetorical analysis, research, collaboration, and substantive revision. By writing multiple drafts of essays typically ranging from three to ten pages, students will learn that writing is a process of forming and refining their ideas and their prose. Rather than approaching writing as an innate talent, the course teaches writing as a unique skill that can be practiced and developed.

MECE E3105 Mechanics: *(Prerequisites: PHYS C1401, and MATH V1101-V1102 and V1201.)* Elements of statics, dynamics of a particle, systems of particles, and rigid bodies.

IEOR E2261 Introduction to accounting and finance: (*Prerequisite: ECON W1105.)* 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: *Calculus*) 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: 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.) 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 W3107 Introduction to statistical inference *(Prerequisite: STAT W3000 or W4105, 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.