CBE Technical Electives for BME+CBE students

Key:

F - Fall	* Available Every Other Year (Even)
S - Spring	** Available Every Other Year (Odd)
SS - Summer	

Abbreviations: "may be taken conc." = "course may be taken concurrently"

See last page of this document for information on how to obtain course overrides

NOTE: **1. Classes otherwise required for the degree are not allowed for TE credit.**
2. Course availability changes frequently. Please check with individual departments regarding course availability.

3. Crosslisted courses (e.g. BIOM/MECH 570) are in italics and must be taken as *BIOM* courses to count for BME Technical Elective credit.

- **From the following CBE TE list, BME+CBE students who have takem CBE 160 must take 5 credits; students who HAVE NOT taken CBE 160 must take 6 credits**

CBE Technical Electives

Course	Course Title	Prerequisite	Terms	Credits
AB 310	**Understanding Pesticides** Identification, properties, use, labeling, environmental interactions and applicatoin of major classes of pesticides	BZ 100-199, at least 3 credits; CHEM 100-199, at least 3 credits	S	3
ATS 555	**Air Pollution** Nature, ambient concentrations, sources, sinks, and physiological activities of pollutants; meteorology; legislation; social and economic factors.	CHEM 113; (MATH 261 or MATH 340; PH 122 or PH 142)	S	3
ATS 560	**Air Pollution Measurement** Examination and application of techniques for air pollution measurement. Includes sampling and analysis of gases, aerosols, and precipitation. .	CHEM 114	F	2
BC 401	**Comprehensive Biochemistry I** Macromolecular structure and dynamics; membranes; enzymes; bioenergetics.	(CHEM 245 or CHEM 343 or CHEM 346, may be taken conc.); (MATH 155 or MATH 160)	F	3
BC 403	**Comprehensive Biochemistry II** Metabolic pathways and their regulation; cellular biochemistry.	CHEM 245 or CHEM 341 or CHEM 345	S	3
BC 404	**Comprehensive Biochemistry Lab** Experimental approaches to studying macromolecules, metabolism, and gene expressions.	(BC 401, may be taken); (CHEM 246 or CHEM 344 or CHEM 346; LIFE 203); LIFE 212	F,S	2
BC 411	**Physical Biochemistry:** Thermodynamics; reaction rates; quantum chemistry; spectroscopy; macromolecular folding and interactions; ligand binding; enzyme kinetics; membranes.	(BC 351 with a B or better or BC 401); CHEM 113; (MATH 161 or MATH 255).	F	4
BC 441	**3D Molecular Models for Biochemistry** Computer indtruction to construct 3D models of proteins and nucleic acids using leading software	BC 401, may be taken conc.	F	1
BC 463	**Molecular Genetics** Molecular basis of gene structure, replication, repair, recombination, and expression.	(BC 351 with a C or better) or (BC 401 with a C or better or taken conc.); (BZ 350 with a C or better or LIFE 201B with a C or better)	F	3
BC 464	**Molecular Genetics Recitation:** Methods used to study the molecular basis of gene structure, replication, repair, recombination and expression	LIFE 201B; (BC 352 or BC 401, may be taken conc.)	F	1
BC 517	**Metabolism** Design and regulation of metabolic pathways	BC 351; BC 403	F,S	2
BC 521	**Principles of Chemical Biology** Chemical methods for understanding and controlling structure and function of biopolymers	CHEM 245 or CHEM 343 or CHEM 346	F	3
BIOM 350A	**Study Abroad: Prosthetics in Ecuador:** Design and fabricate prosthetics for under-served populations in Ecuador. Will take place in Quito,Ecuador in partnership with Range of Motion Project (ROMP).	None	SS	1 or 2
BIOM/ECE 517	**Advanced Optical Imaging** Engineering design principles of advanced optical imaging techniques and image formation theory	ECE 342 or MATH 340 or MATH 345	F*	3
BIOM/MECH 525	**Cell and Tissue Engineering** Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design. Credit allowed for only one of the following: BIOM 525, CBE 525, MECH 525.	BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501	S	3
*BIOM/ ECE 526***	**Biological Physics:** Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.	(MATH 340 or MATH 345); (PH 122 or PH 142).	F	3
BIOM/ MECH 531	**Materials Engineering**: Selection of structural engineering materials by properties, processing, and economics; materials for biomedical and biotechnology applications.	MECH 331 or MECH 431	S	3
BIOM/CIVE 533	**Biomolecular Tools for Engineers**		F	3
BIOM/MECH 573	**Structure and Function of Biomaterials** Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.	MECH 331	S	3
BIOM/ MECH 574	**Bio-Inspired Surfaces:** Analysis of surface functionalities of various biological species; identification of design principles.	CHEM111; MECH 342	S	3
BIOM/ MECH 576	**Quantitative Systems Physiology:** Quantitative, model-oriented approach to cellular and systems physiology with design examples from biomedical engineering.	BMS 300; CHEM 113; MATH 340; PH 142.	S	4
BIOM/MECH 579	**Cardiovascular Biomechanics** Bio-mechanical principles and approaches applied in cardiovascular research	MATH 340; PH 142	F**	3
BMS 301	**Human Gross Anatomy** Structure and function of the human body. Study of prosected human cadavers; clinical applications; living anatomy. Must register for lecture, laboratory, and recitation.	BZ 110 or LIFE 102	F,S,SS	5
BMS 302	**Laboratory in Principles in Physiology** Basic physiology lab exercises. Must register for lecture and laboratory. Credit not allowed for both BMS 302 and BMS 320.	BMS 300 or (BMS 360 may be taken conc.)	F,S	2
BMS 305	**Domestic Animal Gross Anatomy** Comparative gross anatomy of domestic carnivores, ruminants and horses	BZ 311 or LIFE 102	S	4
BMS 325	**Cellular Neurobiology:** Cellular and molecular bases of nervous system function and behavior.	BMS 300 or BMS 360	F	3
BMS 330	**Microscopic Anatomy** Microscopic anatomy of mammalian tissue	BMS 300 or BMS 360	S	4
BMS 345	**Functional Neuroanatomy**: Functional systems and circuits of the human brain and spinal cord.	BMS 300 or BMS 360.	S	4
BMS 360	**Fundamentals of Physiology** Cell, tissue, and organ function related to integrated whole body function.	(BZ 110 or LIFE 102); CHEM 245 or CHEM 341, may be taken conc.)	S	4
BMS 409	**Human and Animal Reproductive Biology**: Basis for male and female reproductive function in humans and animals.	BMS 300 or BMS 360	F	3

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BMS 420	**Cardiopulmonary Physiology** Normal and pathophysiology of cardiovascular and pulmonary systems.	BMS 300 or BMS 360	F	3
BMS 430	**Endocrinology** Physiology of the glands of internal secretion.	BMS 300 or BMS 360	F	3
BMS 450	**Pharmacology** Pharmacologic principles, absorption, distribution, metabolism, excretion, side effects, and actions of drugs.	(BMS 300 or BMS 360); (BC 351 or LIFE 210)	S	3
BMS 460	**Essentials of Pathophysiology** Integration of different facets of mechanisms underlying health and disease	BMS 300 or BMS 360	S	3
BMS 500	**Mammalian Physiology I** Cell physiology of nerve, skeletal, cardiac and smooth muscle with an emphasis on how cellular functions integrate into systems behavior.	BMS 300 or BMS 360	F	4
BMS 501	**Mammalian Physiology II** Respiratory, renal, digestive, endocrine, metabolic, and reproductive function.	BMS 300 or BMS 360	S	4
BMS/ NB 503	**Developmental Neurobiology:** Molecular mechanisms involved in development of nervous system including differentiation, growth, pathfinding, and synaptogenesis	At least one course in each of the following: (BIO 100 to 481); (BZ 100 to 481); (LIFE 100 to 481); (BC 100 to 481); (PH 100 to 481); (MATH 141 or MATH 155 or MATH 160 or MATH 161 or MATH 255 or MATH 261)	S	3
BMS/ NB 505	**Neuronal Circuits, Systems and Behavior:** Anatomical and physiological organization of the nervous system.	BMS 325 or BMS 500 or NB 501.	S	3
BMS 545	**Neuroanatomy** Nervous system structure and function presented from a systems perspective; applied and comparative aspects are emphasized	NA	S	5
BMS 575	**Human Anatomy Dissection** Regional approach to human gross anatomy through laboratory dissection of human cadaver	NA	F	4
BSPM 302	**Applied and General Entomology** Biology and management of insects.	None	F	2
BSPM 361	**Elements of Plant Pathology** Diseases of economic plants. Must register for lecture and laboratory.	BZ 104 or BZ 120 or HORT 100 or LIFE 102	S	3
BSPM 310 ++	***Understanding Pesticides*** *Identification, properties, use, labeling, environmental interactions, and application of major classes of pesticides*	BZ 100 - 199 - at least 3 credits or CHEM 100-199 at least 3 credits	*S**	*3*
BZ 310	**Cell Biology**	(BZ 110 or BZ 120 or LIFE 103); (CHEM 245 or CHEM 341 with a C or better).	F,S,SS	4
BZ 311	**Developmental Biology** Developmental aspects of growth and differentiation stressed in higher plants and animals.	BZ 310	S,SS	4
BZ/MATH 348	**Theory of Population and Evolutionary Ecology** Principles and methods for building, analyzing, and interpreting mathematical models of ecological and evolutionary problems in biology.	MATH 155 or MATH 160	F	4
BZ 350	**Molecular and General Genetics** Mendelian, molecular, and population genetics emphasizing the molecular basis of genetics.	(BZ 110 or BZ 120 or LIFE 102); (STAT 201 or STAT 301 or STAT 307/ERHS 307, may be taken conc.)	F,S,SS	4
BZ 360	**Bioinformatics and Genomics** Genomics, bioinformatics and basic computer programming for biologists	BZ 110 or BZ 120 or LIFE 102	S	3
CBE 406	**Introduction to Transport Phenomena** - BIOM 330??? Fundamental treatment of momentum and mass transport processes; dimensional analysis for parameter identification and order of magnitude estimation.	CBE 332	F	3
CBE 439	**Environmental Engineering Chemical Concepts** Application of chemical principles to environmental engineering problems	CHEM 113; MATH 340	F	3
CBE 501	**Chemical Engineering Thermodynamics** Definition, correlation, and estimation of thermodynamic properties; nonideal chemical and physical equilibria.	CBE 202; MATH 340	F	3
CBE 502	**Advanced Reactor Design** Nonideal flow and tracers, reactions and diffusion, evaluation of complex kinetics, stability of reactors. Biochemical reactor examples.	CBE 320; CBE 332	F	3
CBE 503	**Transport Phenomena Fundamentals** General topics in transport phenomena; analytical and numerical solutions of laminar flows; perturbation techniques; coupled transport.	CBE 406	S	3
CBE/BIOM 504	**Fundamentals of Biochemical Engineering** Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design. Credit not allowed for both CBE 504 and BIOM 504.	(CBE 320, or BIOM 306/BTEC 306, may be taken conc.); (MATH 255 or MATH 340); MIP 300	F	3

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CBE 505	**Biochemical Engineering Laboratory** Fermentation technology, bioprocess control, and protein purificaton	CBE 504, may be taken conc.	F**	1
CBE 514	**Polymer Science and Engineering** Fundamentals of polymer science: synthesis, characterization, processing of polymers. Physical properties of polymers; rheology of melts and solutions.	(CHEM 343 or CHEM 346); (CHEM 474 or CBE 310)	S	3
CBE 521	**Mathematical Modeling for Chemical Engineers** Application of mathematical models to analysis and design of chemical reactors and separation processes.	MATH 340	F	3
CBE/BIOM 522	**Bioseparation Processes** Analysis of processes to recover and purify fermentation products. Must register for lecture and laboratory. Credit not allowed for both CBE 522 and BIOM 522.	CBE 331	F	3
CBE 524	**Bioremediation** Use of biotechnology for site remediation. Biodegradation, bioreactor design, and in situ bioremediation.	CBE 540/CIVE 540	F	1
CBE/CIVE 540	**Advanced Biological Wastewater Processing** Fundamentals of environmental biotechnology: environmental microbiology, microbial kinetics, basic reactor design, wastewater treatment.	CBE 320 or CIVE 438	S	3
CBE 570	**Biomolecular Engineering/Synthetic Biology** Rational design and evolutionary methods for engineering functional protein and nucleic acid systems	BC 351; (CHEM 341 or CHEM 345)	S	3
CHEM 261	**Fundamentals of Inorganic Chemistry** Preparation, structures, properties, and reactions of chemical elements and inorganic compounds; periodic trends, organizing principles; applications	CHEM 113, may be taken conc.	S	3
CHEM 311	**Introduction to Nanoscale Science** Synthesis, characterization, and applications of nanoscale materials	CHEM 113; (CHEM 346 or CHEM 343)	S*	3
CHEM 334	**Quantitative Analysis Laboratory:** Laboratory applications of principles presented in CHEM 335.	CHEM 114; (CHEM 335, may be taken conc.)	F, S	1
CHEM 335	**Intro to Analytical Chemistry**: Modern and classical applications and methods in analytical chemistry including statistical, kinetic, spectroscopic, and chromatographic analysis.	(CHEM 113 with a C or better); (CHEM 334, may be taken conc.)	F,S	3
CHEM 338	**Environmental Chemistry** Processes that control the fate of chemicals in the environment. Focus on the chemistry of the atmosphere, hydrosphere, and soils. Especially as it pertains to pollution of these environmental compartments.	CHEM 113; (CHEM 245 or CHEM 341 or CHEM 345)	S**	3
CHEM 431	**Instrumental Analysis** Instrumental methods of chemical analysis. Must register for lecture and laboratory.	CHEM 334; CBE 310 or CHEM 473 or CHEM 474, may be taken conc.	F	4
CHEM 433	**Clinical Chemistry** Principles and methodology of clinical chemistry. Laboratory experience in methodology and method development. .	CHEM 334; (BC 351 or BC 401)	S	3
CHEM 440	**Advanced Organic Laboratory** Advanced techniques in organic synthesis, mechanisms of reactions, structure determination.	CHEM 344 or CHEM 346	F	2
CHEM 461	**Inorganic Chemistry** Concepts, models to explain structural, spectroscopic, magnetic, thermodynamic, and kinetic properties of inorganic compounds; symmetry, group theory.	CHEM 261; (CHEM 474 or CBE 310)	S	3
CHEM 522	**Methods of Chemical Biology** Approaches to quantitative chemical biology, visualization, study and characterization of macromolecules and macromolecular-dependent processes	(BC 351 with a B or better) or (BC 401 with a B or better)	S	2
CHEM 532	**Advanced Chemical Analysis II** Advanced optics; instrumentation and methodology for analytical spectroscopy; computer applications	CHEM 431	OAN	3
CHEM 537	**Electrochemical Methods** Theory and methods of electrochemistry; applications of modern electrochemical techniques.	CHEM 431	S	3
CHEM 539 (A,B,C)	**Principles of NMR and MRI**	CHEM 474	S	1
CHEM 541	**Organic Molecular Structure Determination** Determination of organic molecular structure by spectroscopic methods	CHEM 440	S	2
CHEM 543	**Structure/Mechanisms in Organic Chemistry** Structure including stereochemistry and conformational isomerism; reactivity and mechanisms in organic chemistry.	CHEM 343 or CHEM 346	F	2
CHEM 545	**Synthetic Organic Chemistry I** Reactions and synthesis in organic chemistry	CHEM 543	S	3
CHEM 547	**Physical Organic Chemistry** Mechanisms, theory, kinetics, and thermodynamics.	CHEM 543	S	3

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CHEM 555	**Chemistry of Sustainability** The central role of chemistry for achieving sustainability in key areas including chemicals and materials, energy and environment	(BC 411 or CBE 310 or CHEM 476); (CHEM 343 or CHEM 346)	F	3
CHEM 569	**Chemical Crystallography** Theory and practice of determination of crystal and molecular structure by single crystal X-ray and neutron diffraction.	CHEM 474	S	3
CHEM 570	**Chemical Bonding** Electronic structure methods; chemical bonding models; intermolecular interactions.	CHEM 474 or CBE 310	F	3
CHEM 575	**Fundamentals of Chemical Thermodynamics** Fundamental thermodynamic concepts and some applications to chemical problems. This is a partial-semester course.	CHEM 476 or CBE 310 or PH 361	F	1
CHEM 576	**Statistical Mechanics** Principles of statistical mechanics with applications to chemical systems. This is a partial-semester course.	CHEM 575, may be taken conc.	S	2
CHEM 577	**Surface Chemistry** Capillarity; interfacial thermodynamics, electrical aspects of surface chemistry, absorbed layers.	CHEM 476 or CBE 310	S	3
CHEM 579	**Chemical Kinetics** Elementary reactions, unimolecular reactions, reactions in solution, gas phase ion chemistry, photochemistry, and kinetic modeling.	CHEM 476 or CBE 310	F	3
CIVE 322	**Basic Hydrology** Hydrologic cycle, soil moisture, groundwater, runoff processes, applications in water resources and environmental engineering.	(CIVE 202 or STAT 301 or STAT 315); (CIVE 300 or CBE 331 or WR 416)	F,S	3
CIVE 330	**Ecological Engineering** Principles of ecological engineering and design of sustainable ecosystems	(BZ 110; BZ 111 or BZ 120 or LIFE 102 or SOCR 240); CHEM 113; (CIVE 300 or LIFE 320)	S	3
CIVE 360	**Mechanics of Solids** Stresses and deformations in structural members and machine elements, combined stresses, stress transformation.	CIVE 260	F,S	3
CIVE 401	**Hydraulic Engineering** Basic principles of fluid mechanics applied to practical problems in hydraulic engineering.	CIVE 300	S	3
CIVE 413	**Environmental River Mechanics** Fluvial geomorphology, river hydraulics, sediment transport, and river response with special emphasis on environmental aspects.	CIVE 300 or WR 416	S	3
CIVE 423	**Groundwater Engineering** Development of groundwater resources; origin, movement, distribution of water below ground surface.	CIVE 300 or CBE 331 or WR 416	S	3
CIVE 425	**Soil and Water Engineering** Control of the soil-water-plant medium for optimum plant growth and environmental protection. Must register for lecture and laboratory.	CIVE 300 or CBE 331 or SOCR 240	S	3
CIVE 438	**Environmental Engineering Concepts** Environmental engineering approaches to designing water supply, wastewater removal, and pollution control systems.	(CIVE 300 or CBE 331 or MECH 342); CHEM 113	F,S	3
CIVE 440	**Nonpoint Source Pollution** Principles, processes, impacts and control of nonpoint source pollution of surface and groundwater.	CIVE 300 or CIVE 322 or SOCR 240 or WR 416	F	3
CIVE 442	**Air Quality Engineering** Air pollution problems and solutions, at scales ranging from local to global. Quantitative analysiss of chemical and physical processes governing air pollutant in nautral and built environments.	(CBE 331 or CIVE 300 or MECH 342) and (CHEM 113)	S	3
CIVE 504	**Wind Engineering** Influence of wind on humanity. Applications to structures, air pollution, wind energy, agricultural aerodynamics, snow movement, human comfort.	CIVE 300	F	3
CIVE 520	**Physical Hydrology** Hydrologic, atmospheric processes in the water cycle; linear systems, hydrologic response; geomorphologic description of hydrologic processes, response.	CIVE 322	F	3
CIVE 531	**Groundwater Hydrology** Groundwater occurrence, distribution, movement, exploration and recharge, well hydraulics and design, interaction of ground and surface water.	CIVE 300 or CBE 331 or MECH 342	F	3
CIVE 538	**Aqueous Chemistry** Principles of solution chemistry applied to aquatic systems.	CHEM 113; MATH 340	S	3
CIVE 560	**Advanced Mechanics of Materials** Analysis of stress and strain failure theory; selected topics in solid mechanics, plate analysis; introduction to elastic stability.	CIVE 360	F	3
CM 501	**Advanced Cell Biology** Cell structure and organelle function.	BZ 310	F	4
CM/NB 502	**Techniques in Molecular & Cellular Biology** Current methods in molecular and cellular neurobiology. Written consent of instructor. Must register for lecture and laboratory. Credit not allowed for both CM 502 and NB 502.	One college-level course with laboratory in each: biology, biochemistry, physics.	F	2
CS165	**Java (CS2) Data Structures & Algorithms** CS 165: Object oriented concepts, assertions, inheritance, polymorphism, algorithms and data structures using Java.	CS 165; (CS 163 or CS 164 with a C or better);MATH 160 with a C or better or may be taken conc.	F,S,SS	4
CS 220	**Discrete Structures and Their Applications** Integer representations and properties, propositions, predicates, sets, functions, program proofs, induction, counting, complexity; Python implementations of these concepts. Sophomore standing.	(CS 163 or CS 164 with C or better); (MATH 159 or MATH 160 with C or better).	F,S	4

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Course Number	Course Title	Prerequisite	Terms	Credits
CS 270	**Computer Organization** Data representation, arithmetic, assembly and C language, digital logic and systems, Boolean algebra, circuits, CPU and memory models, state machines. Sophomore standing. Computer Science and Applied Computing Technology majors only.	(CS 163 or CS 164 with a C or better); CS 220, may be taken conc.; (MATH 159 or MATH 160 with a C or better).	F,S	4
CS/STAT 548 ++	**Bioinformatics Algorithms** Computational methods for analysis of DNA/protein sequences and other biological data	STAT 301 or STAT 307 or STAT 315	*F*	*4*
ECE 204	**Introduction to Electrical Engineering** Efficiency analysis, correctness proofs, design strategies, illustrations from domains such as graph theory, scheduling and optimization, geometry. Must register for lecture and recitation.	MATH 161; PH 142	S	3
ECE/MATH 430 ++	**Fourier and Wavelet Analysis with Apps** Fourier analysis and transforms, FFTs; sampling theorems, computational algorithms; wavelets; applications to communication. Imaging and compression	MATH 340 or MATH 345	*S*	*3*
ENGR 510	**Engineering Optimization: Method/Application** Optimization methods; linear programming, network flows, integer programming, interior point methods, quadratic programming, engineering applications.	MATH 229; MATH 261	F	3
ENGR 550 /MATH 550	**Numerical Methods in Science and Engineering** Finite elements, finite differences, spectral methods, method of lines, conservation laws; stability and convergence analysis for PDEs.			
ERHS 320 ++	**Environmental Health - Water Quality** Identify natural and man-made contaminants that impact water quality and human health; biological, chemical, and physical treatments techniques used to protect water quality	MIP 300, may be taken conc.	*F*	*3*
ERHS 332 ++	**Principles of Epidemiology** Use of epidemiological methods in studying distribution of diseases in human populations	(STAT 301 or STAT 307 may be taken conc.); MIP 300, may be taken conc.	*S*	*3*
ERHS 410 ++	**Environmental Health and Waste Management** Preventing and managing hazards from air pollution sources and handling waste; administrative management for air and waste programs	(CHEM 245 or CHEM 341 or CHEM 346, may be taken conc.); ERHS 230	*S*	*3*
ERHS 446	**Environmental Toxicology** Essentials of environmental toxicology based on problem-oriented discussions addressing environmental impacts of organic/inorganic chemicals.	CHEM 245 or CHEM 343 or CHEM 346	F	3
ERHS 448	**Environmental Contaminants: Exposure and Fate** Pathways of exposure and behavior of environmental contaminants. Exposure assessment in environmental health protection.	(CHEM 245 or CHEM 341 or CHEM 345); LIFE 102	S	3
ERHS 450	**Introduction to Radiation Biology** Genetic and somatic effects of radiation on cells, tissues, and the whole organism; tumor therapy; carcinogenesis; risks vs. benefits of radiation.	LIFE 102	S	3
ERHS 502	**Fundamentals of Toxicology** Fundamental principles of toxicology; dose-response, organ targets, toxic agents.	(BMS 300 or BMS 360); (CHEM 245 or CHEM 341 or CHEM 345)	F	3

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ERHS 503 ++	**Toxicology Principles** Principles of toxicology for applications in industrial hygiene and environmental public health	CHEM 113; LIFE 102	*S*	*1*
ERHS 510	**Cancer Biology** Cancer biology, from epidemiology and classification, through the molecular basis of the phenotypes to detection and treatment.	BC 351 or (BC 403, may be taken conc.) or BZ 310 or CM 501	S	3
ERHS 530 ++	**Radiological Physics and Dosimetry I** Theory and detection of ionizing radiation; measurement and calculation of exposure and dose	(MATH 155 or MATH 160); PH 122	*F*	*3*
ERHS 542 ++	**Biostatistical Methods for Qualitative Data** Statisitcal analysis of categorical data as obtained in epidemiology, toxicology, occupational health and clinical sciences	STAT 301 or ERHS 307 or STAT 307	*F*	*3*
ERHS 547	**Equipment and Instrumentation** Sample collection, quality control, theory and application of equipment and instrumentation for analysis and confirmation of organic-inorganic chemicals.	ERHS 446 or ERHS 502	S	3
F 311	**Forest Ecology** Relationships of ecological concepts to the dynamics of forest ecosystems.	LAND 220/LIFE 220 or LIFE 320	F,S	3
FTEC 447	**Food Chemistry** Chemistry of food constituents as related to food quality and stability.	CHEM 245 or CHEM 345	S	2
GEOL 150	**Physical Geology for Scientists and Engineers** Earth materials, structures, and surface processes. Geologic analysis using field data, topographic and geologic maps, and aerial photos.	None	F	4
GEOL 452	**Hydrogeology** Interaction of water and geologic materials; surface and groundwater; quantitative analysis and geologic effects on quality and flow of groundwater	(GEOL 110 or GEOL 120 or GEOL 122 or GEOL 124 or GEOL 150 or GR 210); (MATH 161 or MATH 255); (PH 121 or PH 141)	F	4
GEOL 454	**Geomorphology** Origin of landforms; morphology and processes. Must register for lecture and laboratory. Must register for lecture and laboratory.	(GEOL 120 or GEOL 122 or GEOL 124 or GEOL 150 or GR 210); (STAT 301 or STAT 307 or STAT 315)	S	4
GES 441	**Analysis of Sustainable Energy Solutions** Methods of evaluating sustainable energy technologies, including life cycle assessment, energy return on investment, technoeconomic analysis, and political ecology	GES 141	S	3
GES 542	**Biobased Fuels, Energy, and Chemicals** Science and engineering aspects of biobased fuel, energy, and chemical production, including plant biologym thermochemical conversion, biomass deconstruction, fermentation, and biofuel properties. Aspects of sustainable production and economics will be discussed	NA	S	3
HES 307	**Biomechanical Principles of Human Movement** Study and elementary analysis of human motion based on anatomical and mechanical principles.	HES 207 or BMS 301; PH 121 or PH 141	F,S,SS	4

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HES 319	**Neuromuscular Aspects of Human Movement** Neuromuscular anatomy and physiology of human movement. Applied/integrated topics: aging, muscle fatigue, training, force control, and neuromuscular disease. Must register for lecture	BMS 300; HES 207	F,S	4
HES 403	**Physiology of Exercise** Effects of exercise on tissues, organs, and systems of the body. Must register for lecture and laboratory.	BMS 300 or BMS 360; LIFE 102	F,S,SS	4
HES 420 ++	**Electrocardiography and Exercise Management** Interpretation of 12-lead ECG tracings, administering exercise tests and perscribing exercise program for healthy individuals and special populations	BMS 300	*F,S*	*3*
HORT 579	**Metabolomics Methods and Analysis** A survey of experimental designs and workflows to generate, computationally process and analyze metabolite and protein data using mass spectrometry	BC 351	S	2
LIFE 201B	**Introductory Genetics:** Molecular/Immunological/Developmental Introduction to genetics, with emphasis on applied genetics, population genetics, and conservation/ecological genetics.	LIFE 102	F,S	3
LIFE 202B	**Introductory Genetics Recitation: Molecular** Case-studies and problem solving in applied genetics, population genetics, and conservation/ecological genetics. Credit not allowed for both LIFE 202A and LIFE 202B.	LIFE 201A, may be taken conc.	F,S	1
LIFE 203	**Introductory Genetics Laboratory** Basic molecular genetics and molecular aspects of development laboratory. Must register for lecture and recitation.	LIFE 201A or LIFE 201B, may be taken conc.	S	2
LIFE 210	**Introductory Eukaryotic Cell Biology** Structure and function of macromolecules focusing on proteins and lipid bilayers. Cellular composition, organelles, and trafficking between them. Basic metabolism, cell signaling, and proliferation control	CHEM 111; CHEM 112; LIFE 102	F,S,SS	3
LIFE 211	**Introductory Cell Biology Honors Recitation** Molecular aspects of cellular and subcellular biology and introductury biochemistry recitation	LIFE 210, may be taken conc.	F,S	1
LIFE 212	**Introductory Cell Biology Laboratory** Molecular aspects of cellular and subcellular biology and introductory biochemistry laboratory.	(LIFE 210, may be taken conc.); (CHEM 112, may be taken conc.)	F,S	2
LIFE 320	**Ecology** Interrelationships among organisms and their environments using conceptual models and quantitative approaches.	(LIFE 102 or BZ 101 or BZ 104 or BZ 110 or BZ 120); (MATH 141 or MATH 155 or MATH 160)	F,S	3
MATH 301	**Introduction to Combinatorial Theory** Matrices, orthogonal Latin squares, designs, difference sets, sets, binomial coefficients, inclusion and exclusion, recurrence, Ramsey's theorem, SDRs	MATH 161	F	3
MATH 331	**Introduction to Mathematical Modeling** Problem formulation. Modeling, theorhetical and empirical. Variable selection. Derivation and simulation of solutions. Model testing including prediction.	(MATH 161, may be taken conc.); (MATH 229 or MATH 369, may be taken conc.)	F	3
MATH 332	**Partial Differential Equations** Partial differential equations, separation of variables, Fourier series and transforms, Laplace, heat and wave equations. Credit not allowed for both MATH 332 and MATH 530.	MATH 340 or MATH 345	S	3
MATH/BZ 348	**Theory of Population and Evolutionary Ecology** Principles and methods for building, analyzing, and interpreting mathematical models of ecological and evolutionary problems in biology.	MATH 155 or MATH 160	F	*4*
MATH 360	**Mathematics of Information Security** Codes, ciphers, Chinese remainder theorem, primality testing, public key ciphers, RSA, finite fields, discrete algorithms, AES encryption	(MATH 229 or MATH 369); MATH 161	F	3
MATH 366	**Introduction to Abstract Algebra** Sets, integers, polynomials, real and complex numbers, groups, integral domains, and fields; development of skills for proving theorems.	MATH 161 or MATH 271	F,S,SS	3
MATH 369	**Linear Algebra** Linear systems, matrices, subspaces of Euclidean spaces, linear transformations on Euclidean spaces, eigenvalues, eigenvectors.	MATH 161 or MATH 255 or MATH 271	F,S,SS	3
MATH 405	**Introduction to Number Theory** Diophantine equations; distribution of primes; multiplicative functions; finite fields; quadratic reciprocity; quadratic number fields.	MATH 360 or MATH 366	S	3
MATH 419	**Introduction to Complex Variables** Analyticity, Cauchy integral theorem and formula, Taylor and Laurent series, residue calculus, conformal mapping and harmonic functions.	MATH 261	F	3
MATH 430/ ECE 430	**Fourier and Wavelet Analysis with Apps.** Fourier analysis and transforms, FFTs; sampling theorems, computational algorithms; wavelets; applications to communication, imaging, and compression.	MATH 340 or MATH 345	S	3
MATH 450	**Intro to Numerical Analysis I:** Solutions of systems of linear and nonlinear equations, interpolation, approximation	(CS 156 or CS 163 or CS 164 or CS 253 or MATH 151); (MATH 255 or MATH 261)	F	3
MATH 451	**Intro to Numerical Analysis II:** Numerical computation of eigenvalues, numerical solution of ordinary and partial differential equations.	(CS 156 or CS 163 or CS 164 or CS 253 or MATH 151); (MATH 340 or MATH 345)	S	3
MATH 455**	**Mathematics in Biology and Medicine:** Models in population biology, cell division, host-parasoid systems, bacterial growth and predator-prey systems.	BZ 348 or MATH 255 or MATH 340 or MATH 345 or MATH 348.	F	3
MATH 460	**Information and Coding Theory** Entropy, mutual information, channel capacity, channel coding theorem, syndrome decoding, BCH codes, recent developments.	(MATH 360 or MATH 366); MATH 369	S	3
MATH 466	**Abstract Algebra I:** Comprehensive introduction to groups, rings, and fields	MATH 235 or MATH 360 or MATH 366	F	3
MATH 467	**Abstract Algebra II** Advanced topics in abstract algebra: Euclidean domains, abstract vector spaces, extension fields, Galois theory	MATH 235 or MATH 360 or MATH 366	S**	3
MATH 469	**Linear Algebra II** Abstract vector spaces, general theory of linear transformations, theory of determinants, canonical forms.	MATH 369	S	3

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CBE Technical Electives

Course Number	Course Title	Prerequisite	Terms	Credits
MATH 525	**Optimal Control** Theory and application of optimal control and optimal estimation theory; continuous and discrete time systems; Pontryagin	MATH 340 or MATH 345	S	3
MATH 530	**Mathematics for Scientists and Engineers** Proof-oriented linear algebra, ordinary and partial differential equations. Credit not allowed for both MATH 530 and MATH 332.	MATH 340 or MATH 345	F	4
MATH 532	**Mathematical Modeling of Large Data Sets** Mathematical theory and algorithms for modeling large data sets. Application to real world problems.	MATH 369 or MATH 530	S	3
MATH 535	**Foundations of Applied Mathematics** Calculus of variations, peturbation methods, models of continuum, dimensional analysis, stochastic models, integral equations, diffusion	MATH 340 or MATH 345	F	3
MATH 546	**Partial Differential Equations II** Distribution theory, Green's functions, Sobolev spaces, elliptic and parabolic equations.	MATH 545	S	3
MATH 560	**Linear Algebra** Finite dimenstional vector spaces, inner products, dual spaces, transformations, projections, adjoints, norms, eigenvalues, eigenvectors	MATH 369	F	3
MECH 303	**Energy Engineering** Energy generation (various methods), conversion, distr ibution, storage, efficiency	CBE 310 or ECE 341 or MECH 237 or MECH 337 or PH 361	F	3
MECH 307	**Mechatronics and Measurement Systems** Mechatronic and measurement system analysis and design; applied electronics; data acquisition; microcontroller interfacing and programming. Must register for lecture and laboratory.	MECH 231; CIVE 261; ECE 204; MATH 340	F,S	4
MECH 324	**Dynamics of Machines** Analysis and synthesis of moving machinery	CIVE 261; (MATH 340, may be taken conc.)	F	4
MECH 325	**Machine Design** Design of mechanical components to avoid failure during operation. Stress analysis, failure theories, and specific mechanical components in design context	CIVE 360	S	3
MECH 331	**Introduction to Engineering Materials** Characteristics of metallic, plastic, and ceramic material; basic principles which relate properties of materials to their atomic and microstructure. Must register for lecture and laboratory.	MECH 231; CHEM 111; CHEM 112	F,S	4
MECH 407	**Laser Applications in Mechanical Engineering** Review of electromagnetic waves; applications of lasers and optics in engineering	PH 142	F	3
MECH 424	**Advanced Dynamics** Kinematics and dynamics of rigid bodies	MECH 324	S	3
MECH 425	**Mechanical Engineering Vibrations** Vibrations applied to totating machinery and structures	MECH 324	F	4
MECH 431	**Metals and Alloys** Engineering metals and alloys, modification of properties by alloying, plastic deformation, and heat treatment. Fundamentals of physical metallurgy.	MECH 331	F	3
MECH 432	**Engineering of Nanomaterials:** Structure, properties, and processing of extremely small (10 to the minus 9 m) synthetic and natural materials.	(MECH 337, may be taken conc.); MATH 340; PH 141	F	3
MECH 502	**Advances/Additive Manufacturing Engineering** Materials, controls, and mechanics applied to additive manufacturing; rapid prototyping; direct digital manufacturing	MECH 202; MECH 331	S	3
MECH 507	**Laser Diagnostics for Thermosciences** Basics of optics, spectroscopy, and lasers	PH 142	S**	3
MECH 509	**Design and Analysis in Engineering Research** Design, model building, analysis and reporting in engineering and manufacturing research and experimentation	MATH 340; STAT 315	S	3
MECH 513	**Simulation Modeling and Experimentation** Logic/analytic modeling in simulations	STAT 315	S	3
MECH 524	**Principles of Dynamics** Kinematics and dynamics of rigid body motion; Lagrangian and Hamiltonian formulations of mechanics; applications to engineering problems	MECH 324	F	3
MECH 527	**Hybrid Electeric Vehicle Powertrains** Hybrid powertrains and modeling including vehicle dynamics, internal combustion engine, electric motor, energy storage, and control	MECH 307	F	3
MECH 529	**Advanced Mechanical Systems** Modeling, analysis, and synthesis of practical mechanical devices in which dynamic response is dominant consideration	MECH 307	F	3
MECH 530	**Advanced Composite Materials** Materials aspects of advanced composite constituents and how their combination yields synergistic results.	MECH 331; CIVE 360	F	3
MECH 543**	**Biofluid Mechanics:** Fluid dynamic concepts for understanding fluid motion in living organs/organisms; advanced research applications.	(BIOM 421 or CBE 331 or MECH 342); (BMS 300 and PH 121) or (BMS 300 and PH 141) or BMS 420	S	3
MECH 552	**Applied Computational Fluid Dynamics** Introductory theory of CFD, formulation of engineering problems for CFD analyses, mesh generation, solver settings, and postprocessing	CIVE 300 or CIVE 331 or MACH 342	F**	3
MIP 300	**General Microbiology** Structure, function, development, physiology, and molecular biology of microorganisms emphasizing bacteria.	(BZ 110 or BZ 120 or LIFE 102); (CHEM 245 or CHEM 341 or CHEM 345, may be taken conc.)	F,S,SS	3
MIP 302	**General Microbiology Laboratory** Laboratory skills and techniques for isolating, characterizing, and identifying bacteria.	MIP 300, may be taken conc.	F,S,SS	2
MIP 315	**Pathology of Human and Animal Disease** Biological systems critical to mammalian physiology and how each is affected by metabolic, genetic, environmental, and infectious agents	BZ 110 or LIFE 102	F,S	3
MIP 334	**Food Microbiology** Microorganisms in production of foods, in preservation and spoilage, and in food-borne diseases. Control of microorganisms in foods.	MIP 300 or LIFE 205	F	3

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CBE Technical Electives

Course Number	Course Title	Prerequisite	Terms	Credits
MIP 335	**Food Microbiology Laboratory** Laboratory skills and techniques related to the presence of microorganisms in food, production, and preservation.	(MIP 302 or LIFE 206); MIP 334, may be taken conc.	F	2
MIP 342	**Immunology** Principles of immunology: components of the immune system, interactions of humoral and cellular elements, and clinical applications of basic concepts.	(MIP 300 or LIFE 201B or LIFE 210); (CHEM 245 or CHEM 341 or CHEM 345, may be taken conc.)	F,S	4
MIP 343	**Immunology Laboratory** Techniques used in research and clinical immunology, including diagnostic problem solving and data analysis.	MIP 302; MIP 342, may be taken conc.	F,S	2
MIP 350	**Microbial Diversity** Physiological, taxonomic, and phylogenic aspects of microbial diversity. Yeasts and filamentous fungi as microbial entities.	MIP 300	S	3
MIP 351	**Medical Bacteriology** Bacteria which cause human and veterinary diseases; host-parasite relationships, disease mechanisms, prevention, and therapy.	MIP 342	S	3
MIP 352	**Medical Bacteriology Laboratory** Laboratory skills and techniques necessary for identifying medically important bacteria.	MIP 302; MIP 351, may be taken conc.	S	3
MIP 420	**Medical and Molecular Virology** Principles of animal virology: structure, classification, assay, diagnosis, control, replication, genetics, host-parasite relationships.	MIP 342; (BC 351 or BC 401, may be taken conc.)	F	4
MIP 425	**Virology and Cell Culture Laboratory** Isolation and chaacterization of viruses. Viral diagnositc and cell culture techniques	MIP 302; MIP 420, may be taken conc.	F	2
MIP 432	**Microbial Ecology** Principles of microorganism interactions with their living and non-living environments; implications for the environment, plants and animals.	MIP 300	S	3
MIP 433	**Microbial Ecology Laboratory** Experimental microbial ecology; the design, conduct and interpretation of experiments that illustrate basic principles of microbial ecology.	MIP 432, may be taken conc.	S	1
MIP 436	**Industrial Microbiology** Use of microorganisms for producing commercially valuable products. Must register for lecture and laboratory.	MIP 302 or LIFE 206	F	4
MIP 443	**Microbial Physiology** Structure, function of bacterial constituents; comparison with other organisms. Bacterial growth, energy production, biosynthesis. Must register for lecture and laboratory.	MIP 300; (BC 351 or BC 401)	S	4
MIP 450	**Microbial Genetics** Principles of genetics at molecular level; mutation, recombination, complementation, suppression, control of gene expression, and recombinant DNA.	MIP 300; (BC 351 or BC 401, may be taken conc.)	F	3
MIP 530	**Advanced Molecular Virology** Virus-host interactions at the molecular and cellular level	(BC 351 or BC 401); (BC 463 or MIP 450)	S*	4
MIP 543	**RNA Biology** Gene expression and regulation that occurs at the level of RNA	BC 351, may be taken conc. or BC 401, may be taken conc.	F**	3
MIP 550	**Microbial and Molecular Genetics Laboratory** Use of both in vivo genetics and in vitro molecular techniques to study gene structure, function, and regulation in bacteria	MIP 302; MIP 450	S	4
MIP 555	**Principles and Mechanisms of Disease** Principles of disease processes; emphasis on reactivity of the diseased cell, tissue, organ or organisms	BMS 300	F	3
MIP/BZ 578	**Genetics of Natural Populations** Theoretical and empirical aspects of the genetics of natural populations; current molecular techniques and statistical analysis.	(BZ 350 or LIFE 201A or LIFE 201B or SOCR 330); (STAT 201 or STAT 301 or STAT 307)	F	4
MSE 501	**Materials Technology Transfer** The pathways toward commercialization of materials from research	MECH 331	F	1
MSE 502 (A-F)	**Materials Science & Engineering Methods** Introduction to the atomic level arrangements of materials, defects, related to these structures, and X-ray Diffraction, X-ray scattering, and electron diffraction methods	MATH 345; MECH 331	F,S	1
MSE 503	**Mechanical Behaviors of Materials** The mechanical behavior of metals, polymeric, ceramic, and composite materials in mechanical designs from a structure to processing properties perspective.	(MSE 501 or MSE 502 A or MECH 331); (MATH 340 or MATH 345)	S	3
MSE 504	**Thermodynamics of Materials** The determination of whether and the means by which a given reaction can occur with a focus on thermodynamic and statistical mechanical aspects of material structure-property relationships	(CBE 210 or CHEM 476 or MECH 331 or PH 361); (MATH 340 or MATH 345)	F	3
MSE 505	**Kinetics of Materials** The determination of whether and the means by whichh a given reaction can occur with a focus on the kinetic aspects of material structure-property relationships	MSE 504	S	3
NR 319	**Geospatial Applications in Natural Resources** Introduction to global positioning systems (GPS), geographic information systems (GIS) and remote sensing (RS) with natural resource applications	NA	F,S	4
NR/GR 323	**Remote Sensing and Image Interpretation** Remote sensing systems and applications; characteristics of photographic, scanner and radar images; imagery interpretation. Must register for lecture and laboratory. Credit allowed for only one of the following: NR 323, NR 503, GR 323, GR 503.	None	F	3
NR 505	**Concepts in GIS** Concepts of geographic information systems and spatial data analysis	STAT 301 or STAT 511A	F	4

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CBE Technical Electives

Course Number	Course Title	Prerequisite	Terms	Credits
PH 314	**Introduction to Modern Physics** Relativity; quantum mechanics; atomic structure; applications to solid-state, nuclear, and elementary particle physics.	PH 142; (MATH 261, may be taken conc.)	S	4
PH 315	**Modern Physics Laboratory** Relativity; quantum mechanics; atomic structure; applications to solid-state, nuclear, and elementary particle physics.	PH 142; (MATH 261, may be taken conc.)	S	2
PH 341	**Mechanics** Particle dynamics, translation and rotation of rigid bodies, moving coordinate systems, Lagrangian mechanics, matrix and tensor methods.	PH 141; (MATH 340 or MATH 345)	F	4
PH 351	**Electricity and Magnetism** Electrostatics, magnetostatics, currents, time-dependent electric and magnetic fields, radiation.	(MATH 340 or MATH 345); PH 142	S	4
PH 353	**Optics and Waves** Geometrical optics; wave optics; interference, diffraction, and polarization; quantum optics.	PH 142; MATH 261	F	4
PH 361	**Physical Thermodynamics** Laws of thermodynamics; thermodynamic potentials; applications such as fluids, phase transitions, electrical and magnetic systems, binary mixtures.	PH 142; MATH 261	S	3
PH 451	**Introductory Quantum Mechanics I** Schrodinger's theory of wave mechanics, potential wells, harmonic oscillators, wave packets, operators, angular momentum.	PH 314; (MATH 340 or MATH 345)	F	3
PH 452	**Introductory Quantum Mechanics II** Approximation techniques, perturbation theory, identical particles and spin, structure and spectra of atoms and molecules, hydrogen atom.	PH 451	S	3
PH 517	**Chaos, Fractals, and Non-linear Dynamics** Strange attractors, fractal dimensions, Lyapunov exponents, multifractal spectrum, period doublind, universality, intermittency, time-delay embedding	(MATH 261; PH 341); (MATH 340 or MATH 345)	S	3
PH 521	**Introduction to Lasers** Stimulated emission; laser resonators; theory of laser oscillation; specific laser systems; applications.	MATH 340; PH 353; (CHEM 476 or PH 451)	S	3
PH 522	**Introductory Laser Laboratory** Experiments providing hands-on experiences with lasers.	PH 521, may be taken conc.	S	1
PH 531	**Introductory Solid State Physics** Crystal structures and bonding, electronic levels and vibrations, dielectric, optical and magnetic properties, quasiparticles, superconductivity.	PH 361; PH 451	S	3
PH 561	**Elementary Particle Physics** Particle interactions and detection techniques. Quark model, scattering models and standard model of electroweak interactions, physics of colliders.	PH 451	S	3
PH 571	**Mathematical Methods for Physicists I** Vector analysis, eigenvalues and eigenvectors, infinite series, method of Frobenius, complex variables, contour integration.	MATH 340	F	3
PH 572	**Mathematical Methods for Physicists II** Partial differential equations, Sturm-Liouville theory, special functions, Green's functions, Fourier series, Fourier and Laplace transforms.	PH 571	S	3
PHIL 410	**Gödel's Incompleteness Theorems** The proofs in detail of Gödel's two incompleteness theorems, two of the most important results in modern logic, along with the necessary mathematical and logical background. .	PHIL 210 or CS 220 or CS 253 or CS 270 or ECE 102	OAN	3
SOCR 330	**Principles of Genetics** Transmission, population, and molecular genetics; practical applications.	BZ 110 or BZ 120 or LIFE 102	F,S	3
SOCR 400	**Soils and Global Change: Science and Impacts** Foundations on the science of global change and its impact on soil processes and biota.	SOCR 240; (LIFE 220 or LIFE 320)		
SOCR 430	**Applications of Plant Biotechnology** Current and potential applications of DNA-based biotechnology in crop agriculture and other plant disciplines	SOCR 330	F*	3
SOCR 455	**Soil Microbiology** Microbial activities in agricultural, forest, and grassland soils; in soil-plant relationships; and in maintenance of environmental quality.	SOCR 240 or MIP 300	F	3
SOCR 456	**Soil Microbiology Laboratory** Techniques used in study of ecology and activities of soil microorganisms.	SOCR 455, may be taken conc.	F	1
SOCR 467	**Soil and Environmental Chemistry** Fundamental principles of soil chemistry with respect to environmental reactions between soils and other natural materials and priority pollutants.	CHEM 335	S	3
SOCR 470	**Soil Physics** Physical properties of soils emphasizing mechanical composition, moisture, aeration, temperature, and structure related to management, plant growth.	SOCR 240 or GEOL 232	F	3
SOCR 471	**Soil Physics Laboratory** Familiarization of techniques and equipment used in evaluation of soil physical properties.	SOCR 470, may be taken conc.	F	1
SOCR 567	**Environmental Soil Chemistry** The chemistry of terrestrial environments and the interactions of soil constituents with bacteria, nutrients and pollutants	CHEM 335	S	4
STAT 305	**Sampling Techniques** Sample designs: simple random, stratified, systematic, cluster, unequal probability, two-phase; methods of estimation and sample size determination.	STAT 301 or STAT 307/ERHS 307 or STAT 311 or STAT 315	F	3
STAT 340	**Multiple Regression Analysis** Estimation and testing for linear, polynomial, and multiple regression models; analysis of residuals; selection of variables; nonlinear regression.	STAT 301 or STAT 307/ERHS 307 or STAT 311 or STAT 315	S,SS	3
STAT 341	**Statistical Data Analysis I** Estimation and inference based upon Gaussian liner regression models; residual analysis; variable selection; non-linear regression	STAT 158; (STAT 301 or STAT 307 or STAT 311 or STAT 315	F	3

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CBE Technical Electives

Course Number	Course Title	Prerequisite	Terms	Credits
STAT 342	**Statistical Data Analysis II** Single factor analysis of variance models; multi-factor analysis of variance models; randomized block design; Latin squares; split-plot design	STAT 340 or STAT 341	S	3
STAT 350	**Design of Experiments** Analysis of variance, covariance; randomization; completely randomized, randomized block, latin-square, split-plot, factorial and other designs.	STAT 301 or STAT 307/ERHS 307 or STAT 311 or STAT 315	F,SS	3
STAT 400	**Statistical Computing** Computationally intensive statistical methods; optimization for statistical problems; simulation and Monte Carlo methods; resampling methods; smoothing	(CS 160 or CS 163 or CS 164 or MATH 151; MATH 153); (STAT 420, may be taken conc.)	F	3
STAT 420	**Probability and Mathematical Statistics I** Probability, random variables, distribution functions, and expectations; joint and conditional distributions and expectations; transformations.	MATH 255 or MATH 261	F	3
STAT421	**Introduction to Stochastic Processes:** Modeling phenomena with stochastic processes and the simulation and analysis of stochastic process models.	(MATH 229 or MATH 369); STAT 420	S	3
STAT 430	**Probability and Mathematical Statistics II** Theories and applications of estimation, testing, and confidence intervals, sampling distributions including normal, gamma, beta X-squared, t, and F.	STAT 420	S	3
STAT 460	**Applied Multivariate Analysis** Principles for multivariate estimation and testing, multivariate analysis of variance, discriminant analysis; principal components, factor analysis	(STAT 340 or STAT 341); (DSCI 369 or MATH 229 or MATH 340 or MATH 369)	F,S,SS	3
STAT 512	**Design and Data Analysis for Researchers II** Statistical methods for experimenters and researchers emphasizing design and analysis of experiments. Must register for lecture and recitation.	STAT 511	S	4
STAT 548	**Bioinformatics Algorithms** Computational methods for analysis of DNA/protein sequences and other biological data	STAT 301 or STAT 307 or STAT 315	F	4

A maximum of 3 credits may be selected from the following courses for CBE Tes

Course Number	Course Title	Prerequisite	Terms	Credits
ENGR 422	**Technology and Entrepreneurship** Principles of technology-based entrepreneurship, including recognizing, analyzing, and acting on technology-based business opportunities; and development of an opportunity analysis.	MGT 340	S	3
ENGR 502	**Engineering Project and Program Management** Engineering program management fundamentals, program planning and control strategies, risk assessment, work breakdown structures and costing options.	None	F, S	3
ENGR 525	**Intellectual Property and Invention Systems** Focused on the appropriate application of "patterns for patenting" together with intuition, inspiration, and cross-disciplinary connecting. De-mystify "inventing" as applied to science, engineering and technology.	None	S	3
FIN 305	**Fundamentals of Finance** Role of finance in management of the firm; role, structure of financial markets and institutions, valuation of basic securities.	(ACT 205 or ACT 210)	F, S, SS	3
IDEA 310B	**Design Thinking Toolbox: 3D Modeling** Employing design theories and methods to 3D modeling projects that promote "iterative tinkering" through exploration of various design processes using computer software.	IDEA 210, May be taken CONC	OAN	2
IDEA 310D	**Design Thinking Toolbox: Digital Imaging** Design theories and methods employing digital imaging projects that promote "iterative tinkering" experiences through exploration of various design processes.	IDEA 210, May be taken CONC	OAN	1
MGT 305	**Fundamentals of Management** Managerial process of planning, directing, and controlling inputs of an organization. Analysis, decision making, and survey of research literature.	None	F, S, SS	3
MGT 340	**Fundamentals of Entrepreneurship** Concepts of entrepreneurship and role of entrepreneurs in the economy.	None	F, S, SS	3
MKT 305	**Fundamentals of Marketing** Overview of marketing activities involved in provision of products and services to customers, including target markets and managerial aspects.	AREC 202 or ECON 101 or ECON 202	F, S, SS	3

To Request Overrides - Include your CSU ID and verification that you meet prerequisites. If you need an override for a non-engineering course, reach out to the prof and request override. For engineering courses, follow procedures as indicated below.

- For 500-level BIOM or MECH courses, request permission from Sara.Mattern@colostate.edu (BME grad adviser) to request override.
- For 500-level CBE courses, you should be able to register if you meet the pre-requisistes. If you need an override, request from prof; forward permission to Claire.Lavelle@colostate.edu.
- For 500-level ECE courses, you should be able to register if you meet the pre-requisistes. If you need an override, request from prof; forward permission to Courtney.Johnsrud@colostate.edu
- For CIVE courses, email your BME adviser with the reason you want the override (e.g. meet pre-reqs but are not in the major) and she will forward request to the department on your behalf.
- To request overrides for other courses (e.g. non-engr, 500-level or prereq override), email the course professor or the department teaching the course.

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