

Listing of Approved Technical Electives

Code Definition of Codes used in Table

B	Biomolecular option courses (these courses are also recommended for pre-health students)
C	counts towards the requirement for 6 credit hours in ChBE technical electives
E	Environmental option
M	satisfies the requirement for 3 credit hours in advanced math
N	new course (planned for near future, or may have already been offered)
P	Polymer Option
R	offered infrequently (most ChBE technical electives are offered every 1 or 2 years)

Course	Credit	Subject	Codes
Biochem 511	2 or 5	Introduction to Biochemistry	B
Biomed Eng 500	3	Introduction to Biomedical Engineering	B
Biomed Eng 739	3	Biopolymer Structure & Function	B, P
Biomed Eng 721	3	Biological Transport	B
Civil En 511	3	Introduction to Environmental Engineering	E
Civil En 520	4	Design of Treatment Facilities (water treatment)	E
Civil En 610	3	Analysis of Natural and Polluted Waters	E
Civil En 618	4	Environmental Pollution	E
Civil En 711	4	Biological Processes for Used Water Treatment	E
Civil En 714	3	Hazardous Waste Management	E
Civil En 717	4	Municipal and Industrial Solid Waste Management	E
Civil En 719	3	Water Quality Monitoring	E
Civil En 760	5	Civil and Environmental Engineering Planning	E
Chem 221	5	Analytical Chemistry I	
Chem 255	3	Organic Chemistry Laboratory	
Chem 587	3	Analytical Chemistry II: Instrumental Analysis	
Chem 588	3	Laboratory Practice in Instrumental Analysis	
ChBE 626	3	Digital Control Techniques in Chemical Engineering	C, R
ChBE 632 (ECE)	3	Introduction to Nanofabrication and Nanomanufacturing	
ChBE 693	1-6	Individual Studies (undergraduate research) (6 hours max)	
ChBE H783	1-9	Undergraduate Honors Program Research (9 hours max)	
ChBE 694	3	Fundamentals of Injection Molding	C, N
ChBE 694	3	Transport Phenomena in Biological Systems	C, B
ChBE 702	3	Dynamics of Multiphase Flows (formerly 694)	C
ChBE 712	3	Catalysis and Catalytic Processes	C
ChBE 713	3	Fuel Cells & Catalysis (formerly 694)	C
ChBE 715	3	Particle Technology	C
ChBE 717	3	Colloids and Surfaces	C
ChBE 726	3	Chemical & Biomolecular Process Dynamics and Control II	C, R
ChBE 733	3	Chemical & Biomolecular Separation Processes	B, C
ChBE 734	3	Molecular Informatics	B, C, R
ChBE 735	3	Cellular Nanotechnology (formerly 694)	B, C

ChBE 739	3	Knowledge-Based Systems in Engineering	C, R
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Listing of Approved Technical Electives (Dept. of Chemical & Biomolecular Engineering)

Course	Credit	Subject	Codes
ChBE 755	3	Process Safety (formerly 694)	C
ChBE 761	3	Chemical & Biomolecular Engineering Processes	C
ChBE 763	3	Special Problems in Process Design (AIChE Student Contest)	
ChBE 765	3	Principles of Biochemical Engineering	B, C, P
ChBE 766	3	Biotechnology and Bioprocess Engineering	B, C, P
ChBE 769	3	Biomedical Nanotechnology	B
ChBE 771	3	Air Pollution	C
ChBE 772	3	Industrial Ecology	C, E, N
ChBE 773	3	Introduction to High Polymer Engineering	C, P
ChBE 774	3	Polymer Membranes	C, N, P
ChBE 775	3	Rheology of Fluids	C, P
ChBE 776	3	Principles of Polymer Conversion Operations	C, P
ChBE 777	3	Polymer Micro/Nano Engineering (formerly 694)	C, P
ChBE 779	3	Chemical & Biomolecular Engineering Experimental Design	C, B, E, P
ChBE 780	3	Advanced Experimental Design (formerly 694)	C
ChBE 781	3	Chemical Engineering Optimization	C, R
ChBE 790	3	Process Modeling and Simulation	C, R
CS&E 541	3	Elementary Numerical Methods	M
CS&E 640	3	Numerical Analyses	
CS&E 642	3	Numerical Linear Algebra	
CS&E 630	3	Survey of Artificial Intelligence I: Basic Techniques	
CS&E 730	3	Survey of Artificial Intelligence I: Advanced Techniques	
FA&B Eng 784	3	Advanced Food Process Engineering	
FD SC&TE 401	3	Intro to Food Processing	
FD SC&TE 605	4	Advanced Food Chemistry	
FD SC&TE 611	4	Food Fermentation	
FD SC&TE 630	4	Principles of Food Processing	
FD SC&TE 650	4	Food Product Development	
Geol 651	5	Hydrogeology	E
MatSci Eng 642	3	Polymer Science & Engineering	P
MatSci Eng 645	3	Materials in Medicine I	P
MatSci Eng 646	3	Materials in Medicine II	P
Math 366	3	Discrete Math	M
Math 512	3	Partial Differential Equations and Boundary Value Problems	M
Math 513	3	Vector Analysis for Engineers	M
Math 514	3	Complex Variables for Engineers	M
Math 530	3	Probability	M
Math 551	3	Vector Analysis (not open to students with 513)	M

Math 568	3	Linear Algebra I	M
Course	Credit	Subject	Codes
Math 569	3	Linear Algebra II	
Math 571	3	Linear Algebra for Applications I	M
Math 572	3	Linear Algebra for Applications II	
Mech Eng 505	3	Introduction to Nuclear Science and Engineering	
Micrbiol 509	5	Basic and Practical Microbiology	B
Micrbiol 520	6	General Microbiology I	B
Micrbiol 521	6	General Microbiology II	B
Micrbiol 661	5	General Microbial Physiology	B
Mol Gen 500	5	General Genetics	B
Mol Gen 607	3	Cell Biology	B
Nuclr En 505	3	Introduction to Nuclear Science and Engineering	
Nuclr En 606	3	Radiological Safety	
Nuclr En 771	3	Radioactive Waste Management	E
Physiocb 601	5	Organ System Physiology	B
Pubh-Ehs 731	4	Principles of Environmental Health	B, E
Stat 427	3	Intro to Probability and Statistics for Engineering and the Sciences	M
Stat 428	3	Intro to Probability and Statistics for Engineering and the Sciences II	M
Stat 420	5	Mathematical Statistics I	B, M
Stat 421	5	Mathematical Statistics II	

Technical Electives - Descriptions, Quarters Offered & Pre-Requisites

Bio-Chemistry 511 Introduction to Biological Chemistry U G 5

An introductory course in biochemistry dealing with the molecular basis of structure and metabolism of plants, animals, and microorganisms.

Su, Au, Wi, Sp Qtrs. 5 cl. Prereq: Chem 123 and 242 or 252, and 2 qtrs of biological sciences. The organic chemistry requirement may also be satisfied by Chem 231 with a grade of at least C. This course is available for EM credit.

* Biochem 511 may be used as a substitute for Chem 253, the third course in the organic chemistry sequence. Since Biochem 511 is 5 credits and Chem 253 is 3 credits, students choosing this option can apply the extra 2 credits from Biochem 511 towards their technical elective requirements. Students who take both Biochem 511 and Chem 253 can use all 5 credits as technical electives.

Biomedical Engineering 500 Survey of Biomedical Engineering U G 3

Multi-lecturer survey course designed to introduce fundamental technologies and design methodologies relevant to biomedical engineering product development and clinical applications.

2 1.5-hr cl. Prereq: ME 410, EEOB 232

Biomedical Engineering 721: Biological Transport U G 3

Theoretical and phenomenological derivation of transport mechanisms important for biological systems. Includes passive, active and extracellular transport.

2 1.5-hr cl. Prereq: Math 255 or 415; ChBE 420 or ME 500; Chem 125 or equiv; Biomed E 500 or grad standing; or permission of instructor.

Biomedical Engineering 739 Biopolymer Structure and Function U G 3

Discussion of biopolymers, critical for normal body function, including those involved in bone structure, coagulation, elasticity, extracellular matrix, genetics.

Au Qtr. 2 1.5-hr cl. Prereq: Chem 125 or equiv; Chem 231 or equiv; Biomed E 400 or grad standing; or permission of instructor

Civil Engineering 511 Introduction to Environmental Engineering U G 3

Quantitative analysis of water, air, and noise pollution, hazardous waste management, ionizing radiation, occupational and environmental health engineering, and pollution prevention.

Sp Qtr. 3 cl. Prereq: Chem 122 or 125, and Math 152; acceptance as an engineering or environmental science major or permission of instructor.

Civil Engineering 520 Design of Treatment Facilities U G 4

Selection and design of processes for the purification of natural and used waters.

Sp Qtr. 4 cl. Prereq: Chem 122 or 125

Civil Engineering 610 Analysis of Natural and Polluted Waters U G 3

A laboratory study of the measurement and interpretation of water quality indices and pollution parameters including BOD, COD, alkalinity, nutrients, PH, and heavy metals.

Au Qtr. 2 cl, 1 3-hr lab. Prereq: Chem 122 or 125 and Math 152 or equiv.

Civil Engineering 618 Ecological Engineering and Science U G 4

Definition, classification, and practice of Ecological Engineering. Course describes ecological systems and the design of natural systems to provide societal services and benefits to nature.

Wi Qtr. 2 2-hr cl. Prereq: Jr standing with at least one course in one of the following subject areas: biology, ecology, engineering, or geology. Not open to students with credit for FA&B Eng 618 or Nat Res 618. Cross-listed in Food, Agricultural and Biological Engineering, and Natural Resources.

Civil Engineering 711 Biological Processes for Used Water Treatment U G 4

Principles and design of biological processes for used water treatment.

Wi Qtr. 4 cl. Prereq: 520 or equiv.

Civil Engineering 714 Hazardous Waste Management U G 3

Environmental regulations; site remediation process; remedial alternatives; implementation; case studies.

Sp Qtr. 3 cl. Prereq: 520.

Civil Engineering 717 Municipal and Industrial Solid Waste Management U G 4

Characterization and sources of solid wastes; solid waste management; collection systems; processing; disposal; and recycle.

Sp Qtr. 4 cl. Prereq or concur: 520.

Civil Engineering 719 Water Quality Modeling U G 3

Stream and effluent standards for beneficial uses, and computer modeling of pollutant impacts on rivers.

Au Qtr. 3 cl. Prereq: 520 or equiv with written permission of instructor.

Civil Engineering 760 Civil and Environmental Engineering Planning U G 5

Water resource planning process, benefit-cost analysis; environmental, economic, and social impacts of civil engineering projects; project selection; and case studies in water resources, transportation, and energy.

Sp Qtr. 5 cl. Prereq: 516. Odd years.

Chemistry 221 Analytical Chemistry I U 5

Analytical chemistry for chemistry majors; quantitative analysis of the elemental and molecular composition of complex systems.

Su, Au, Wi, Sp Qtrs. 3 cl, 8 lab hrs. H221 (honors) may be available to students enrolled in an honors program or by permission of department or instructor. Prereq: 123 or equiv and eligibility to enroll in Math 151. Safety glasses must be worn in lab.

Chemistry 255 Organic Chemistry Laboratory U 3

Continuation of 254.

Au, Wi, Sp Qtrs. 1 cl, 2 4-hr labs. H255 (honors) may be available to students enrolled in an honors program or by permission of department or instructor. Prereq for 255: 252 and 254. Prereq for H255: 252, 254, and permission of instructor. H255: Sp Qtr only. Safety glasses must be worn in lab.

Chemistry 587 Analytical Chemistry II: Instrumental Analysis U G 3

Applications of physico-chemical principles to problems of quantitative analysis.

Wi, Sp Qtrs. 3 cl. Prereq or concur: 521 or 532, and 541.

Chemistry 588 Laboratory Practice in Instrumental Analysis U G 3

Laboratory applications of physico-chemical principles to instrumental analysis.

Wi, Sp Qtrs. 2 3-hr labs. Prereq or concur: 587 or permission of instructor. Safety glasses must be worn in lab.

Chemical & Biomolecular Eng 626 Digital Control Techniques in Chemical Engineering U G 3

Study of real-time data acquisition and digital control techniques as applied to chemical processes.

Prereq: 624 and En Graph 200, or permission of instructor.

** Please note: This course has not been offered in the past five years*

Chemical & Biomolecular Eng 693 Individual Studies in Chemical & Biomolecular Engineering U G 1-8

1 to 8 credit hours per quarter, repeatable to a maximum of 15 hours. A maximum of 6 credit hours can be counted towards the 18 hour technical elective requirement. Please note that these hours are independent of the Chemical Engineering 6 hour requirement.

Under the direction of a faculty member, students work on a research problem that may involve laboratory work, computer programming and data analysis, and literature searching. This course provides students with experience solving open-ended research problems and is ideal for students who enjoy working in the lab or on the computer, or those who are interested in graduate school.

For more information on getting started in research and reviewing faculty research interests, please see: http://www.chbmeng.ohio-state.edu/undergrad/cs_research.html on the undergraduate webpage.

Prereq: Permission of instructor. This course is graded S/U. To register for research hours, students must contact Mary Hoy.

Chemical & Biomolecular Eng 694 Group Studies in Chemical & Biomolecular Engineering U G 1-6

Repeatable to a maximum of 15 cr hrs. Note that these courses are new courses and have individual pre-requisites.

- Transport Phenomena for Biological Processes
- Fundamentals of Injection Molding

*The 694 course number is generally used for new courses the first (and often also the second) time a course is taught. Students may therefore take ChE 694 multiple times as long as the course content is different.

Chemical & Biomolecular Eng 715 Particle Technology U G 3

An introduction to engineering processes involving particulates and powders. Multiphase transport phenomena and fluidization are emphasized.

Prereq: 523, Math 415, or grad standing or permission of instructor.

Chemical & Biomolecular Eng 717 Colloids and Surfaces U G 3

Introduction to various aspects of colloids and surfaces, including sedimentation, diffusion, thermodynamics, light scattering, surface tension, contact angle, and surfactants.

Prereq: 509 or Chem 531, Math 255, Chem 253.

Chemical & Biomolecular Eng 726 Process Dynamics and Control II U G 3

Further development of process dynamics and control topics begun in 624.

Prereq: 624 or permission of instructor.

** Please note: This course has not been offered in the past five years*

Chemical & Biomolecular Eng 733 Novel Separation Processes U G 3

Provides further depth beyond 523 in the area of separations applied to chemical processing and introduces some novel techniques that are at the leading edge of separations research.

Prereq: 509, 523 or grad standing, or permission of instructor.

Chemical & Biomolecular Eng 739 Knowledge-Based Systems in Engineering U G 3

Application of knowledge-based system principles to engineering problems, including practical knowledge engineering, techniques for problem assessment, and implementation.

Prereq: Cptr/Inf 630 or permission of instructor. Cross-listed in Computer and information Science; Civil Engineering.

** Please note: This course has not been offered in the past five years*

Chemical & Biomolecular Eng 761 Chemical & Biomolecular Engineering Processes U G 3

Integration of fundamentals of chemistry, chemical engineering operations, thermodynamics, reaction kinetics, and economics for optimum design and operation of chemical process plants.

Prereq: Sr standing in ChBE or chem.

Chemical & Biomolecular Eng 763 Special Problems in Process Design U 2

Analysis of definite problems having theoretical and practical application to the chemical industry; individual effort guided by a chemical engineering staff member. This course is an independent group design project. If you are interested in registering for this course, please contact John Corn at corn@chbmeng.ohio-state.edu.

Prereq or concur: 760.

Chemical & Biomolecular Eng 765 Principles of Biochemical Engineering U G 3

The application of biochemical engineering principles for modern bioprocesses and in the area of industrial biotechnology.

Prereq: 523, 610, or grad standing or permission of instructor. Not open to students with credit for 666.

Chemical & Biomolecular Eng 766 Biotechnology and Bioprocess Engineering U G 3

Fundamentals of biotechnology and their applications to bioprocessing with emphasis on fermentation and bioseparation.

Chemical & Biomolecular Eng 769 Biomedical Nanotechnology U G 3

Survey of biomedical technology with particular emphasis on nanoscale mass transport, nanomechanics, nanofluidics and medical therapeutics.

Prereq: Math 153. Cross-listed with Biomed E 761.

Chemical & Biomolecular Eng 771 Air Pollution U G 3

Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control.

Prereq: Senior standing in engineering or permission of instructor.

Chemical & Biomolecular Eng 772 Principles of Sustainable Engineering U G 3

Introduce systematic methods for evaluating the broader impact of engineering activities on the environment and society, with an emphasis on sustainability of emerging technologies and management strategies.

Chemical & Biomolecular Eng 773 Introduction to High Polymer Engineering U G 3

Engineering of polymerization and polymer forming processes based upon thermodynamics, transport phenomena, and reaction kinetics; relationships of engineering properties of high polymers to molecular characteristics.

Prereq: 610 and Chem. 251 or permission of instructor.

Chemical & Biomolecular Eng 774 Polymer Membranes U G 3

In-depth study of membrane separation mechanisms, transport models, membrane permeability computations/measurements, membrane materials/types/modules and membrane reactions.

Prereq: 509 or sr standing in MatSc&En or grad standing. Not open to students with credit for MatSc&En 774. Cross-listed in Materials Science and Engineering.

Chemical & Biomolecular Eng 775 Rheology of Fluids U G 3

Principles of rheology including the characteristics of non-Newtonian materials, rheological equations of state, viscometric flows, measurements and applications to the flow of industrial materials.

Prereq: 420 or 520 or equiv with written permission of instructor.

Chemical & Biomolecular Eng 776 Principles of Polymer Conversion Operations U G 3

Principles of thermodynamics, transport phenomena, polymer chemistry and physics will be related to polymer processing (converting high polymers) through application of mathematical and analytical approaches.

Prereq: 773 or permission of instructor.

Chemical & Biomolecular Eng 779 Engineering Experimental Design U G 3

Industrial and research experiments designed with special emphasis on reducing the number of experiments, interpreting final results, and ensuring against unknown factors.

Prereq: En Graph 167 or equiv or permission of instructor.

Chemical & Biomolecular Eng 781 Engineering Optimization U G 3

Description, analysis, and comparison of the techniques in use in unimodel optimization; linear programming; geometric programming.

Prereq: En Graph 167 or equiv or permission of instructor.

** Please note: This course has not been offered in the past five years*

Chemical & Biomolecular Eng H783 Undergraduate Honors Program Research U 1-3

1 to 3 credits per quarter, repeatable to a maximum of 9 credit hours, all of which count towards the 18 hour technical elective requirement. Please note that these hours are independent of the Chemical Engineering 6 hour requirement. This course should be used for students planning on writing an undergraduate honors thesis.

Under the direction of a faculty member, students work on a research problem that may involve laboratory work, computer programming and data analysis, and literature searching. This course provides students with experience solving open-ended research problems and is ideal for students who enjoy working in the lab or on the computer, or those who are interested in graduate school.

Honors research projects also require students to prepare a written final report and oral presentation to ChBE faculty. Before beginning the project, students have the option of writing a research proposal; the College of Engineering evaluates these proposals and a significant number of applicants receive fellowship awards.

For more information on getting started in research and reviewing faculty research interests, please see: http://www.chbmeng.ohio-state.edu/undergrad/cs_research.html on the undergraduate webpage. Students interested in ChBE H783 should also contact Dr. Koelling (koelling.1@osu.edu) for more information on honors thesis requirements and see: <http://www.eng.ohio-state.edu/currentstudents/honorsstudents.php> for more information writing an abstract, applying for funding and graduating with distinction (honors research thesis).

Prereq: GPA of 3.4 or higher; Permission of instructor. To register for research hours, students must contact Mary Hoy quarterly.

Chemical & Biomolecular Eng 790 Process Modeling and Simulation U G 3

Application of basic chemical and biomolecular engineering principles to construct mathematical models of industrial processes and the simulation thereof by digital and analog techniques.

Prereq: Permission of instructor.

** Please note: This course has not been offered in the past five years*

Computer Science 541 Elementary Numerical Methods U G 3

Survey of basic numerical methods; number systems and errors of finite representation, solution of a single non-linear equation, interpolation, numerical integration, and solution of linear systems.

Su, Au, Wi, Sp Qtrs. 3 cl. Prereq: 221 or 230; Math153.

Computer Science 630 Survey of Artificial Intelligence I: Basic Techniques U G 3

A survey of the basic concepts and techniques, problem solving, and knowledge representation, including an introduction to expert systems.

Au, Wi, Sp Qtrs. 3 cl. Prereq: 222 and Math 366 and sr/grad standing.

Computer Science 640 Numerical Analysis U G 3

Analysis of numerical methods for ordinary differential equations, boundary value, and characteristic value problems, splines, non-linear equations, approximation of functions; standard mathematical software libraries.

Wi Qtr. 3 cl. Prereq: 221 or equiv; Math 255 or 415; and 541 or grad standing.

Computer Science 642 Numerical Linear Algebra U G 3

Iterative methods for the solution of linear systems, computation of eigenvalues and eigenvectors, linear programming-simplex method, use of standard mathematical software libraries.

Au Qtr. 3 cl. Prereq: 541; Math 568 or 571.

Computer Science 730 Survey of Artificial Intelligence II: Advanced Topics U G 3

A survey of advanced concepts, techniques, and applications of artificial intelligence, including knowledge-based systems, learning, natural language understanding, and vision.

Au Qtr. 3 cl. Prereq: 630.

Food, Ag, & Bio Eng 784 Advanced Food Process Engineering U G 3

Application of heat and mass transfer, fluid flow, food properties, and food processing constraints in the design and selection of food process equipment.

Sp Qtr. 3 cl. Prereq: ChBE 521 or Mech Eng 510 or equiv.

Food Science & Technology 401 Introduction to Food Processing U 3

Unit operations in food processing, basic elements of food processing equipment, product formulation, food manufacturing, quality control, cleaning, and sanitizing.

Au, Sp Qtrs. 1 cl, 2 3-hr labs.

Food Science & Technology 605 Advanced Food Chemistry U G 4

Intensive coverage of the chemical reactions of food components with emphasis on the reaction mechanisms responsible for changes in food products.

Wi Qtr. 3 cl, 1 2-hr lab. Prereq: 601, Chem 252 and Biochem 511.

Food Science & Technology 611 Fermented Foods U G 4

Principles and practices related to the manufacture, processing, distribution, and marketing, nutritional value and safety of fermented foods.

Wi Qtr. 3 cl, 1 3-hr lab. Prereq: 401, 522, or 602, and Micrbiol 509.

Food Science & Technology 630 Principles of Food Processing U G 4

Principles of science and engineering applied in food processing and their unit operations including concentration, separation, and thermal sterilization processes.

Wi Qtr. 3 cl, 2-hr lab. Prereq: 541 or grad standing or permission of instructor.

Food Science & Technology 650 Food Product Development U G 4

Development of a new food product including generation of concepts, consumer panel testing, development of prototypes, process optimization and consumer testing.

Sp Qtr. 2 cl, 2 3-hr labs. Prereq: 401 and 621 or permission of instructor.

Geology 651 Hydrogeology U G 5

Geologic and hydrologic factors controlling the occurrence, movement, storage, and chemical quality of ground water; exploration, evaluation, development, and management of ground-water resources.

Au Qtr. 4 cl, 1 2-hr lab, 1 all-day field trip. Prereq: 121 and Math 153.

Materials Science and Eng 642 Polymer Science and Engineering U G 3

Principles of polymer science and engineering and the important concepts that distinguish plastics from inorganic materials. Structure/property relationships that drive new applications.

Au Qtr. 3 1-hr cl. Prereq: Physics 132, Math 254, Chem 121, and MatSc&En 205.

Materials Science and Eng 644 Structure and Properties of Composite Materials U G 3

Structure and properties of polymer matrix, metal matrix, and ceramic matrix composites. Tailoring of properties by composite design.

Wi Qtr. 3 1-hr cl. Prereq: 341, 361. Not open to students with credit for 684.

Materials Science and Eng 645 Materials in Medicine I U G 3

The science and engineering of materials having medical applications.

Wi Qtr. 3 1-hr cl. Prereq: 205 and 642 or ChBE 773 or equiv.

366 Discrete Mathematical Structures I U 3

Mathematical formalization and reasoning, logic, and Boolean algebra; sets, functions, relations, recursive definitions, and mathematical induction; and elementary counting principles.

Su Term 1, Au, Wi, Sp Qtrs. 3 cl. Prereq: 132 or 152 or permission of dept.

Math 512 Partial Differential Equations and Boundary Value Problems U G 3

Fourier series, orthogonality relations, vibrating string, steady state heat, Laplace transform, and applications.

Su (1st term), Au, Wi, Sp Qtrs. 3 cl. Prereq: 255 or 415 or equiv with written permission of dept. Not open to students with credit for 557.

Math 513 Vector Analysis for Engineers U G 3

Vector algebra, vector operators, line integrals, vector integral theorems, curvilinear coordinates; applications.

Au, Wi Qtrs. 3 cl. Prereq: 254. Not open to students with credit for 551.

Math 514 Complex Variables for Engineers U G 3

Introduction to complex variables, analytic functions, complex integral theorems, power series, residues, conformal mapping.

Sp Qtr. 3 cl. Prereq: 254 or equiv with written permission of dept. Not open to students with credit for 552 or 654.

Math 530 Probability U G 3

Combinatorial probability, random variables, independence, expectations, variance.

Au Qtr. 3 cl. Prereq: 254

551 Vector Analysis U G 5

Vector operations in three dimensions, vector operators, surface area, the theorems of Green and Stokes, the divergence theorem; applications.

Sp Qtr. 5 cl. Prereq: 254. Not open to students with credit for 513.

Math 568 Introductory Linear Algebra I U G 3

The space R^n and its subspaces; matrices as mappings; matrix algebra; systems of equations; determinants; dot product in R^n ; geometric interpretations.

Prereq: 254 or equiv with written permission of dept. Not open to students with credit for 571.

Math 569 Introductory Linear Algebra II U G 3

Vector spaces over \mathbb{R} and \mathbb{C} ; linear transformations; the polynomial ring $\mathbb{R}[x]$; characteristic values and vectors; inner product spaces; quadratic form reduction; principal axis theorem.

Su (2nd term), Au, Wi, Sp Qtrs. 3 cl. Prereq: 568 or equiv with written permission of dept. Not open to students with credit for 572.

Math 571 Linear Algebra for Applications I U G 3

Linear systems of equations; vector spaces, matrices, linear operators; inner products, projections and least squares, approximations or eigenvalue problems; applications.

Su (1st term), Au, Sp Qtrs. 3 cl. Prereq: 254. Not open to students with credit for 569 or 601.

Math 572 Linear Algebra for Applications II U G 3

The eigenvalue problem or inner product spaces, projections and least squares approximation; classification of operators and quadratic forms; applications.

Su (2nd term), Wi Qtrs. 3 cl. Prereq: 571 or written permission of dept. Not open to students with credit for 601

Mech. Eng. 505 Introduction to Nuclear Science and Engineering U G 3

Discussion of nuclear energy and nuclear radiation; sources, methods of utilization, and projections for future engineering uses.

Au, Sp Qtrs. 2 1.5-hr cl. Prereq: Math 255 or 415 and Physics 133, or permission of instructor. Not open to students with credit for Nuclr En 505. Cross-listed in Nuclear Engineering.

Microbiology 509 Basic and Practical Microbiology U G 5

Provides an understanding of microorganisms and their interaction with the human experience.

Su, Au, Wi, Sp Qtrs. 509N: Sp Qtr. 3 cl, 2 2-hr labs. Prereq: Biology 101 or 110 or 113 or H115 or 201. GEC bio sci course. NS Admis Cond course.

Microbiology 520 General Microbiology I U G 5

Fundamental principles of microbiology and the characteristics of microorganisms with emphasis on their structure, molecular biology, growth and classification.

Au, Sp Qtrs. 3 cl, 2 3-hr labs. Prereq: Biology 114 or H116. May not be taken concur with 509.

Microbiology 521 General Microbiology II U G 5

Continuation of 520; basic principles of microbiology with emphasis on physiology ecology, and biotechnology, ecology, and applied pathogenic microbiology.

Wi Qtr. 3 cl, 2 3-hr labs. Prereq: 520 and Chem 252.

Microbiology 661 General Microbial Physiology U G 5

Principles of microbial growth, of metabolism, of microbial structure and function, and regulation of microbial metabolism.

Au Qtr. 5 cl. Prereq: 521 and Biochem 511

Molecular Genetics 500 General Genetics U G 5

The principles of genetics, including molecular genetics, transmission genetics of prokaryotes and eukaryotes, developmental and non-chromosomal genetics, and the genetics and evolution of populations.

Su, Au, Wi, Sp Qtrs. 3 1.5-hr cl. Prereq: Biology 101 or 113 or H115

*Molecular Genetics 500 may be used as a substitute for Chem 532, the third course in the physical chemistry sequence. Since Mol Gen 500 is 5 credits and Chem 532 is 3 credits, students choosing this option can apply the extra 2 credits from Mol Gen 500 towards their technical elective requirements. Students who take both Mol Gen 500 and Chem 532 can use all 5 credits as technical electives.

Molecular Genetics 607 Cell Biology U G 3

Analysis of the structure and function of cells and their components stressing molecular genetic and biochemical approaches.

Au Qtr. 3 1-hr cl. Prereq: 500 or 606. Not open to students with credit for 502.

Nuclear Eng. 505 Introduction to Nuclear Science and Engineering U G 3

Discussion of nuclear energy and nuclear radiation; sources, methods of utilization, and projections for future engineering uses.

Au, Sp Qtrs. 2 1.5-hr cl. Prereq: Math 255 or 415 and Physics 133, or permission of instructor. Not open to students with credit for Mech Eng 505.

Nuclear Eng. 771 Radioactive Waste Management U G 3

Overview of radioactive waste management. Covers waste categories, sources, treatment and disposal methods, minimization, transportation and current research topics.

Au Qtr. Prereq: 505 or 606 or permission of instructor. Cross-listed in Civil Engineering.

Physiology and Cell Biology 601 Organ System Physiology I U P G 5

First of a two-quarter sequence presenting the following areas of physiology: Cell, Neuroscience, Gastrointestinal, Endocrine, Reproduction, Muscle, Cardiovascular, Respiration, Renal and Acid-base.

Au Qtr. 5 cl. Open only to students enrolled in the College of Pharmacy, Biomedical Engineering, Sport and Exercise Science, or permission of the instructor. Not open to students with credit for Physiol 601.

Public Health: Env. Health Sci.731 Principles of Environmental Health G 4

Survey of major environmental factors affecting human health, including air, water, and land pollution, occupational hazards, trace metals, chemical carcinogens, radiation, and noise.

Au Qtr. 2 2-hr cl. Prereq: Grad standing in pub hlth or permission of instructor. Not open to students with credit for 731

Statistics 427 Introduction to Probability and Statistics for Engineering and the Sciences I U 3

Introduction to probability, discrete and continuous random variables, expected value, and sampling distributions.

Su, Au, Wi, Sp Qtrs. 3 cl. Prereq: Math 153 or 254 or permission of instructor. This course is not intended to stand alone as an introduction to probability and statistics. It should be followed by 428. GEC data analysis course.

Statistics 520 Mathematical Statistics I U G 5

Probability, random variables, discrete and continuous distributions; binomial, Poisson, normal, gamma (chi-square), t, F, distributions; change of variable and moment-generating function techniques; order statistics; limit theorems.

Au, Wi Qtrs. 5 cl. Prereq: Math 254 or written permission of chairperson. Not open to students with credit for 610 or 620. GEC data analysis course.

Statistics 521 Mathematical Statistics II U G 5

Confidence intervals; minimum variance unbiased estimation, maximum likelihood estimation; Neyman-Pearson theorem, uniformly most powerful tests, likelihood ratio tests, chi-square and F tests, nonparametric tests.

Sp Qtr. 5 cl. Prereq: 520. Not open to students with credit for 621.