LA 454, LA 455, LA 456  Design for Landscape Architects (4) (4) (4)
Advanced design studio. Emphasis is on complex design problems and special environmental situations or interdisciplinary work and involvement in current design issues. At least one course in the series must be self-directed. 4 laboratories. Prerequisite: Completion of fourth-year design sequence (LA 451, LA 452, LA 461).

LA 461 Senior Design Project (5)
Student selection and completion of approved design or research project sufficient in scale and complexity to encompass issues common to landscape architecture. Time management, documentation, and communication skills emphasized. Miscellaneous course fee required—see Class Schedule. 5 laboratories. Prerequisite: LA 442, LA 451, LA 452.

LA 464 Senior Seminar (1) (CR/NC)
Identification and exploration of problems and opportunities in the environmental design field. Intensive thinking, research and discussion of issues relating to local, regional or global significance. To be taken each quarter during fifth year. Credit/No Credit grading only. 1 seminar. Prerequisite: Fifth-year standing in Landscape Architecture.

LA 470 Selected Advanced Topics (1–4)
Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. Class Schedule will list topic selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

LA 471 Selected Advanced Laboratory (1–4)
Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. Class Schedule will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

LA 474 Collaborative Studio: Rendering, Animation and Modeling (4) (Also listed as ARCH 474/ART 474)
A collaborative visualization and design studio focusing on rendering, animation and modeling. Modeling and animation software for design conceptualization and expression. Collaboration in teams with students from the College of Architecture and Environmental Design and the Art and Design Department. Total credit limited to 8 units. 2 lectures, 2 activities. Prerequisite: ART 335 or ARCH 350 or LA 310, ARCH 460 or consent of instructor.

LA 481 Visual Resource Management Methods (3)
Investigation and application of the major visual resource management methods relevant to landscape architecture. Theoretical basis for visual resource assessment, the different assessment techniques, and the process of translating assessment results into visual resource management techniques. 2 lectures, 1 laboratory. Prerequisite: Fourth-year standing or graduate standing or consent of instructor.

LA 482 Evaluating Social and Behavioral Factors for Open Space Design (3)
User oriented approach to open space design. Interview and survey techniques, behavioral trace mapping and systematic observation, post occupancy evaluation and similar methods are used to generate user input and feedback in the design process. Understanding the behavioral implications of designed environments. 2 lectures, 1 laboratory. Prerequisite: Fourth-year or graduate standing or consent of instructor.

LA 483 Special Studies in Landscape Architecture (1–12)
Special issues and problems through research, field trips, seminars and other forms of investigation and involvement. Course requirements are determined prior to each individual project through a contractual agreement between students and department. Departmental Off Campus Study Program guidelines apply. Miscellaneous course fee required—see Class Schedule. Total credit limited to 36 units. 1–12 activities. Prerequisite: Fourth or fifth year standing, or consent of instructor.

LA 485 Cooperative Education Experience (6) (CR/NC)
Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Junior standing and consent of instructor.

LA 495 Cooperative Education Experience (12) (CR/NC)
Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Junior standing and consent of instructor.

LA 551 Regional Landscape Assessment I (4)
Definition, research and filing of data covering the biological, cultural and physical resources of a specific region. Concepts of regionalism, land planning, reclamation and preservation are integral to the course. Utilization of mainframe and microcomputer facilities and software. 4 laboratories. Prerequisite: LA 551 and graduate standing.

LA 552 Regional Landscape Assessment II (4)
Application of data manipulation techniques in order to model both impacts on natural systems and land development potentials. Use of planning strategies to predict outcomes resulting from the land use decision process. Utilization of mainframe and microcomputer facilities and software. 4 laboratories. Prerequisite: LA 551 and graduate standing.

LA 585 Cooperative Education Experience (6) (CR/NC)
Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

LA 595 Cooperative Education Experience (12) (CR/NC)
Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.
LIB 303 Library and Internet Computer Searching (1)
Instruction and practice in use of computerized information retrieval systems including CD-ROM, local and Internet sources, and vendor services. Emphasis on efficient searching skills utilizing controlled and/or keyword searching, limiters, Boolean logic, truncation, proximity operators, field searching, etc. 1 lecture. Prerequisite: ENGL 134, junior standing or consent of instructor.

LS–LIBERAL STUDIES

LS 101 Orientation to Liberal Studies (1) (CR/NC)
Exploration of the Liberal Studies Program as preparation for the Multiple Subjects Credential and for alternate career objectives. To be taken during the first quarter in attendance at Cal Poly as a Liberal Studies major. Credit/No Credit grading only. 1 lecture.

LS 211 The American Enterprise: The Birth of a Nation to the 1876 Centennial (4)

LS 212 The American Enterprise: The 1876 Centennial to the 21st Century (4)
Manifest Destiny. Evolution of our government institutions–parallels between the past and present. Immigration in the 20th Century. The Nation steps into a larger world–World Wars. Civil Rights–equity for all. 3 lectures, 1 activity. Prerequisite: ENGL 134.

LS 230 Community-Based Field Experience (1–3)
Community service such as tutoring and aiding in a school setting or volunteering to work for a public service or non-profit group. Explore careers while putting academic experience to work. Offered in conjunction with Cal Poly Community Service Center. Total credit limited to 5 units.

LS 250 Teaching Experience in Spanish (1) (CR/NC)
(Also listed as FORL 250)
Interdisciplinary focus on lesson planning for K-8. Theory and practice of teaching methodology. Open only to Liberal Studies majors. Prerequisite: SPAN 103 competency.

LS 310 Storytelling: The Oral Tradition (4)
(Also listed as SCOM 310)
Techniques for performing traditional folklore and myths in primary and secondary teaching situations. Selection, preparation and presentation of folklore for an audience; lectures on function of folk literature and mythology in modern society. 4 lectures. Prerequisite: SCOM 101 or SCOM 102.

LS 400 Special Problems for Advanced Undergraduates (1–2)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: consent of instructor, junior standing.

LS 461 Senior Project (2)
Selection and completion of an individual report or group project and report. For those planning careers as teachers project will involve field experience and inquiry project focused on content area selected for emphasis area. 1 seminar, 1 activity. Prerequisite: Senior standing and Elementary Education Track.

LS 462 Senior Project (2)
Selection and completion of a project or report under faculty supervision. Topic must be chosen with departmental approval. Results must be in a formal, written report. Prerequisite: Senior standing, General Track, and consent of Liberal Studies coordinator.

MATE–MATERIALS ENGINEERING

MATE 110 Introduction to Materials Engineering (1)
A lecture series involving materials engineers from industry as well as Cal Poly faculty. 1 lecture.

MATE 120 Introduction to Materials Engineering Practice (1)
Introduction to various topics in materials engineering with emphasis on industrial and laboratory practices. 1 activity.

MATE 200 Special Problems for Undergraduates (1–4)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

MATE 210 Materials Engineering (3)
Structure of matter. Physical and mechanical properties of materials including metals, polymers, ceramics, composites, and electronic materials. Equilibrium diagrams. Heat treatments, materials selection and corrosion phenomena. 3 lectures. Prerequisite: CHEM 111, CHEM 124 or CHEM 127.

MATE 215 Materials Engineering Laboratory (1)

MATE 220 Structure of Materials (3)

MATE 225 Structure of Materials Laboratory (1)
Relationship of atomic bonding to material properties. Building of crystals with physical models and by computer. Characterization of materials by x-ray diffraction (XRD) for phase identification, crystal structure determination and lattice constant measurements. Microstructural analysis by qualitative and quantitative metallography. Miscellaneous course fee required—see Class Schedule. 1 laboratory. Prerequisite: MATE 210. Concurrent: MATE 220.

MATE 230 Physical Metallurgy (4)

MATE 235 Physical Metallurgy Laboratory (1)
Interpretation of microstructures in metals and alloys and laboratory methods for revealing and documenting such microstructures. Casting and heat treating of metals. Miscellaneous course fee required—see Class Schedule. 1 laboratory. Prerequisite: MATE 225; MATE 230 should be taken concurrently.

MATE 240 Additional Materials Laboratory (1) (CR/NC)
Special assignments undertaken by students who need or wish to acquire abilities supplementary to their required course work. Assignments must be of a laboratory nature. Work is done by the student with a minimum of faculty supervision. Credit/No Credit grading only. 1 laboratory. Prerequisite: Consent of department head.
MATE 310 Polymers (4)
Molecular structures of polymers and polymer systems. Synthesis, processing techniques, properties and fabrication methods of polymeric materials. 4 lectures. Prerequisite: MATE 210.

MATE 320 Ceramics (4)
Development, utilization, and control of properties in ceramic materials (inorganic-nonmetallic solids). Structure of crystalline ceramics and of glasses. Mechanical, thermal, optical, magnetic, and electrical properties. Physical chemistry of ceramics. 4 lectures. Prerequisite: MATE 210, CHEM 305.

MATE 330 Composites (4)
Fundamentals of polymer-matrix, ceramic-fiber composites from materials engineering and applied mechanics viewpoints. Materials (matrices, fibers) and manufacturing methods treated in detail. Beginning applied mechanics of continuous and discontinuous fiber-reinforced composites covered including properties of an orthotropic lamina; behavior of laminated plates. 4 lectures. Prerequisite: MATE 210, MATE 350, CE 204 or consent of instructor.

MATE 340 Electronic Properties of Materials (3)
Basic concepts in electron theory of solids (quantum mechanics, energy band theory, Fermi energy, distribution and density of states), electrical properties and conduction in metals, semiconductors, polymers, ceramics, and superconductors, magnetic phenomena and optical properties in materials with applications in recording media. 3 lectures. Prerequisite: MATE 210, PHYS 133.

MATE 345 Electronic Properties of Materials Laboratory (1)
Exploration of electrical, optical and magnetic properties of materials. Optical absorption, electrical conductivity, ferromagnetism, superconductivity. 1 laboratory. Concurrent or prerequisite: MATE 340.

MATE 350 Mechanical Behavior of Materials (3)
Fundamental behavior, emphasis on the relationship between microstructure and mechanical properties. Continuum mechanics—stress, strain, elasticity, anelasticity, plasticity. Detailed treatment of the mechanical behavior of (1) crystalline materials (metals, ceramics)—dislocation dynamics, slip, strengthening mechanisms; (2) non-crystalline materials (polymers). 3 lectures. Prerequisites: MATE 210, CE 204; MATE 355 should be taken concurrently.

MATE 355 Mechanical Behavior of Materials Laboratory (2)
Additional meaning to major concepts in MATE 350. Mechanical properties of materials. Major concepts in stress, strain, elasticity, and plasticity in a range of engineering materials. Multiple session laboratories. Significant component of technical writing. Miscellaneous course fee required—see Class Schedule. Prerequisite: MATE 210, CE 204. Concurrent: MATE 350.

MATE 359 Living in a Material World (4) GE Area F
(Also listed as HIST 359)
Evolution of materials (ceramics, metals, polymers, composites, semiconductors) in the context of history. Traces the link between historical and technological developments enabled by materials from the Stone Age to the Electronic Age. 4 lectures. Prerequisite: Completion of GE Area B.

MATE 360 Thermodynamics of Materials (4)
Mass and energy balances, thermochemistry of reactions, design of materials processes including evaluation of energy needs and input/output stream compositions. 4 lectures. Prerequisite: MATE 210, CHEM 305.

MATE 400 Special Problems for Advanced Undergraduates (1–4)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

MATE 405 Kinetics of Materials (5)
Basis of kinetic theory, solid-state diffusion (steady-state and non-steady-state), nucleation and growth kinetics, solid state phase transformations. Laboratory emphasizes practical applications of kinetics: carburization, annealing cycle, sintering.. 4 lectures, 1 laboratory. Prerequisite: MATE 360.

MATE 410 Materials Inspection (2)
Special physical and mechanical techniques for non-destructive and destructive examination of materials, to determine their fitness for service. Topics include: statistical methods and control charts, hardness testing, quantitative metallography, grain size measurement and analysis, ultrasonics, liquid penetrant, magnetic particle, radiography, and eddy current. 2 lectures. Prerequisite: MATE 210; MATE 415 should be taken concurrently. Materials analysis and characterization course.

MATE 415 Materials Inspection Laboratory (2)
Special physical and mechanical techniques for non-destructive and destructive examination of materials, to determine their fitness for service. Laboratory topics include: hardness testing, quantitative metallography, grain size determination, and various NDT methods. Miscellaneous course fee required—see Class Schedule. 2 laboratories. Prerequisite: MATE 235, MATE 410 as corequisite. Materials analysis and characterization course.

MATE 425 Corrosion Engineering (4)
Forms of corrosion. Influences of environmental variables on corrosion. Methods of corrosion control. 3 lectures, 1 laboratory. Prerequisite: CHEM 125 or CHEM 128, MATE 210. Materials analysis and characterization course or Special topics course.

MATE 430 Microelectronic Materials Processing (3)
Integrated circuit fabrication, oxidation, diffusion, ion implantation, etching, chemical and physical vapor deposition, photolithography. 3 lectures. Prerequisite: MATE 210. Prerequisite or concurrent: MATE 360 or permission of instructor. Materials processing course.

MATE 435 Microelectronics Processing Laboratory (2)
Basic processes involved in integrated circuits; cleanroom protocol, oxidation, diffusion, photolithographic and etching processes, sputtering and evaporation, device testing. Each student will be part of a 4-6 person team that will fabricate an integrated circuit. Miscellaneous course fee required—see Class Schedule. 2 laboratories. Prerequisite or concurrent: MATE 430. Materials processing course.

MATE 440 Welding Metallurgy and Joining of Advanced Materials (3)
Principles, primary variables, and microstructural changes associated with the joining process. Physics of energy transfer. Heat and mass balances in joining, thermodynamic and kinetic justification of solidification and near interface microstructures. Heterogeneous interfaces, adhesion, wetting. Relation between process selection, interface design, microstructure, and properties, weldability. 3 lectures. Prerequisite: MATE 210. Materials processing course.

MATE 445 Joining of Advanced Materials Laboratory (2)
Laboratory to accompany MATE 440. Illustration of principles, primary variables, and microstructural changes associated with the joining process. Physics of energy transfer. Heat and mass balances in joining, thermodynamic and kinetic justification of solidification and near interface microstructures. Heterogeneous interfaces, adhesion, wetting. Relation between process selection, interface design, microstructure, and properties, weldability. Miscellaneous course fee may be required—see Class Schedule. 2 laboratories. Prerequisite: MATE 210. Materials processing course.

MATE 446 Surface Chemistry of Materials (3)
(Also listed as CHEM 446)
Surface energy, capillarity, solid and liquid interface. Adsorption, surface areas of solids, contact angles and wetting. Friction, lubrication and adhesion. Relationship of surface to bulk properties of materials. Applications. 3 lectures. Prerequisite: CHEM 306 or consent of instructor. Special topics course.
MATE 450 Failure Analysis (3)
Procedures for analyzing failed materials. Actual failure analysis of a component by each student. Topics include fracture, fatigue, wear and overload failures, exposure to techniques of metallurgy, electron microscopy, energy dispersive x-ray spectroscopy, chemical analysis and heat treatment. Miscellaneous course fee required—see Class Schedule. 1 lecture, 2 laboratories. Prerequisite: MATE 220, MATE 230, MATE 350, MATE 410. Concurrent: MATE 415. Materials analysis and characterization course.

MATE 460 Materials Selection in Mechanical Design (4)
Materials-based approach to mechanical design. Using mechanical and physical properties of materials (performance indices) to select them for design needs (Materials Selection Charts). Detailed background of material properties—information from materials and mechanics. Numerous case studies highlight the concepts covered. 4 lectures. Prerequisite: MATE 210, CE 204, or consent of instructor. Special topics course.

MATE 461, 462 Senior Project (1) (4)
Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 150 hours total time.

MATE 463 Undergraduate Seminar (1)
Developments, policies, practices and procedures discussed through regular seminar. 1 seminar. Prerequisite: Senior standing.

MATE 485 Cooperative Education Experience (6) (CR/NC)
Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

MATE 495 Cooperative Education Experience (12) (CR/NC)
Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

MATE 500 Individual Study (1–4)
Advanced study planned and completed under the direction of a member of department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Total credit limited to 12 units. Prerequisite: Consent of department head, graduate adviser, or supervising faculty member.

MATE 518 Special Topics in Superconductivity (2)
Basic concepts in the theory of superconductivity and current and potential applications of high-temperature superconducting materials. 2 lectures. Prerequisite: MATE 340 or PHYS 412, graduate standing in engineering or science or instructor’s permission. Special topics course.

MATE 520 X-Ray Diffraction (3)
Theory and application of x-ray diffraction as applied to advanced materials problems such as crystal quality and identification, thin film applications and structural transformations at high and low temperatures. Course will cover techniques in sample preparation, operation of equipment and interpretation of diffraction data. 3 lectures. Prerequisite: Graduate status or instructor’s permission. Materials analysis and characterization or Special topics course.

MATE 522 Advanced Ceramics (5)
Development, utilization, and control of properties in ceramic materials (inorganic-nonmetallic solids). Emphasis on application on processing to achieve structure and properties. Structure of crystalline ceramics and of glasses. Mechanical, thermal, optical, magnetic, and electrical properties. Application of ceramics in technology. Physical chemistry of ceramics. 4 lectures, 1 seminar. Prerequisite: Graduate standing or permission of instructor.

MATE 525 X-Ray Diffraction Laboratory (2)
X-ray diffraction laboratory experiments of advanced materials problems such as crystal quality and identification, thin film applications and structural transformations at high and low temperatures. Radiation safety training, techniques in sample preparation, operation of equipment and interpretation of diffraction data. 2 laboratories. Prerequisite: Graduate standing in engineering or science or instructor’s permission. Concurrent: MATE 520. Materials analysis and characterization or Special topics course.

MATE 530 Biomaterials (4)
Structures of biological materials—plant/animal. Biomechanics. Structure-function relationships for materials in contact with biological systems. Interactions of materials implanted in the body. Histological and hematological considerations including foreign body responses, inflammation, carcinogenicity, thrombosis, hemolysis, immunogenic and toxic properties. Microbial interaction with material surfaces, degradation. 4 lectures. Prerequisite: ENGR 213, MATE 210 and graduate standing or permission of instructor. Special topics course.

MATE 540 Tribology (4)

MATE 550 Numerical Methods for Materials Engineers (4)
Numerical analysis techniques relevant to materials engineers. Topics include computer programming, data analysis and reduction methods, linear and non-linear regression; materials modeling methods such as finite differences; and finite elements. 3 lectures, 1 laboratory. Prerequisite: CSC 231/234, MATH 242, MATE 350, MATE 360 or consent of instructor. Materials analysis and characterization or Special topics course.

MATE 560 Thin-Film Processing (3)
Thin film science and technology: deposition techniques, surface crystal notation, energy and kinetic processes, epitaxy. Schottky barriers and surface states, stress analysis, characterization techniques, electronics devices incorporating thin films. Class Schedule will list topics for selection. Total credit limited to 6 units. 3 lectures. Prerequisite: Graduate standing or permission of instructor. Materials processing course.

MATE 562 Mechanical Behavior of Materials (4)
Complex stress analysis, dislocation theory, fracture mechanisms, introductory fracture mechanics. Fatigue, creep, brittle-ductile transition, environmental embrittlement. Special project assignment. 4 seminars. Prerequisite: Graduate standing. Special topics course.

MATE 565 Thin-Film Processing Laboratory (2)
Thin film processing and analytical techniques: direct current and radio frequency magnetron sputtering, reactive sputtering, co-evaporation, epitaxy, grazing incidence x-ray diffraction, magnetic force imaging. Class Schedule will list topics for selection. Total credit limited to 6 units. 2 laboratories. Concurrent: MATE 560 or consent of instructor. Materials processing course.

MATE 570 Advanced Engineering Materials (4)
An advanced treatment of the structure of matter. Physical and mechanical properties of materials including metals, alloys, ceramics, insulating materials, semiconductors, super semiconductors, polymers and composites based on detailed theoretical understanding of material microstructures. Discussions of Equilibrium diagrams, processing approaches, material selection based on thermodynamic and kinetic arguments. Degradation and failure, fitness for purpose. 4 lectures. Prerequisite: Graduate standing or permission of instructor. Special topics course.
MATE 580 Fracture and Fracture Mechanics of Materials (4)  Fracture modes and mechanisms in engineering materials, fracture mechanics fundamentals (stress analysis of cracks, energy analysis of fracture process). Use of fracture mechanics in design. Laboratory gives concentrated exposure to fracture development in materials, fracture surface evaluation, fracture toughness testing. 3 lectures, 1 laboratory. Prerequisite: MATE 350, MATE 355, or graduate standing. Special topics course.


MATE 599 Design Project (Thesis) (2) (2) (5)  Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master’s degree, culminating in a written report/thesis. Prerequisite: Graduate standing.

MATH–MATHEMATICS

Satisfactory completion of the Entry Level Mathematics (ELM) requirement is a prerequisite for enrollment in all mathematics courses except MATH 100 and MATH 104.

MATH 100 Beginning Algebra Review (3) (CR/NC)  Review of basic algebra skills at the beginning algebra level intended primarily to prepare students for MATH 104. Course open only to students who have taken the ELM examination and are not qualified for MATH 104. Not for baccalaureate credit. Credit/No Credit grading only. Miscellaneous course fee may be required—see Class Schedule. 3 lectures. Prerequisite: Two years of high school algebra.

MATH 104 Intermediate Algebra (3) (CR/NC)  Review of basic algebra skills at the intermediate algebra level intended primarily to prepare students for MATH 116. Not for baccalaureate credit. Credit/No Credit grading only. Miscellaneous course fee may be required—see Class Schedule. 3 lectures. Prerequisite: Two years high school algebra and appropriate score on the ELM examination, or credit in MATH 100.

MATH 112 The Nature of Modern Mathematics (4)  GE B1  Topics from contemporary mathematics, their development, applications, and role in society. Some typical topics, to be chosen by the instructor: graph theory, critical path analysis, statistical inference, coding, game theory, and symmetry. 4 lectures. Prerequisite: Appropriate score on ELM examination or an ELM exemption or credit in MATH 104.

MATH 114 Intermediate Algebra Laboratory (1) (CR/NC)  Facilitated study and discussion of the theory, problems, and applications of intermediate algebra. Not for baccalaureate credit. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 104.

MATH 116, 117 Pre-Calculus Algebra I, II (3) (3)  For MATH 116 and 117: GE B1  Pre-calculus college algebra without trigonometry. Special products and factoring, exponents and radicals. Fractional and polynomial equations. Matrices, determinants, and systems of equations. Polynomial, rational, exponential, and logarithmic functions. Graphing, inequalities, absolute value, complex numbers, and analytic geometry. MATH 116 and MATH 117 are equivalent to MATH 118, but are taught at a slower pace. Upon completion of MATH 116 and MATH 117, a student will receive 4 units of GE credit for Area B1. Not open to students with credit in MATH 118 or MATH 120. 3 lectures. MATH 116 prerequisite: Appropriate score on ELM examination, or an ELM exemption, or credit in MATH 104. MATH 117 prerequisite: MATH 116 with a grade of C- or better or consent of instructor.

MATH 118 Pre-Calculus Algebra (4)  GE B1  Pre-calculus algebra without trigonometry. Special products and factoring, exponents and radicals. Fractional and polynomial equations. Matrices, determinants, and systems of equations. Polynomial, rational, exponential, and logarithmic functions. Graphing, inequalities, absolute value, complex numbers, and analytic geometry. MATH 118 is equivalent to MATH 116 and MATH 117. Not open to students with credit in MATH 117 or MATH 120. 4 lectures. Prerequisite: Appropriate score on ELM examination, or an appropriate ELM exemption.

MATH 119 Pre-Calculus Trigonometry (4)  GE B1  Rectangular and polar coordinates. Trigonometric functions, fundamental identities. Inverse trigonometric functions and relations. Vectors, complex numbers, conic sections. Not open to students with credit in MATH 120. 4 lectures. Prerequisite: Completion of ELM requirement and passing score on appropriate Mathematics Placement Examination, or MATH 117, or MATH 118 or equivalent.

MATH 120 Pre-Calculus Algebra and Trigonometry (5)  GE B1  An integrated review course in pre-calculus algebra and trigonometry covering function concepts and symbols, rectangular coordinates, linear, quadratic, polynomial, and rational functions, inequalities, trigonometric functions, inverse trigonometric functions, exponential and logarithmic functions, systems of equations, complex numbers, and analytic geometry. MATH 120 is equivalent to MATH 118 and MATH 119. Not open to students with credit in MATH 117, MATH 118, or MATH 119. 5 lectures. Prerequisite: Completion of ELM requirement and passing score on appropriate Mathematics Placement Examination and high school trigonometry or equivalent.

MATH 126 Pre-Calculus Algebra I Laboratory (1) (CR/NC)  Facilitated study and discussion of the theory, problems, and applications of pre-calculus algebra. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 116.

MATH 127 Pre-Calculus Algebra II Laboratory (1) (CR/NC)  Facilitated study and discussion of the theory, problems, and applications of pre-calculus algebra. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 117.

MATH 128 Pre-Calculus Algebra Laboratory (1) (CR/NC)  Facilitated study and discussion of the theory, problems, and applications of pre-calculus algebra. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 118.

MATH 129 Pre-Calculus Trigonometry Laboratory (1) (CR/NC)  Facilitated study and discussion of the theory, problems, and applications of pre-calculus trigonometry. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 119.

MATH 131, 132, 133 Technical Calculus (4) (4) (4)  Functions, their graphs and limits; techniques and applications of differential and integral calculus; introduction to applied differential equations. Designed principally for technology students and others interested in an applied three-quarter calculus sequence. Not open to students with credit in MATH 142, MATH 143, MATH 318 (respectively) or equivalents. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: ELM requirement, and passing score on Mathematics Placement Examination, or MATH 118 and MATH 119, or equivalent.

MATH 141, 142, 143 Calculus I, II, III (4) (4) (4)  GE B1  (Also listed as HNRS 141, 142, 143)  Limits, continuity, differentiation, integration. Techniques of integration, applications to physics, transcendental functions. Infinite sequences and series, vector algebra, curves. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: ELM requirement and passing score on Mathematics Placement Examination, or MATH 118 and MATH 119, or equivalent.

Each course in a combined listing of sequentially numbered courses is a prerequisite to its successor in the same listing.
score on appropriate Mathematics Placement Examination, or MATH 118 and MATH 119 or equivalent. MATH 142 prerequisite: MATH 141 with a grade of C- or better or consent of instructor.

MATH 151, 152, 153 Calculus Laboratories I, II, III (1) (1) (1) (CR/NC)
Facilitated study and discussion of the theory, problems, and applications of calculus. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 141, MATH 142, or MATH 143.

MATH 161, 162 Calculus for the Life Sciences I, II (4) (4) GE B1
Review of exponential, logarithmic, and trigonometric functions. Differential and integral calculus with applications to the biological sciences. Introduction to differential equations and mathematical modeling. Examples, exercises and applications to emphasize problems in life sciences. Not open to students with credit in MATH 141, 142 respectively. 4 lectures. Prerequisite: Completion of ELM requirement and passing score on appropriate Mathematics Placement Examination, or MATH 118 or equivalent.

MATH 202 Orientation to the Mathematics Major (1) (CR/NC)
Career opportunities in the field of mathematics, preparing a field of study, and a survey of departmental facilities and procedures related to research, study and graduation. Credit/No Credit grading only. 1 lecture. Corequisite: Sophomore standing or consent of instructor.

MATH 206 Linear Algebra I (4)
Matrices, inverses, linear systems, determinants, eigenvalues, eigenvectors, vector spaces, linear transformations, applications. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 143 or consent of instructor.

MATH 211 Calculus for Business and Economics (4) GE B1
Polynomial calculus for optimization and marginal analysis, and elementary integration. Not open to students with credit in MATH 142. 4 lectures. Prerequisite: Completion of ELM requirement and passing score on appropriate Mathematics Placement Examination, or MATH 118 or equivalent.

MATH 231 Calculus for Business and Economics Laboratory (1) (CR/NC)
Facilitated study and discussion of the theory, problems, and applications of business calculus. Credit/No Credit grading only. 1 laboratory. Corequisite: Concurrent enrollment in the associated section of MATH 221.

MATH 241 Calculus IV (4)
Partial derivatives, multiple integrals, introduction to vector analysis. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 143.

MATH 242 Differential Equations (4)
Ordinary differential equations: introduction with applications in engineering and science; classification of equations and their analytic solutions; study of interrelationships between differential systems, graphs, and physical problems. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 241.

MATH 248 Methods of Proof in Mathematics (4)
Methods of proof (direct, contradiction, conditional, contraposition); valid and invalid arguments. Examples from set theory. Quantified statements and their negations. Functions, indexed sets, set functions. Proofs in number theory, algebra, geometry and analysis. Proof by induction. Equivalence and well-defined operations and functions. The axiomatic method. 4 lectures. Prerequisite: MATH 143 or consent of instructor.

MATH 300 Technology in Mathematics Education (3)
Examination of existing hardware and software designed for educational uses. Mathematical topics appropriate for computer enhancement. Special methods and techniques for educational uses of computers. Emphasis on activity learning and applications. Computer as a classroom management device. 2 lectures, 1 activity. Prerequisite: MATH 118, and CSC 101 or CSC 110 or CSC 113, or consent of instructor.

MATH 304 Vector Analysis (4)
Algebra of free vectors with applications. Differential and integral calculus of vectors. Development of theory and application of vector operations. Green’s Theorem, Stokes’ Theorem, and the Divergence Theorem. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 241 or consent of instructor.

MATH 306 Linear Algebra II (4)
Inner product spaces, orthogonality, Fourier series and orthogonal bases, linear transformations and similarity, eigenvalues and diagonalization. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 206, MATH 242, and a C- or better in MATH 248, or consent of instructor.

MATH 317 Topics in Engineering Mathematics (4) GE B6
Fourier series, Fourier transforms, and their properties. Introduction to generalized functions. Introductory probabilistic concepts encountered in data analysis and engineering. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 242.

MATH 318 Advanced Engineering Mathematics (4) GE B6
Power series solutions of differential equations and Bessel functions. Fourier series and transforms; matrices. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 242.

MATH 327, 328, 329 Mathematics for Elementary Teaching I, II, III (4) (4) (4)
Introduction to set theory, number theory, real numbers, probability, statistics, and geometry. Computer applications. 2 lectures, 2 activities.

MATH 327 prerequisite: Completion of ELM requirement, and passing score on appropriate Mathematics Placement Examination, or MATH 118 or equivalent. MATH 328 prerequisite: MATH 327 with a grade of C- or better or consent of instructor.

MATH 333 Numerical Analysis I (4)
Topics in interpolation and approximation methods, initial value problems, and boundary value problems of ordinary differential equations. 4 lectures. Prerequisite: MATH 242 or equivalent.

MATH 335 Graph Theory (4)
Introduction to graph theory and its applications: isomorphism, paths and searching, connectedness, trees, tournaments, planarity, graph colorings, matching theory, network flow, adjacency and incidence matrices. Further topics to be selected from the theory of finite state machines, Ramsey theory, extremal theory, and graphical enumeration. 4 lectures. Prerequisite: Junior standing or consent of instructor.

MATH 336 Combinatorial Mathematics (4)
Methods of enumerative combinatorics: sum, product, and division rules, bijective and recursive techniques, inclusion and exclusion, generating functions, and the finite difference calculus. Advanced topics to be selected from the theory of partitions, Polya theory, designs, and codes. 4 lectures. Prerequisite: Junior standing or consent of instructor.

MATH 341 Theory of Numbers (4)
Properties of numbers. Euclid’s Algorithm, greatest common divisors, diophantine equations, prime numbers, congruences, number theoretic functions, the quadratic reciprocity laws, primitive roots and indices. Miscellaneous course fee may be required—see Class Schedule. 4 lectures. Prerequisite: MATH 248 with a grade of C- or better or consent of instructor.

Each course in a combined listing of sequentially numbered courses is a prerequisite to its successor in the same listing.
MATH 350 **Mathematica (4)**
Problem-solving using Mathematica in a UNIX environment. 4 lectures. Prerequisite: MATH 241.

MATH 370 **Putnam Exam Seminar (2)**
Directed group study of mathematical problem solving techniques. Open to undergraduate students only. Class members are expected to participate in the annual William Lowell Putnam Mathematical Competition. Course may be repeated up to eight units. 2 seminars. Prerequisite: Consent of instructor.

MATH 371 **Math Modeling Seminar (2)**
Directed group study of mathematical modeling techniques. Open to undergraduate students only. Class members are expected to participate in the annual Mathematical Competition in Modeling. Total credit limited to 8 units. 2 seminars. Prerequisite: Consent of instructor.

MATH 372 **Mathematical Community Service Projects (2) (CR/NC)**
Directed group mathematical research in support of volunteer community service projects. Total credit limited to 8 units. 2 seminars. Prerequisite: consent of instructor and consent of department chair.

MATH 400 **Special Problems for Advanced Undergraduates (1-4)**
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units. Prerequisite: Junior standing and consent of department chair.

MATH 404 **Introduction to Differential Geometry and Topology (4)**
Theory of curves and surfaces in space. Topics such as curvature, geodesics, Gauss map, Gauss-Bonnet Theorem, combinatorial topology, point set topology. 4 lectures. Prerequisite: MATH 206 and MATH 304.

MATH 406 **Linear Algebra III (4)**
Complex vector spaces, unitary and self-adjoint matrices, Spectral Theorem, Jordan canonical form. Selected topics in linear programming, convexity, numerical methods, and functional analysis. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 306 or consent of instructor.

MATH 408, 409 **Complex Analysis I, II (4)**
Elementary analytic functions and mappings. Cauchy’s Integral Theorem; Poisson’s Integral Formula. Taylor and Laurent series, theory of residues, and the evaluation of integrals. Harmonic functions, conformal mappings. 4 lectures. Prerequisite: MATH 242.

MATH 412 **Introduction to Analysis I (4)**
Mathematical formulation of physical laws. Separation of variables. Orthogonal functions and generalized Fourier series. Bessel functions, Legendre polynomials, Sturm-Liouville problem. Boundary value problems; nonhomogeneous techniques. Applications to heat flow, potential theory, vibrating strings and membranes. Miscellaneous course fee may be required in sections with a computer component—see Class Schedule. 4 lectures. Prerequisite: MATH 318 or equivalent, or MATH 364. 1 MATH 419, 420 **Introduction to the History of Mathematics (4)**
Evolution of mathematics from earliest to modern times. Major trends in mathematical thought, the interplay of mathematical and technological innovations, and the contributions of great mathematicians. Appropriate for prospective and in-service teachers. 4 lectures. Prerequisite: MATH 248 with a grade of C- or better and at least one upper division course in mathematics, or consent of instructor.

MATH 424 **Organizing and Teaching Mathematics (4)**
Organization, selection, presentation, application and interpretation of subject matter in mathematics. Introduction to current issues in mathematics education. For students who will be teaching in secondary schools. 4 lectures. Prerequisite: Senior standing or consent of instructor.

MATH 431, 432 **Mathematical Optimization I, II (4)**
Classical optimization. Maximum/minimum of functions, linear and nonlinear optimization problems, duality, constrained optimization. Model building and applications to various fields. 4 lectures. Prerequisite: MATH 206 and MATH 241 or consent of instructor.

MATH 433 **Numerical Analysis II (4)**
Numerical techniques for solving partial differential equations of the parabolic, hyperbolic and elliptic type. 4 lectures. Prerequisite: MATH 333 or equivalent.

MATH 434 **Game Theory (4)**
Development of the mathematical concepts, techniques, and models used to investigate optimal strategies in competitive situations; games in extensive, normal, and characteristic form, Nash equilibrium points and Nash Bargaining Model. 4 lectures. Prerequisite: MATH 206 or consent of instructor. Recommended: MATH 335 and MATH 431.

MATH 442 **Euclidean Geometry (4)**
Foundations of Euclidean geometry, finite geometries, congruence, similarities, polygonal regions, circles and spheres. Constructions, mensuration, the parallel postulate. Appropriate for prospective and in-service mathematics teachers. 4 lectures. Prerequisite: MATH 248 with a grade of C- or better or consent of instructor.

MATH 443 **Modern Geometries (4)**
Non-Euclidean and projective geometries. Properties of parallels, triangles, Saccheri and Lambert quadrilaterals, angle-sum and area. Limiting curves, hyperbolic trigonometry, duality, perspective, quadrangles, fundamental theorems of projective geometry, conics. 4 lectures. Prerequisite: MATH 442.

MATH 459 **Undergraduate Seminar (4)**
Written and oral analysis and presentations by students on topics from mathematical modeling. 4 seminars. Prerequisite: MATH 206 and MATH 242.

MATH 461, 462 **Senior Project (2)**
Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 120 hours total time. Prerequisite: MATH 459.

MATH 470 **Selected Advanced Topics (1-4)**
Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Junior standing and consent of instructor.

MATH 481, 482 **Abstract Algebra I, II (4)**
Fundamental algebraic structures and types of algebras, including operations within them and relations among them. Groups, rings and

1 Each course in a combined listing of sequentially numbered courses is a prerequisite to its successor in the same listing.
fields. 4 lectures. Prerequisite: MATH 248 with a grade of C- or better or consent of instructor.

**MATH 485 Cooperative Education Experience (6) (CR/NC)**
Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**MATH 495 Cooperative Education Experience (12) (CR/NC)**
Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

**MATH 500 Individual Study (1–4)**
Individual research or advanced study planned and completed under the direction of a departmental faculty member. Open only to graduate students demonstrating ability to do independent work. Prerequisite: Graduate standing and consent of department chair.

**MATH 501, 502 Methods of Applied Mathematics I, II (4) (4)**
Introduction to advanced methods of mathematics useful in the analysis of engineering problems. Theory of vector fields, Fourier analysis, Sturm-Liouville theory, functions of a complex variable. Selected topics in asymptotic analysis, special functions, perturbation theory. Not open to students in major or master’s degree program in mathematics. MATH 501: Miscellaneous course fee and/or Distance Learning Lab fee may be required—see Class Schedule. 4 lectures. Prerequisite: MATH 318 or equivalent, and graduate standing or consent of instructor.

**MATH 510 Survey of Modern Mathematics (4)**
Selected topics from the field of modern mathematics. Projective and synthetic geometry, topology, logic, matrices, vectors. Theory of games, probability, linear and modern algebra and convex sets. Boolean algebras, synthetic geometry, topology, logic, matrices, vectors. Theory of games, probability, linear and modern algebra and convex sets. Boolean algebras, graph theory, lattice theory, geometry of complex numbers. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

**MATH 520, 521 Applied Analysis I, II (4) (4)**
Advanced mathematical methods of analysis in science and engineering, integrated with modeling of physical phenomena. Topics include applications of complex analysis, Fourier analysis, ordinary and partial differential equations. Additional topics to be drawn from perturbation methods, asymptotic analysis, dynamical systems, numerical methods, optimization, and the calculus of variations. 4 lectures. Prerequisite: MATH 408, MATH 412, MATH 418 and graduate standing, or consent of the instructor.

**MATH 522 Applied Analysis III (4)**
Selected topics in applied analysis. 4 lectures. Prerequisite: MATH 521 and graduate standing, or consent of the instructor.

**MATH 530, 531 Discrete Mathematics with Applications I, II (4) (4)**
Advanced mathematical methods of discrete mathematics with applications. Topics will include probability theory with generating functions, difference equations and number theory. Additional topics to be drawn from the theory of algorithms, coding theory, set theory, and the relation of discrete mathematics to complex analysis. 4 lectures. Prerequisite: MATH 481, MATH 506 and graduate standing, or consent of instructor.

**MATH 532 Discrete Mathematics with Applications III (4)**
Selected advanced topics in discrete mathematics. These topics may include foundations, numerical and computational methods of discrete mathematics, finite geometries or current problems in discrete mathematics. 4 lectures. Prerequisite: MATH 531 and graduate standing, or consent of the instructor.

**MATH 540 Introduction to Topology (4)**
Basic ideas of general topology, metric spaces, homeomorphisms and the separation axioms. 4 seminars. Prerequisite: Satisfactory completion of the Graduate Written Examination in Analysis or consent of the Graduate Committee.

**MATH 550 Real Analysis (4)**
Introduction to Lebesgue measure and integration, convergence theorems, $L^1$ spaces, Radon-Nikodym Theorem and Fubini’s Theorem. 4 seminars. Prerequisite: Satisfactory completion of the Graduate Written Examination in Analysis or consent of the Graduate Committee.

**MATH 550 Field Theory (4)**
Polynomial rings, field extensions, normal and separable extensions, automorphisms of fields, fundamental theorem of Galois theory, solvable groups, solution by radicals, insolvability of the quintic. 4 lectures. Prerequisite: Satisfactory completion of the Graduate Written Examination in Algebra or consent of the Graduate Committee.

**MATH 550 Seminar (1–4)**
Built around topics in advanced mathematics chosen according to the common interests and needs of the students enrolled. Each seminar will have a title according to the nature of the content. Total credit limited to 12 units. 1–4 seminars. Prerequisite: Graduate standing and consent of instructor.

**MATH 596 Thesis (3)**
Serious research endeavor devoted to the development, pedagogy or learning of mathematics. Course to be taken twice for a total of 6 units. Prerequisite: Graduate standing and consent of instructor.

**MCRO–MICROBIOLOGY**

**MCRO 221 Microbiology (4) GE B2 & B4**
Morphology, metabolism, classification and identification; bacteriology of air, soil, water and foods with applications to industry, agriculture, medicine, and public health. Not open to students with credit in MCRO 224. 2 lectures, 2 laboratories. Prerequisite: One quarter of chemistry.

**MCRO 224 General Microbiology I (5) GE B2 & B4**
Microbial cellular structure and function, nutrition and growth dynamics, control of microbial growth, metabolism, genetics and viruses. Both prokaryotic and eukaryotic microorganisms emphasized. 3 lectures, 2 laboratories. Prerequisite: BIO 151 and CHEM 128. Recommended: CHEM 129.

**MCRO 225 General Microbiology II (5)**
Microbial diversity, systematics, ecology, and symbiotic relationships. Introduction to host-microorganism interactions including pathogenesis, epidemiology, and immunology. 3 lectures, 2 laboratories. Prerequisite: MCRO 224.

**MCRO 342 Sanitary Microbiology (4)**
Principles of disease prevention and control. Water-, food-, and air-borne microbial contaminations and epidemiology of ensuing diseases. Laboratory techniques in detection and control of wastes and disease-causing microorganisms. 2 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224.

**MCRO 402 General Virology (5)**
Infective macromolecules (prions, viroids, and viruses) associated with microbes, plants, and animals. Epidemiology, immune responses, pathogenicity, pathogenesis, prevention, diagnoses and treatments. 5 lectures. Prerequisite: BIO 351 or CHEM 373.

**MCRO 404 Microbial Diversity and Evolution (4)**
Diversity, taxonomy, systematics, and molecular evolution of microorganisms. Fundamentals of microbial classification, molecular
evolution, and tools used in evaluating phylogenetic relationships among microbial groups. 3 lectures, 1 laboratory. Prerequisite: MCRO 225.

**MCRO 421 Food Microbiology (4)**
Physiological activities of microorganisms involved in the preparation, preservation, deterioration and toxicity of foods and related products. 2 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224. Recommended: CHEM 212/312.

**MCRO 423 Medical Microbiology (5)**

**MCRO 424 Microbial Physiology (5)**
Cellular structure and life processes of bacteria; chemical composition, growth and metabolism. General biological and evolutionary considerations. 3 lectures, 2 laboratories. Prerequisite: MCRO 225 and CHEM 313.

**MCRO 430 Medical Mycology (4)**
Morphology, physiology, infectivity, and immunogenicity of fungi pathogenic for man and other mammals. Host-parasite interactions. Demonstration and isolation of pathogenic fungi from clinical material. 2 lectures, 2 laboratories. Prerequisite: MCRO 225 and MCRO 423.

**MCRO 433 Industrial Microbiology and Biotechnology (5)**
Principles and methods used for production of enzymes, pharmaceuticals, chemicals and food additives using micro-organisms. Topics include screening and strain improvement, regulation of metabolite production, genetic engineering, heterologous gene expression systems, large-scale production and intellectual property. 3 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224, BIO 351 or equivalent, CHEM 212/312 or equivalent.

**MCRO 436 Microbial Ecology (5)**
Ecology and interactions of prokaryotic and eukaryotic microorganisms in natural environments. Fundamentals of microbial ecology, microbial evolution, microbes and ecosystem function (bioremediation), practical aspects of microbial interactions, and microbial systematics. 3 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224.

**MCRO 444 Dairy Microbiology (4)**
Microorganisms involved in the fermentation and ripening processes in the dairy industry, as well as those involved in spoilage of milk and dairy products, in the transmission of disease through these products, and indicator systems used to determine sanitary quality of these products. 2 lectures, 2 laboratories. Prerequisite: MCRO 221 or MCRO 224.

**ME–MECHANICAL ENGINEERING**

**ME 134 Mechanical Systems (3)**
Introduction to mechanical engineering and its application in professional practice. Includes design, analysis, testing and dissection of mechanical devices, from simple machines to more complicated systems. 2 lectures, 1 laboratory.

**ME 151 Engineering Design Communication I (2)**
Communication of designs to manufacturing using basic definitions of points, lines and planes in space. Pictorials, orthographic projection, section views and auxiliary views. Techniques from geometry, vectors, analysis, and spatial definitions integrated to provide information to both the design and manufacturing processes. 1 lecture, 1 laboratory.

**ME 152 Engineering Design Communication II (2)**
Use of advanced communication principles to communicate project designs to manufacturing processes. Projects evaluated in terms of meeting design criteria. Techniques of advanced communication including weld symbols, threaded fasteners, dimensioning and tolerancing. Use of computers to enhance these processes. 1 lecture, 1 laboratory. Prerequisite: ME 151.

**ME 153 Introduction to Solid Modeling (1)**
Introduction to solid modeling, using current software and hardware. Creation of part models and assembly models; working drawings produced from the models. Introduction to finite element analysis using the chosen software. Relevancy of solid modeling to design and manufacturing. 1 laboratory. Prerequisite: ME 152 or equivalent.

**ME 211 Engineering Statics (3)**
Analysis of forces on engineering structures in equilibrium. Properties of forces, moments, couples, and resultants. Equilibrium conditions, friction, centroids, area moments of inertia. Introduction to mathematical modeling and problem solving. Vector mathematics where appropriate. 3 lectures. Prerequisite: MATH 241 (or concurrently), PHYS 131.

**ME 212 Engineering Dynamics (3)**
Analysis of motions of particles and rigid bodies encountered in engineering. Velocity, acceleration, relative motion, work, energy, impulse, and momentum. Further development of mathematical modeling and problem solving. Vector mathematics where appropriate. 3 lectures. Prerequisite: MATH 241, ME 211.

**ME 234 Philosophy of Design (3)**
General approach to the meaning of engineering design. Conceptual blocks, creativity, design process, design considerations and elements. Intended for transfer students as a substitution for ME 134. 3 lectures.

**ME 236 Thermal Systems (3)**
Fundamentals of measuring temperature, pressure, and other thermal-fluid parameters. Measurement principles including error analysis. Theory and practice of writing lab reports. 2 lectures, 1 laboratory. Prerequisite: CHEM 125, ENGL 134, PHYS 132.

**ME 240 Additional Engineering Laboratory (1) (CR/NC)**
Special assignments undertaken by students who need or wish to acquire abilities supplementary to their standard pattern of courses. Assignments must be primarily of shop or laboratory nature. Work is done by the student with a minimum of faculty supervision. Credit/No Credit grading only. 1 laboratory. Prerequisite: Consent of department head.

**ME 302 Thermodynamics (3)**
Properties of working fluids and fundamental relations for processes involving the transfer of energy. First and second laws of thermodynamics, irreversibility and availability. 3 lectures. Prerequisite: PHYS 132, ME 212.

**ME 313 Heat Transfer (3)**
Basic principles of heat transfer. Conduction, convection, radiation, and combined modes. 3 lectures. Prerequisite: ME 341, ME 302 or CHEM 305, MATH 242, CSC 231 or CSC 234.

**ME 318 Mechanical Vibrations (4)**
Free and forced vibration response of single and multiple degree of freedom systems. Experimental studies of the dynamic behavior of structures and machines. Instrumentation methods utilized in field and laboratory. 3 lectures, 1 laboratory. Prerequisite: MATH 318, ME 326, EE 201.

**ME 321 Solar Energy (4) GE Area F**
Methods of utilizing solar energy. Energy concepts, collection and storage systems; greenhouse effect. Commercial and residential building applications. Solar power generation and recent technical developments. International achievements in solar energy with emphasis on solar energy application in developing countries for water purification and other life support functions. 4 lectures. Prerequisite: PHYS 131 or PHYS 123, completion of GE Area B and junior standing.

**ME 326 Intermediate Dynamics (4)**
Continuation of ME 212. Additional analysis of planar motion of rigid bodies with particular attention to the kinematics of mechanisms.
Rotating reference frames. Introduction to three dimensional dynamics. Dynamic simulation of mechanisms. 4 lectures. Prerequisite: MATH 242 (or concurrent), ME 212, CSC 231.

ME 328 Introduction to Design (4)
Design of machine parts by stress and deflection. Effects of fluctuating stresses and stress concentration. Design of shafts and other machine parts. Modern industrial design practice using standard components and design layout drawings. 3 lectures, 1 laboratory. Prerequisite: CE 205, ME 152, MATE 210, CSC 231, ME 212.

ME 329 Intermediate Design (4)
Design of mechanical equipment and systems using various machine elements and components such as threaded fasteners, power screws, springs, gears, bearings, clutches, prime movers, etc. Decision modeling based on technical and economic feasibility. 3 lectures, 1 laboratory. Prerequisite: ME 341, CSC 231 or equivalent.

ME 341, 342 Fluid Mechanics (3) (3)
Fluid statics. Conservation equations of fluid dynamics. Viscous flow, boundary layer concepts, lift and drag, compressible flow, turbomachinery. ME 341: 3 lectures. Prerequisite: ME 212. ME 342: 3 lectures. Prerequisite: ME 341, CSC 231 or equivalent.

ME 344 Thermal Engineering (4)
Vapor and gas power cycles, refrigeration cycles, thermodynamic relations, psychrometrics, chemical reactions, and a thermal engineering design project. 4 lectures. Prerequisite: ME 236, ME 313, ME 341.

ME 345 Fluid Mechanics Laboratory (1)
Planning, execution and reporting of fluid mechanics experiments involving flow measurement and control, conservation equations, pressure and velocity distributions, performance of turbomachines, dimensional analysis for lift and drag on airfoils or bearings. 1 laboratory. Prerequisite: ME 236, ME 342.

ME 346 Thermal Science Laboratory (1)
Heat transfer and thermodynamic experiments covering combined free convection and radiation, transient conduction, energy conversion, heat exchanger, polytropic blowdown, steam turbine, and refrigeration system. 1 laboratory. Prerequisite: ME 341, ME 344.

ME 400 Special Problems for Advanced Undergraduates (1–2)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ME 401 Stress Analysis (4)
Advanced strength of materials: behavior of disks, plates, and shells. Theory of elasticity. Energy methods. 3 lectures, 1 laboratory. Prerequisite: CE 206, MATH 318, ME 328 or consent of instructor.

ME 405 Mechatronics (4)
Microprocessor applications in machine control and product design. Applied electronics. Drive technology; transducers and electromechanical systems. Real-time programming. Mechatronic design methodology. 3 lectures, 1 laboratory. Prerequisite: EE 321, EE 361, ME 329.

ME 406 Mechatronics Design (4)
Application of micro-controllers and programmable logic controllers in the design of mechatronic products and automation systems. Digital feedback motion and process control. Modern industrial mechatronics applications. 3 lectures, 1 laboratory. Prerequisite: ME 329 and ME 405 or consent of instructor.

ME 410 Experimental Methods in Mechanical Design I (4)
Bonded resistance strain gages for static and dynamic measurements; rosettes, bridge circuits, lead wire effects, special gages. Photoelastic and moire fringe methods including birefringent coatings, shadow, and projection moire. Applications in mechanical design and metrology. 3 lectures, 1 laboratory. Prerequisite: ME 328.

ME 412 Composite Materials Analysis and Design (4)

ME 415 Energy Conversion (4)
Engineering aspects of energy sources, conversion and storage. Topics selected from fossil fuel systems, nuclear power, thermoelectric systems, thermonic converters, fuel cells, magnetohydrodynamic generators, and geothermal, tidal, wind and ocean temperature energy conversion systems. 4 lectures. Prerequisite: ME 302.

ME 416 Ground Vehicle Dynamics and Design (4)
Design of ground vehicles for directional stability and control. Tire mechanics and their effects on vehicle performance. Simulation of vehicle dynamics using digital computer. Synthesis of steering mechanism and suspension system. 2 lectures, 2 laboratories. Prerequisite: ME 318, ME 328.

ME 418 Machinery Vibration and Rotordynamics (4)
 Vibrations relating to rotating machinery. Modeling of structural rotordynamic phenomena induced by shaft flexibility, bearings, and seals. Laboratory measurement of rotor system dynamic response and interpretation of machinery diagnostic information. 3 lectures, 1 laboratory. Prerequisite: ME 318.

ME 422 Mechanical Control Systems (4)
Modeling and control of physical systems. Design of mechanical, hydraulic and electrical systems using time response, frequency response, state space, and computer simulation. 3 lectures, 1 laboratory. Prerequisite: ME 318.

ME 423 Robotics: Fundamentals and Applications (4)
Introduction to robots and their types. Homogeneous transformations. Kinematic equations and their solutions. Motion trajectories, statics, dynamics, and control of robots. Robot programming. Actuators, sensors and vision systems. 3 lectures, 1 laboratory. Prerequisite: ME 326, ME 422.

ME 424 Design of Piping Systems (4)
Pipe specifications and pertinent codes. Valves, fittings, pumps and compressors. The transportation function of piping as related to power plants, refineries, slurry systems, pumping systems and drainage. Philosophy of system design. 3 lectures, 1 laboratory. Prerequisite: CE 205, CE 206, ME 342, CSC 231, MATE 210.

ME 428 Design (4)
Component and system design from global integration point of view of various design parameters, using real life problems. Techniques of brainstorming, decision making, PERT, feasibility studies. Industrial participation design program. Subsystem design involving gears, bearings, etc. 2 lectures, 2 laboratories. Prerequisite: ME 313, ME 329, ME 342, ENGL 148.

ME 431 Mechanical Design Techniques (4)
Comprehensive study of various design methods and techniques. Techniques used to explore various structural concepts such as prestressing, shaping, sizing, etc. Simulation of systems using digital computer. Design criteria identification of design parameters and constraints. 3 lectures, 1 laboratory. Prerequisite: ME 329.

ME 432 Petroleum Reservoir Engineering (4)
Types of reservoirs and reservoir rocks. Measurement and interpretation of physical properties of reservoir rocks and fluids: porosity, permeability, compressibility, electrical resistivity, fluid saturation, viscosity, solution gas and PVT properties of reservoir fluids. Introduction to flow in porous media, reserve calculations for different reservoirs and computer applications. 3 lectures, 1 laboratory. Prerequisite: ME 341.
ME 434 Enhanced Oil Recovery (4)
Primary, secondary, and tertiary (enhanced) oil recovery methods. Waterflooding, polymerflooding, gas injection, steam injection, in-situ combustion, chemical flooding, miscible flooding. Performance calculations and computer applications in EOR. 4 lectures. Prerequisite: ME 342, ME 344.

ME 435 Drilling Engineering (4)
Theory and practice of oilwell planning, drilling, well logging, and completion applied to the development of new oil and gas production, from onshore and offshore fields. 4 lectures. Prerequisite: ME 329, ME 342.

ME 436 Petroleum Production Engineering (4)
Design and operation of surface and subsurface equipment required in oil production. Processes and systems involved are rod pumping, gas lifting, acidizing, hydraulic fracturing, fluid gathering and storage, separation of oil, gas, water and sediment from produced fluid. Includes equipment used in enhanced oil recovery processes. 4 lectures. Prerequisite: ME 329, ME 342.

ME 438 Heat Exchanger Design (4)
Theory and application of numerical, analytical, and experimental methods to selected heat transfer problems. Application of principles of conduction, convection, condensation, and boiling heat transfer, stress, and vibrations to design of heat exchange equipment. 4 lectures. Prerequisite: ME 313, ME 342.

ME 440 Thermal System Design (4)
Design and optimization of thermal systems. Engineering economics, thermal component sizing, steady-state simulation, and optimization techniques applied to the design and performance analysis of thermal systems. 3 lectures, 1 laboratory. Prerequisite: ME 342, ME 344.

ME 441 Single Track Vehicle Design (4)
Handling qualities of two-wheeled vehicles, and the application to vehicle design. Modeling of single-track vehicles begins with the complete free body diagram of the steerable section and the dynamics of the vehicle. Laboratory demonstrations of geometry changes to the control spring and control authority. Determination of vehicle geometry values of cg position, longitudinal radius of gyration, headtube angle, etc. as their effect on handling qualities. 3 lectures, 1 laboratory. Prerequisite: ME 318, ME 326, ME 422 or consent of instructor.

ME 443 Turbomachinery (4)

ME 444 Combustion Engine Design (4)
Application of design parameters to the various engine cycles. Aspects of the combustion processes. Emission regulation effects on engine design. Static and dynamic loading. 3 lectures, 1 laboratory. Prerequisite: ME 344.

ME 445 Convective Heat and Mass Transfer (4)
Forced convection in laminar and turbulent flow, free convection, diffusion, combined heat and mass transfer. 4 lectures. Prerequisite: ME 342, ME 344.

ME 450 Solar Power Systems (4)
High and intermediate temperature systems for conversion of solar energy to mechanical power and heat. Thermal energy storage and total thermal energy system design. Recommended as a complement to ME 415. 3 lectures, 1 laboratory. Prerequisite: ME 313.

ME 456 Ventilation Principles and Design (4)
Individual and team project work (including computer simulation) in designing systems, selecting equipment, estimating energy consumption and operating costs for applications in industrial ventilation, exhaust and pollution control. 3 lectures, 1 laboratory. Prerequisite: ME 341, ME 344 or ENVE 304, EE 201.

ME 457 Refrigeration Principles and Design (4)
Basic engineering principles of refrigeration processes including: vapor compression cycles, multipressure systems, absorption systems, steam jet cooling, air cycles, and low temperature refrigeration. 3 lectures, 1 laboratory. Prerequisite: ME 313, ME 341, ME 344.

ME 458 Air Conditioning Principles and Design (4)
Individual and team projects in designing systems, using psychrometrics and load calculations for selecting equipment, estimating energy consumption and operating costs for air conditioning systems. 3 lectures, 1 laboratory. Prerequisite: ME 313, ME 341 and ME 344.

ME 461, 462 Senior Project (2) (3)
Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 150 hours total time. Prerequisite: Senior standing, ME 344 and ME 329 (or concurrent).

ME 463 Undergraduate Seminar (1)
New developments, policies, practices, and procedures discussed through seminar mode. Codes of ethics and case studies interpretations through panel discussions by students. 1 seminar. Prerequisite: Senior standing, ME 344 and ME 329 (or concurrent).

ME 467 Selected Advanced Topics (1–4)
Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

ME 471 Selected Advanced Laboratory (1–4)
Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

ME 475 Cooperative Education Experience (6) (CR/NC)
Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

ME 479 Cooperative Education Experience (12) (CR/NC)
Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.

ME 495 Cooperative Education Experience (12) (CR/NC)
Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Total credit limited to 16 units. Credit/No Credit grading only. Prerequisite: Sophomore standing and consent of instructor.
ME 503 Inelastic Stress Analysis (4)

ME 517 Advanced Vibrations (4)
Vibration of complex engineering systems. Inertia and stiffness matrices. Natural frequencies and normal modes. Approximate solutions and computer techniques. Response to transient and periodic inputs. 3 lectures, 1 laboratory. Prerequisite: ME 318, graduate standing or consent of instructor.

ME 531 Acoustics and Noise Control (3)
Description of sound using normal modes and waves. Interaction between vibrating solids and sound fields. Sound absorption in enclosed spaces. Sound transmission through barriers. Applications in acoustic enclosures, room acoustics, design of quiet machinery and transducers. 3 lectures. Prerequisite: ME 318, MATH 318.

ME 541 Advanced Thermodynamics (4)
Selected modern applications of thermodynamics which may include topics from 1) equilibrium and kinetics as applied to combustion and air pollution, analysis and evaluation of techniques used to predict properties of gases and liquids, and 2) improvement of modern thermodynamic cycles by second law analysis. 4 lectures. Prerequisite: ME 342, ME 344 and graduate standing or consent of instructor.

ME 542 Dynamics and Thermodynamics of Compressible Flow (4)
Control volume analysis of fluid-thermo equations for one-dimensional, compressible flow involving area change, normal shocks, friction, and heat transfer. Two-dimensional supersonic flow including linearization, method of characteristics, and oblique shocks. One-dimensional constant area, unsteady flow, 4 lectures. Prerequisite: ME 342, ME 344, MATH 242, and graduate standing or consent of instructor.

ME 551 Mechanical Systems Analysis (4)
Various system modeling methods applied to mechanical systems. System stability studies and system optimization methods. 3 seminars, 1 laboratory. Prerequisite: Graduate standing or consent of instructor.

ME 552 Conductive Heat Transfer (3)
Theory of steady-state and transient conduction in isotropic and anisotropic media. Development of differential equations, solutions by series, transforms, Duhamel's Method, variational methods. 3 seminars. Prerequisite: ME 342, ME 344, MATH 318, and graduate standing or consent of instructor.

ME 553 Convective Heat Transfer (3)
Conservation of mass, momentum, and energy applied to laminar forced and free convection and turbulent flows. Differential, integral, and scale analysis solutions. 3 seminars. Prerequisite ME 342, ME 344, MATH 318, and graduate standing or consent of instructor.

ME 554 Computational Heat Transfer (3)
Numerical solutions of classical, industrial, and experimental problems in conduction, convection, and radiation heat transfer. 3 seminars. Prerequisite: ME 552, ME 553, graduate standing or consent of instructor.

ME 563 Graduate Seminar (1)
Current developments in mechanical engineering. Participation by graduate students, faculty and guests. 1 seminar. Prerequisite: Graduate standing in mechanical engineering program.

ME 585 Cooperative Education Experience (6) (CR/NC)
Advanced study analysis and part-time work experience in student’s career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

ME 595 Cooperative Education Experience (12) (CR/NC)
Advanced study analysis and full-time work experience in student’s career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 9 units. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

ME 599 Design Project (Thesis) (2) (2) (5)
Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master’s degree, culminating in a written report/thesis. Prerequisite: Graduate standing.

MSC—MILITARY SCIENCE

MSC 111 Orienteering (2)
Principles of orienteering, basic map reading and compass skills; course running techniques applied in field orienteering events. Open to all freshmen and sophomores. 1 lecture, 1 activity.

MSC 112 Survival Training—Wilderness (2)
Techniques of survival in a wilderness environment. Traps and snares, building fires, preparing plant and animal food, locating water, and first aid. Open to all freshmen and sophomores. 1 lecture, 1 activity.

MSC 116 Basic Military Skills (2)
Conducting and evaluating individual, squad, platoon, and company drill and ceremony skills. Conducting manual of arms, evaluating physical fitness principles. Conducting and evaluating physical fitness program. Techniques of rifle marksmanship. Open to all freshmen and sophomores. 1 lecture, 1 activity.

MSC 211 Current Military Affairs (2)
Organization and functions of the Department of Defense. Issues related to U.S. military affairs: selective service, arms control, nuclear weapons and alliances. Purpose of ROTC, military customs, the military as a profession. Open to all students. 2 lectures.

MSC 212 Basic Camp (1–7)
One to seven units of credit may be granted depending upon successful completion of training. Six weeks of training, Fort Knox, Kentucky. Travel pay and salary provided through the Military Science Department. No obligation. Camp graduates eligible to enroll in ROTC Advanced Program.

MSC 213 Mountaineering (2)
Techniques of survival in a mountainous environment. Rappelling, hot and cold weather survival, basic mountaineering, and rope bridges. Open to all freshmen and sophomores. 1 lecture, 1 activity.

MSC 215 Leadership/Management Seminar (2)
Exploration of key, basic managerial and leadership concepts/techniques. Emphasis is on practical application with experiential learning situations demonstrating key leadership and management principles. Open to all students. 2 seminars.

MSC 217 Institutionalizing Diversity:
The U.S. Army (3)
Exploration of the various roles and contributions of minorities and females to the United States Army, from the Revolutionary War to the present. Current policies and demographics. 3 lectures.

MSC 225 Advanced Survival Techniques (2)
Mastery of advanced survival skills including water survival, water crossings, expedient tools, weapons, and shelters. Signaling, weather forecasting and survival medicine. 2 activities. Prerequisite: MSC 112, MSC 213 or consent of instructor. Must be able to swim.
MSC 226 Advanced Orienteering (2)
Continuation of MSC 111. Skills will be enhanced with emphasis placed on practical application. 2 activities. Prerequisite: MSC 111 or consent of instructor.

MSC 229 Ranger Challenge (2) (CR/NC)
Selection and preparation of the Ranger Challenge Team which will represent Cal Poly in military tactical skills competition. Includes rope bridging, orienteering, weapons knowledge, hand grenade accuracy, 10K road march with equipment, first aid, marksmanship, physical fitness and tactics. Credit/No Credit grading only. 2 activities.

MSC 311 Leadership and Management (3)
Descriptive model of platoon leadership including personnel within a platoon and tasks of platoon leaders; major theories of leadership; instruction and practice in communication, human relations, organizational structure, power and influence, and management. 3 lectures.

MSC 312 Leader Communication Skills (3)
Principles and usage of verbal, nonverbal, and symbolic communications. Preparing, conducting, and evaluating training. Principles and techniques of meeting management; leadership counseling techniques; proper radio procedures. 3 lectures.

MSC 313 Tactical Military Operations (3)
Organization of the United States Army land combat forces including tactical doctrine and equipment; organization of the modern battlefield; fundamentals of small unit tactics; planning, organizing and conducting small unit operations; fundamentals of land navigation. 3 lectures.

MSC 314 ROTC Advanced Camp (6) (CR/NC)
Six week summer training program required to achieve an Army commission. Testing and training as functional Army officers and determination of potential for service. Travel pay, room and board, and salary are provided by the U.S. Army. Held at Fort Lewis, Washington. Credit/No Credit grading only. Prerequisite: MSC 111 or consent of instructor.

MSC 400 Special Problems for Advanced Undergraduates (1–2)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of instructor.

MSC 411 Military Professionalism and Ethics (3)
Professional knowledge subjects including command and staff functions, personnel, training and logistics management, military correspondence and leadership counseling. Discussion of moral philosophy and values essential to the military profession. 3 lectures.

MSC 412 Military Justice (2)
Uniform code of military justice, including the court martial system, disciplinary measures, military crimes, search and seizure, apprehension and safeguarding evidence. Overview of the laws of war. 2 lectures.

MSC 413 Military Organizations and Management (2)
Planning and organizing military functions. Managing staff positions of responsibility. Cadets will be responsible for all coordination and execution of assigned projects. 2 lectures. Prerequisite: MSC 411, MSC 412 and consent of instructor.

MSC 470 Selected Advanced Topics (1–4)
Directed group study of selected topics for advanced students. Class Schedule will list topic selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

MU–MUSIC

MU 100 Music Fundamentals (4)
Traditional music notation. Use of treble and bass staff for pitch and rhythm, harmonization using principal triads, major and minor, and common seventh chords. Performance of simple pieces individually and in groups using common classroom instruments. 3 lectures, 1 activity.

MU 101 Introduction to Music Theory (4) GE C3
Introduction to the elements of music and their use by composers and performers. Notation of pitch and rhythm, scales, key signatures, intervals and chords. 3 lectures, 1 activity.

MU 103 Music Theory I (4)
Structure of tonality, four-part writing of root position and inverted triads, cadences and melodic structure, harmonic progressions, harmonization of a melody and nonharmonic tones. Composition project. 4 lectures. Prerequisite: MU 101 or permission of instructor.

MU 104 Musicanship I (2)
Introductory sightsinging; rhythmic performance and dictation in simple meters; identification and performance of melodic and harmonic intervals and triads, dictation of major diatonic melodies. 2 activities. Prerequisite: Previous or current enrollment in MU 101; Music major or minor status.

MU 106 Musicanship II (2)
Sightsinging in all forms of the minor mode; rhythmic performance and dictation in compound meters and syncopation; identification of triad inversions and cadence formulas; dictation of minor diatonic melodies; interval identification in multiple timbres. 2 activities. Prerequisite: MU 104 or consent of instructor.

MU 114 Introduction to Composing (4)
Fundamental concepts in music composition. Creative projects. Compositional techniques, development, and structure. Analysis of examples from the literature. 3 lectures, 1 activity. Prerequisite: MU 101 or consent of instructor.

MU 120 Music Appreciation (4) GE C3
Explores the world of music with emphasis on Western tradition. Language of music, the role of music in society. Historical context and major composers from the Middle Ages to the present. 3 lectures, 1 activity.

MU 121 Introduction to Non-Western Musics (4)
Survey of selected non-Western music cultures. Emphasis on listening and understanding the ensemble type, aesthetic principle, musical style, and performance practice of each. 3 lectures, 1 activity. Prerequisite: Music major, minor, or consent of instructor.

MU 149 Applied Study/Technique (1)
Individual instruction in performance with emphasis on the technical skills needed for the performance of repertoire. Total credit limited to 3 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 150 Applied Music (1)
Individual instruction in performance with emphasis on repertoire, technical skills, style, and interpretation. Total credit limited to 6 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 151 Beginning Piano (2)
Beginning piano for student with no background in keyboard instruments. Includes fundamentals of notation, keyboard techniques, tone production, sightreading and facility. 1 lecture, 1 activity.

MU 152 Elementary Class Piano (1)
Continuation of MU 151. Piano for students with the ability to play a simple Bach or Mozart Minuet. Total credit limited to 3 units. 1 activity. Prerequisite: MU 151 or equivalent. For non-music majors.

MU 153 Intermediate Class Piano (1)
Continuation of MU 152. Students are expected to play at the level of the easier Clementi Sonatinas. Total credit limited to 3 units. 1 activity. Prerequisite: MU 152 or one year of piano instruction. For non-music majors.
MU 154 Beginning Voice (2)
Beginning study of vocal and performance technique for the untrained singer. Includes the beginning study of the vocal mechanism and the fundamentals of notation. 1 lecture, 1 activity.

MU 155 Guitar I (1)

MU 161 Piano Skills I (1)
Preparation for Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization or a melody, accompanying, improvisation of a melody. 1 activity. Prerequisite: Consent of instructor.

MU 162 Piano Skills II (1)
Continuation of MU 161. Preparation for Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization of a melody, accompanying, improvisation of a melody. 1 activity. Prerequisite: MU 161 or consent of instructor.

MU 163 Piano Skills III (1)
Continuation of MU 162. Preparation for Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization of a melody, accompanying, improvisation of a melody. 1 activity. Prerequisite: MU 162 or consent of instructor.

MU 170 University Jazz Band (1)
Study and public performance of music written for big band jazz. Limited to those who have had considerable experience playing musical instruments. The band performs concerts on campus and makes at least one tour annually. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 171 Instrumental Ensembles (1)
Open to qualified musicians. Rehearsal and public performances in large and small ensembles. Total credit limited to 6 units. 1 activity. Prerequisite: Consent of instructor.

MU 172 Wind Orchestra (1)
Study and public performance of music written for large wind bands (woodwinds, brass, and percussion). Limited to those students who have had experience with wind and percussion instruments. The band performs concerts on campus and makes at least one tour annually. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 173 Wind Ensemble (1)
Study and public performance of music written for wind ensembles (woodwinds, brass and percussion). Limited to those students who have had experience with wind and percussion instruments. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 174 Orchestra (1)
Preparation and performance of orchestral music including both the standard repertoire and rarely performed works. Open to all students whose technique is adequate. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 175 Contemporary Music Ensemble (1)
Open to all instrumentalists who are interested in performing 20th-century classical literature. Limited to students who are proficient on their instrument. Total credit limited to 6 units. 1 activity. Prerequisite: By audition or consent of instructor.

MU 176 Mustang Band (1)
Public performance of music and specially-designed shows written for marching band (woodwinds, brass, percussion, and flag team auxiliary). Limited to those students who have had marching experience with wind and percussion instruments, or flag, rifle or dance lines. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 180 Men’s Chorus (1)
Study and public performance of music composed for men’s voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 181 PolyPhonics (1)
Study and public performance of music for mixed voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 182 Women’s Chorus (1)
Study and public performance of music composed for women’s voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 183 Vocal Ensemble (1)
Open to qualified singers. Rehearsal and performance of specialized vocal music. Total credit limited to 6 units. 1 activity. Prerequisite: Consent of instructor.

MU 184 Music Production Workshop (2)
Preparation of a musical theatre production for public presentation. Includes acting and stage management. Total credit limited to 6 units. 2 laboratories. Prerequisite: By audition or consent of instructor.

MU 185 University Singers (1)
Study and public performance of music for large mixed chorus. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 187 Vocal Jazz Ensemble (1)
Study and performance of vocal jazz, including ensemble performance as well as solo performance and improvisation. Total credit limited to 6 units. 1 laboratory. Prerequisite: Consent of instructor.

MU 200 Special Problems for Undergraduates (1)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of instructor.

MU 207 Music Theory II (4)
Construction and resolution of seventh chords, secondary dominants, nondominant seventh chord, basic modulation, change of mode. Augmented sixth chord and Neapolitan sixth chord. Binary and ternary form. Composition project. 4 lectures. Prerequisite: MU 103.

MU 208 Musicianship III (2)
Sightsinging in all modes in two or more parts; rhythmic dictation in 2 parts; identification of triadic chord progressions and root position seventh chords; dictation of two-part melodies in all modes. 2 activities. Prerequisite: MU 106 or consent of instructor.

MU 210 Musicianship IV (1)
Continuation of MU 208. Sightsinging with chromatic tones; rhythmic performance in irregular meters; chord progressions with triads and dominant seventh chords; seventh chord inversions; and 2-part diatonic dictation. 1 activity. Prerequisite: MU 208 or consent of instructor.

MU 211 Musicianship V (1)
Continuation of MU 210. Sightsinging with non-diatonic tones; rhythmic dictation in irregular meters; chord progressions with secondary dominant chords; modulatory progressions and dictations. 1 activity. Prerequisite: MU 210 or consent of instructor.

MU 212 Musicianship VI (1)
Continuation of MU 211. Emphasis on previously acquired skills, plus performance and dictation of complex beat divisions; identification of augmented and neapolitan 6th chords; and modulatory dictation in 2 parts. 1 activity. Prerequisite: MU 211 or consent of instructor.

MU 221 Jazz Styles (4)
Survey of Jazz as a significant American art form from 1900 to the present; its historical background and development in the United States; key elements, leading performers, and significant compositions in each style. Emphasis on listening skills. 3 lectures, 1 activity.

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MU 229  Music of the 60s: War and Peace (4)  GE C3  USCP
Explores wide spectrum of rock, folk and pop styles of the 60s. Relates music to social turmoil and historical trends, including Vietnam War, Civil Rights Movement, American Indian Movement, Chicano Movement, Free Speech Movement. 3 lectures, 1 activity.
MU 249  Applied Study/Technique (1)
Individual instruction in performance with emphasis on the technical skills needed for the performance of repertoire. Total credit limited to 3 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.
MU 250  Applied Music (1)
Individual instruction in performance with emphasis on repertoire, technical skills, style, and interpretation. Total credit limited to 6 units. Specific areas of study are listed in the Class Schedule. Prerequisite: 3 units of MU 150 and consent of instructor.
MU 251  Diction for Singers (1)
The study of diction as it applies to singing in English, French, German, Italian and Spanish. Class Schedule will list topic elected. Total credit limited to 3 units. 1 activity. Prerequisite: Consent of instructor.
MU 252  Intermediate Voice (1)
Vocal and performance technique for experienced singers. Total credit limited to 3 units. 1 activity. Prerequisite: MU 154 or consent of instructor.
MU 253  Advanced Class Piano (1)
Advanced level piano techniques with emphasis on style, interpretation, sightreading, basic performance practices and the solution to general musical problems. Total credit limited to 3 units. 1 activity. Prerequisite: MU 153 or consent of instructor. For non-music majors.
MU 255  Guitar II (1)
Develops intermediate guitar techniques and performance. Elements of classical, pop, and folk styles. Intermediate skills, reading notes and chord charts. 1 activity. Prerequisite: MU 155 or permission of instructor.
MU 259  Beginning Jazz Improvisation (1)
Development of improvised melodies in mainstream jazz with play-along recordings. Modal, blues and II-V-I progressions with relevant jazz theory. Swing, eighth-note phrasing, and performance of transcribed solos. Total credit limited to 3 units. 1 activity. Prerequisite: MU 101 or consent of instructor.
MU 260  Intermediate Jazz Improvisation (1)
Further development of improvised melodies in mainstream jazz with play-along recordings. Blues and II-V-I progressions with relevant jazz theory. Swing, eighth-note phrasing, and performance of transcribed solos. Total credit limited to 3 units. 1 activity. Prerequisite: MU 259 or consent of instructor.
MU 261  Piano Skills IV (1)
Continuation of MU 163. Preparation for Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization of a melody, accompanying, and improvisation of a melody. 1 activity. Prerequisite: MU 163 or consent of instructor.
MU 262  Piano Skills V (1)
Continuation of MU 261. Preparation for Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization of a melody, accompanying, improvisation of a melody. 1 activity. Prerequisite: MU 261 or consent of instructor.
MU 263  Piano Skills VI (1)
Continuation of MU 262. Successful completion of this course represents fulfillment of the Piano Proficiency Examination. Study of piano repertoire, sightreading, transposition, harmonization of a melody, accompanying, improvisation of a melody. 1 activity. Prerequisite: MU 262 or consent of instructor.
MU 301  Counterpoint (4)
Counterpoint as a compositional technique. Modal, tonal, and post-tonal practices. Creative project. 4 lectures. Prerequisite: MU 309.
MU 308  Sound Design: Technologies (4)
Fundamental tools of electroacoustic sound design. Concepts and application of music studio procedure, recording, synthesis, and MIDI. Studio projects. 3 lectures, 1 activity. Prerequisite: MU 101, MU 120 or consent of instructor.
MU 309  Music Theory III (4)
Compositional procedures employed by composers of the Classical and Romantic periods. Chromatic third-related harmony, ninth, eleventh and thirteenth chords. Chromatic and enharmonic modulation. Sonata and rondo form. Composition project. 4 lectures. Prerequisite: MU 207.
MU 310  Sound Design: Recording (4)
Exploring creative use of recording technology. Analog and digital equipment for recording music. Analysis and creative projects. 3 lectures, 1 activity. Prerequisite: MU 308 or permission of instructor.
MU 320  Music Research and Writing (4)
Methodology for researching, analyzing, and writing about music. Exploration of investigative tools including library resources, periodicals, bibliographic tools, computerized search methods. Computerized software for text and music notation. Formatting music for publication. Performance practice. 4 lectures. Prerequisite: MU 207 and ENGL 134. Recommended: MU 120; or permission of instructor.
MU 324  Music and Society (4)  GE C4
Exploration into the role of music historically and culturally. Emphasis on deeper understanding and appreciation of the context of music through topics of special interest. Class Schedule will list topics selected. Total credit limited to 12 units. 3 lectures, 1 activity. Prerequisite: Completion of GE Area A and a foundation course in Area C.
MU 325  America’s Music (4)  USCP
Explorations of many styles of America’s music through lectures, readings, sound recordings, musical scores, and performance. Includes “Native American,” “folk,” “popular,” and “fine art” traditions. How American music reflects the different cultural heritages, social contexts, and philosophies of its creators. 4 lectures. Prerequisite: MU 207. Recommended: MU 120.
MU 326  Cultural Concepts and Structures in Music (4)
Exploring the definition, concepts, and structures of music in terms of theory, performance practice, and compositional procedures of selected non-Western cultures. 3 lectures, 1 activity. Prerequisite: Junior standing or consent of instructor.
MU 328  Women in Music (4)  GE C4
Survey of women’s contributions as composers and performers of western art and popular music; historical overview of the experiences and perception of women as musicians. 3 lectures, 1 activity. Prerequisite: Completion of GE Area A and a foundation course in Area C.
MU 331  Music of the Middle Ages and Renaissance (4)
Musical literature, styles, composers, theory, genres and notation of the Middle Ages and Renaissance. Relationship to historical trends. 4 lectures. Prerequisite: MU 320; Recommended: MU 120; or permission of instructor.
MU 332  Music of the Baroque and Early Classic Eras (4)
Survey of the history of western art music from 1600 to 1780. 4 lectures. Prerequisite: MU 320; Recommended: MU 120; or permission of instructor.
MU 333  Music of the Classic and Romantic Eras (4)
Survey of the history of western art music from 1780 to 1900. 4 lectures. Prerequisite: MU 320; Recommended: MU 120; or permission of instructor.

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MU 334  Music of the 20th Century (4)
Composers, important works, and significant trends in the Western European and American classical tradition during the 20th Century. 4 lectures. Prerequisite: MU 320; Recommended: MU 120; or permission of instructor.

MU 335  Survey of Keyboard Literature (4)
Intensive survey of solo piano literature from early keyboard music through contemporary composers; emphasis upon composers’ influences, stylistic characteristics, performance practices, and the development of the piano forte. 4 lectures. Prerequisite: MU 207 or consent of instructor.

MU 336  Jazz History and Theory (4)
Survey of Jazz theoretical techniques. Emphasis upon historical context and development of Jazz through study and analysis of scores and historical performances. 4 lectures. Prerequisite: MU 207.

MU 337  Survey of Vocal Literature (4)
Comprehensive survey of vocal literature from early to contemporary composers. Emphasis upon composers’ influences, style characteristics, and performance practices. 4 lectures. Prerequisite: MU 207 or consent of instructor.

MU 340  Conducting: Fundamentals (2)
Principles and techniques of conducting with experience in score reading. 2 activities. Prerequisite: MU 207 or consent of instructor.

MU 341  Conducting: Choral (2)
Continuation of MU 340. Emphasis on choral literature. Score reading, rehearsal techniques, and musical details associated with vocal music. 2 activities. Prerequisite: MU 340.

MU 342  Conducting: Instrumental (2)
Continuation of MU 340. Emphasis on band and orchestra literature. Score reading, rehearsal techniques, and musical details associated with instrumental music. 2 activities. Prerequisite: MU 340.

MU 349  Applied Study/Technique (1)
Individual instruction in performance with emphasis on the technical skills needed for the performance of repertoire. Total credit limited to 3 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 350  Applied Music (1)
Individual instruction in performance and composition. Total credit limited to 6 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 351  Jazz and Popular Music Arranging (2)
Arranging for small and large jazz ensembles. Score and part preparation. 2 activities. Prerequisite: MU 207.

MU 352  Orchestration (4)
Ranges, transposition, technical capabilities, and scoring of vocal ensembles, band, and orchestra instruments. Creative project. 3 lectures, 1 activity. Prerequisite: MU 207.

MU 360  Music for Classroom Teachers (4)
Development of skills for fostering creative music experiences in the classroom. Exploration of various approaches to motivating children musically. Study of folk songs for singing, playing instruments, and learning about music as well as for their ethnic and cultural significance. 3 lectures, 1 activity. Prerequisite: MU 100 or MU 101.

MU 361  Instruments (1)
Fundamentals of playing and teaching woodwind, brass, string, and percussion instruments. Separate sections in specific areas of study are arranged with instructor. Total credit limited to 6 units. 1 activity. Prerequisite: Junior standing and consent of instructor.

MU 365  Music in the Elementary School (4)
Study and application of Orff, Dalcroze, Kodaly, Manhattanville, and Suzuki. Philosophy, objectives and methodologies for implementing an effective school music program. Includes fieldwork. 3 lectures, 1 activity. Prerequisite: MU 207; junior standing.

MU 366  Piano Pedagogy (2)
Survey of elementary, intermediate and advanced teaching methods and literature; private and group instruction; studio policies. 2 activities. Prerequisite: MU 207 or consent of instructor.

MU 367  Vocal Pedagogy (2)
Survey of elementary, intermediate and advanced teaching methods including a comprehensive study of the vocal mechanism. 2 activities. Prerequisite: MU 207 or consent of instructor.

MU 370  University Jazz Band (1)
Study and public performance of music written for big band jazz. Limited to those who have had considerable experience playing musical instruments. The band performs concerts on campus and makes at least one tour annually. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 371  Instrumental Ensemble (1)
Open to qualified musicians. Rehearsal and public performance in large and small ensembles. Total credit limited to 6 units. 1 activity. Prerequisite: Junior standing and consent of instructor.

MU 372  Wind Orchestra (1)
Study and public performance of music written for large wind band (woodwinds, brass and percussion). Limited to those students who have had experience with wind and percussion instruments. The band performs concerts on campus and makes at least one tour annually. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 373  Wind Ensemble (1)
Study and public performance of music written for wind ensemble (woodwinds, brass and percussion). Limited to those students who have had experience with wind and percussion instruments. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 374  Orchestra (1)
Preparation and performance of orchestral music including both the standard repertoire and rarely performed works. Open to all students whose technique is adequate. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 375  Contemporary Music Ensemble (1)
Open to all instrumentalists who are interested in performing 20th-century classical literature. Total credit limited to 6 units. 1 activity. Prerequisite: Junior standing; by audition or consent of instructor.

MU 376  Mustang Band (1)
Public performance of music and specially-designed shows written for marching band (woodwinds, brass, percussion, and flag team auxiliary). Limited to those students who have had marching experience with wind and percussion instruments, or flag, rifle or dance lines. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 380  Men’s Chorus (1)
Study and performance of music for men’s voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 381  PolyPhonics (1)
Study and public performance of music for mixed voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 382  Women’s Chorus (1)
Study and public performance of music for women’s voices. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.
MU 383 Vocal Ensemble (1)
Open to qualified singers. Rehearsal and performance of specialized vocal music. Total credit limited to 6 units. 1 activity. Prerequisite: Junior standing and consent of instructor.

MU 384 Music Production Workshop (2)
Preparation of a musical theatre production for public presentation, including acting and stage management. Total credit limited to 6 units. 2 laboratories. Prerequisite: Junior standing and by audition, or consent of instructor.

MU 385 University Singers (1)
Study and public performance of music for large mixed chorus. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 387 Vocal Jazz Ensemble (1)
Study and performance of vocal jazz, including ensemble performance as well as solo performance and improvisation. Total credit limited to 6 units. 1 laboratory. Prerequisite: Junior standing and consent of instructor.

MU 400 Special Problems for Advanced Undergraduates (1–2)
Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Junior standing and consent of department head.

MU 401 Contemporary Music Theory (4)
Examination of modern compositional practices including impressionism, polytonality, serialism, timbre and form, minimalism, and the new eclecticism. Analysis and creative projects. 4 lectures. Prerequisite: MU 309 or permission of instructor.

MU 404 Composition (2)
Independent creative projects. Exercises in compositional methods designed to increase technical facility. Total credit limited to 6 units. 2 activities. Prerequisite: MU 309 or permission of instructor.

MU 411 Sound Design: Synthesis (4)
Compositional application of sound synthesis techniques. Realization of computer music. Creative projects. 3 lectures, 1 activity. Prerequisite: MU 310.

MU 412 Sound Design: Composition and Production (4)
Production of electroacoustic music in media. Program analysis, technical planning, composition, and product development. 3 lectures, 1 activity. Prerequisite: MU 310.

MU 420 Music History: Selected Topics (4)
Intensive study of selected topics in music history through the use of readings, recordings, scores, and class presentations. Class Schedule will list topics selected. Total credit limited to 8 units. 3 lectures, 1 activity. Prerequisite: MU 331, MU 332, MU 333, MU 334, or consent of instructor.

MU 449 Applied Study/Technique (1)
Individual instruction in performance with emphasis on the technical skills needed for the performance of repertoire. Total credit limited to 3 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 450 Applied Music (1)
Individual instruction in performance and composition. Total credit limited to 6 units. Specific areas of study are listed in the Class Schedule. Prerequisite: Consent of instructor.

MU 461 Senior Project (3)
Selection and completion of a project under faculty supervision. Minimum of 90 hours total time. Results presented in a recital, creative work, formal report, or a combination of all three. Prerequisite: Senior standing and consent of department head.

MU 465 Choral Literature and Rehearsal Techniques (4)
Survey of choral literature especially suited for secondary schools. Philosophy and strategy for developing a school program. Musical as well as non-musical techniques for effective rehearsal. 3 lectures, 1 activity. Prerequisite: MU 341, or consent of instructor.

MU 466 Instrumental Literature and Rehearsal Techniques (4)
Survey of instrumental literature especially suited for secondary schools. Philosophy and strategy for developing a school program. Musical as well as non-musical techniques for effective rehearsal. 3 lectures, 1 activity. Prerequisite: MU 342, or consent of instructor.

PE–PHYSICAL EDUCATION
(See also KINE–Kinesiology)

BASIC INSTRUCTIONAL PROGRAM
Enrollment is open to all students except for designated intramural courses. Courses carry 1 unit of credit, meet 2 hours per week, and are designed to develop skill, knowledge of rules, background and analysis of techniques, and desirable attitudes toward physical fitness and participation in physical activities. The beginning course or its equivalent is prerequisite to the intermediate, and the intermediate to the advanced. Prerequisite may be waived by consent of the instructor.
No more than two different activity courses nor more than one section of an individual activity course may be taken for credit in any one quarter. A student may not enroll simultaneously in the same quarter for a beginning, intermediate and/or advanced activity course. Any level of an activity course may be repeated once only for credit.
Students not majoring in kinesiology may apply a maximum of 12 units of credit earned in general and intramural activity courses toward the bachelor’s degree.
All basic instructional courses (PE 100–176) are evaluated on a Credit/No Credit basis. A miscellaneous course fee may be required—see Class Schedule.

Coed
PE 100 Adaptive Activity
PE 101 Gymnastics
PE 102 Tumbling and Vaulting
PE 103 Archery
PE 104 Badminton, Beg.
PE 105 Badminton, Int.–Adv.
PE 107 Billiards
PE 108 Basketball
PE 109 Bowling
PE 110 Cycling
PE 111 Fencing
PE 112 Bowling, Int.
PE 116 Aerobic Exercise
PE 121 Golf, Beg.
PE 122 Golf, Int.–Adv.
PE 125 Jogging
PE 126 Judo
PE 129 Stretch, Flex and Relax
PE 131 Physical Conditioning
PE 132 Racquetball, Beg.
PE 133 Racquetball, Int.–Adv.
PE 135 Skin Diving
PE 136 Scuba Diving
PE 137 Self-Defense
PE 138 Karate
PE 139 Soccer
PE 140 Ultimate Disc
PE 142 Softball
PE 143 Swimming for Non-Swimmers
PE 144 Swimming, Advanced Beginner
PE 145 Swimming, Int.
PE 146 Swimming, Adv.

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The nature of deductive logical systems. Methods of notation, translation

PHIL 225 Symbolic Logic (4) GE A2
The nature of deductive logical systems. Methods of notation, translation and proof in the sentential, predicate and relational calculi including indirect and conditional methods of proof. 4 lectures. Prerequisite: Completion of GE Areas A1 and A2.

PHIL 230 Philosophical Classics: Metaphysics and Epistemology (4) GE C2
Study of several classic works from the history of philosophy on issues in metaphysics and epistemology. At least one will be from the Ancient period, and at least one from the Modern era. No more than one from the twentieth century. 4 lectures. Prerequisite: Completion of GE Area A.

PHIL 231 Philosophical Classics: Social and Political Philosophy (4) GE C2
Readings from primary philosophical texts, from the ancient and modern periods, with focus on the identification and evaluation of the central ethical and political themes and arguments presented in them. 4 lectures. Prerequisite: Completion of GE Area A.

PHIL 311 Greek Philosophy (4) GE C4
Beginnings of Western philosophy and science. The Presocratics, Socrates, Plato, and Aristotle. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 312 Medieval Philosophy (4) GE C4
Development of Western philosophy from Augustine to Ockham, including Anselm, Abelard, Roger Bacon, Bonaventure, Aquinas, and Duns Scotus. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 313 Continental Philosophy: Descartes to Leibniz (4) GE C4
Development of Western philosophy from the late Renaissance through Leibniz, with special emphasis upon the epistemology and metaphysics of the Continental Rationalists. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 314 British Philosophy: Bacon to Mill (4) GE C4
Development of Western philosophy from the Renaissance through Mill, with special emphasis on British Empiricism. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 315 German Philosophy: Kant to Nietzsche (4) GE C4
Primary issues and concepts found in German philosophy from 1780 to 1900, with emphasis on Kant, Hegel, and Nietzsche. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 316 Contemporary European Philosophy (4) GE C4
Recent movements within the Continental tradition, including French and German existentialism, phenomenology, and post-metaphysical philosophy. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 317 Contemporary British and American Philosophy (4) GE C4
Major developments within 20th century British and American philosophy, with focus chiefly around Analytic philosophy. Other schools, such as Pragmatism, may be included, as may some philosophers outside of Britain and America whose work was influential in those countries. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 320 Asian Philosophy (4) GE C4
Philosophies developed in India, South Asia, China and Japan, including the logical and epistemological presuppositions of the Six Schools of Hindu metaphysics, Buddhist philosophy, Confucian moral philosophy, Taoist metaphysics and social ecology. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 321 Philosophy of Science (4) GE C4
The rational foundations of inquiry and explanation in the physical, biological and social sciences. Justification of scientific claims, the difference between science and pseudoscience, the relationship between science and other fields of investigation. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 331 Ethics (4) GE C4
Analyses of various traditional and contemporary positions on the difference between right and wrong, if there is one. Theories of metaethics and normative ethics including the divine command theory, relativism, intuitionism, noncognitivism, virtue ethics, egoism, utilitarianism and duty-based ethics. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

PHIL 332 History of Ethics (4) GE C4
The history of moral thought from Homer and the Pre-Socratics to the 20th century, and focus on theories of moral goodness and rightness of action. Related issues and areas of thought, e.g. metaphysics, theology, science, politics, psychology freedom/determinism to be considered, where they
 shed light on moral thought. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 333 Political Philosophy (4)**  GE C4
Analyses of the philosophical foundations of political ideologies, including theories of political authority, legitimacy, obligation, and rights, and of the proper function of the state, and the relation of these theories to issues in metaphysics, theory of knowledge, and ethics. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 334 Philosophy of Law (4)**  GE C4

**PHIL 335 Social Ethics (4)**  GE C4
Examination of contemporary moral problems, solutions to these problems, and the arguments for these solutions, with emphasis on two or more of the following sample problem areas: abortion, suicide and euthanasia, capital punishment, family ethics, race relations, social justice, war, women's issues. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 337 Business Ethics (4)**  GE C4
Critical examination of ethical problems that arise in business. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 338 Ethics and Education (4)**  GE C4
Critical discussion of moral issues as a means to the educational goals of autonomy and freedom. Critical examination of major ethical theories. Examination of classroom approaches to discussions of ethical values and moral controversy in education. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 339 Biomedical Ethics (4)**  GE C4
Critical examination of problems in biomedical ethics, proposed solutions to these problems, and the arguments for such solutions. Emphasis on two or more of the following sample problem areas: concepts of health and disease, human experimentation, informed consent, behavior control, genetic intervention, new birth technologies, euthanasia and physician-assisted dying. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 340 Environmental Ethics (4)**  GE C4
Analyses of various positions on the moral status of nonhuman entities and problems such as the treatment of animals, wilderness preservation, population, pollution and global warming. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 342 Philosophy of Religion (4)**  GE C4
Inquiry into the rational and nonrational bases of religious claims. Arguments for and against the existence of God. Discussion of miracles, revelation, the definition of God, the problem of evil, the relation of faith and reason, the nature of religious experience, the verification of religious claims. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 350 Aesthetics (4)**  GE C4
Critical examination of philosophical views of art from both a historical and contemporary perspective. Treatment of theories from Plato and Aristotle through those of the twentieth century. Discussion of the problems raised by modern art. The relation between aesthetic values and metaphysics, epistemology, ethics and politics. 4 lectures. Prerequisite: Completion of GE Area A, and PHIL 230 or PHIL 231.

**PHIL 400 Special Problems for Advanced Undergraduates (1–2)**
Individual investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of department chair.

**PHIL 411 Metaphysics (4)**
Traditional and current ideas and arguments about substance, the relation of universals to particulars, space and time, events, causation and necessity, the self and free will. 3 lectures, research paper. Prerequisite: PHIL 230.

**PHIL 412 Epistemology (4)**
Analysis of the concept of knowledge. Development of competing theories of epistemic justification and truth. Inquiry into relationship between knowledge, belief, justification and truth. Examination of skepticism. 3 lectures, research paper. Prerequisite: PHIL 230.

**PHIL 422 Philosophy of Mind (4)**
Classic and current work in the problems and issues of the nature and unity of the self, consciousness, mental representations, and action, and of the relation of philosophy of mind to psychology, linguistics and computer science. 3 lectures, research paper. Prerequisite: PHIL 230 or PHIL 231.

**PHIL 429 Special Topics in the History of Philosophy (4)**
Advanced discussion of selected topics in the history of philosophy. Examination and analysis of important philosophical movements (e.g., positivism, postmodernism) or alternatively, of particular philosophers or philosophical works of exceptional importance (e.g., David Hume; Kant's *Critique of Pure Reason*). Class Schedule will list topic selected. Total credit limited to 12 units. 3 lectures, research paper. Prerequisite: PHIL 230.

**PHIL 439 Selected Problems in Ethics and Political Philosophy (4)**
Advanced discussion of selected topics in ethics and political philosophy. Examination and analysis of significant ethical or political theories (e.g., utilitarianism, contractarianism) or alternatively, of particular philosophers or philosophical works of exceptional importance (e.g., John Stuart Mill; John Rawls' *A Theory of Justice*). Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, research paper. Prerequisite: PHIL 231 and PHIL 331 or PHIL 333.

**PHIL 460, 461 Senior Project (2) (2)**
Selection, development and completion of a project under faculty supervision. Results presented in a formal thesis. Minimum of 60 hours per quarter. Requirements for PHIL 460 must be completed before student can enroll in PHIL 461. Prerequisite: Senior standing, consent of instructor.

**PHIL 470 Selected Advanced Topics (1–4)**
Directed group study of selected topics for advanced students. Class Schedule will list topics selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

**PHYS—PHYSICS**

**PHYS 104 Introductory Physics (4)**  GE B3
Elementary introduction to mechanics, gases, liquids and solids, heat, vibrations and waves, light, electricity and magnetism. Intended to provide non-science students with an understanding of basic physical concepts. Not open to students who have credit in a college physics course. 4 lectures. Prerequisite: Appropriate ELM exemption or an appropriate score on the ELM examination or MATH 104.

**PHYS 121 College Physics (4)**  GE B3 & B4
Introductory course in mechanics emphasizing motion, force, and energy. Not open to students having a grade of C- or better in PHYS 131. 3 lectures, 1 laboratory. Prerequisite: MATH 118 and high school trigonometry, or MATH 119 or MATH 120.

**PHYS 122 College Physics (4)**
Continuation of PHYS 121. Topics include properties of materials, fluids, waves and vibrations, sound, heat, light and optics. Not open for credit to students having a grade of C- or better in PHYS 132. 3 lectures, 1 laboratory. Prerequisite: PHYS 121.