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## University of Minnesota Duluth 2020-2022 Graduate Courses

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For current information, refer to:

- Program search: [z.umn.edu/publicprogramsearch](https://z.umn.edu/publicprogramsearch)
- Course search: [z.umn.edu/publiccoursecatalog](https://z.umn.edu/publiccoursecatalog)
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University of Minnesota Duluth  
1049 University Drive  
Duluth, MN  
55812

University of Minnesota Duluth Catalog Fall, 2020

req: MBA student or department consent

**ACCT 5402. Advanced Business Taxation.**  
(3 cr. ; A-F or Audit; Every Fall)

Understanding how taxes impact basic business and entrepreneurial decisions. It takes a tax planning/minimization perspective and presents advanced tax research and resource materials available on the web. pre

**ACCT 5501. Advanced Accounting.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) Topics including consolidated financial statements, partnership, and fiduciary accounting.  
pre-req: MBA student or department consent

**ACCT 5505. International Accounting.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)  
International accounting measurement and reporting issues unique to multinational

business transactions and multinational enterprises; consolidations; foreign exchange accounting; forward and option markets; translation of foreign currency financial statement; international audit environment; international taxation and transfer pricing; harmonization of worldwide accounting. pre req: MBA student or department consent

**ACCT 5600. Employee Benefit and Retirement Planning.** (3 cr. ; A-F or Audit; Periodic Fall)

This course will provide preparation for professionals who will be providing employee benefits and retirement planning services for clients. The course will focus on the importance of retirement planning, an evaluation of the client's needs, and understanding of Social Security and Medicare, and qualified and non-qualified retirement plans. pre-req: MBA student or department consent

**AMIN 8593. Directed Study.** ( ; 1-6 cr. [max 12 cr.] ; Student Option; Every Fall & Spring)  
Individual graduate study under supervision of a faculty member in the Department of American Indian Studies. pre-req: graduate student and instructor consent

**ANTH 8593. Directed Study.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)  
Individualized graduate study under supervision of a faculty member in the Anthropology Program. pre-req: grad student, instructor consent

**AMS 5101. Materials Analysis & Design I.** (6 cr. ; A-F or Audit; Every Fall)  
Overview of the structure, properties, processing, and performance of traditional materials of metals, ceramics, and polymers. Course will be delivered via an integrated learning approach, where course content taught in the lectures and labs will be applied to 2-3 projects concurrently throughout the semester on product or equipment design. pre-req: CHE 3231 or ME 2105 or Grad student or instructor consent

**AMS 5102. Materials Analysis & Design II.** (6 cr. ; A-F or Audit; Every Spring)  
Overview of design, manufacturing and experimental characterization of fiber reinforced polymer (FRP) composite materials and degradation of materials. Course will be delivered via an integrated learning approach, where course content taught in the lectures and labs will be applied to 2-3 projects concurrently throughout the semester on product or equipment design. pre-req: AMS 5101 or MATH 1297 and CHEM 11545 and PHYS 2015 or Grad student or instructor consent

**AMS 5555. Applied Materials Science Project Credits.** (3-6 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Master of Applied Science project work as determined by faculty adviser and student with approval by the program director of graduate studies. pre-req: MS AMS candidate, instructor consent

**AMS 8777. Thesis Credits: Master's.** (1-10 cr. ; No Grade Associated; Every Fall, Spring & Summer)  
Master's thesis credits. pre-req: AMS graduate student and instructor consent

**ARTH 5391. Directed Study in Renaissance and Baroque Art.** (1-3 cr. [max 9 cr.] ; A-F or Audit; Every Fall & Spring)  
Independent research in an area of art history pertinent to the interests of the student. Fundamental knowledge of period or subject required. pre-req: instructor consent; max 6 credits for undergraduates

**BHSC 5491. University as Change Agent: Extension Approaches to Strengthening Community Wellbeing.** ( ; 1 cr. ; S-N or Audit; Every Fall)

This online course is a broad introduction to University extension education models that play key roles in the Land Grant University mission to bring communities together to strengthen rural health and vitality. A broad overview of examples from (but not limited to) food systems, forestry, and health and how to work in those content areas with youth, adults, families and communities will be presented. The objective is for students to learn skills that can be applied to strengthening community health systems or to their own field of study. This will be transdisciplinary, connecting students and faculty from different disciplines. Students will leave the course with skills and understanding of extension structure and functions that will serve them in their professional lives. pre-req: Undergrad, upper div or grad student, instructor consent

**BHSC 5591. Social and Behavioral Medicine II.** (2 cr. [max 4 cr.] ; P-N only; Every Fall)  
Selectives on topics in general medical behavioral science, typically including women's mental health issues, chronic pain, socialization into medicine, aging, hypnosis and others. pre-req: Registered med student, instructor consent

**BHSC 6652. Social and Behavioral Medicine I.** ( ; 4 cr. [max 5 cr.] ; P-N only; Every Spring) Human psychological development throughout life; normal cognitive,

learning, social, and personality development; problems expressed during various stages of life in the family and other settings. Assessment/treatment described as relevant to practice of family medicine. pre-req: Regis med student

**BMS 5001. Introduction to Pharmacology.** (2 cr. ; A-F only; Every Spring)  
Elementary course in pharmacology. Actions and use of drugs in selected health conditions. pre-req: 5601 or 3011 or equivalent

**BMS 5101. Principles of Neuroscience.** (4 cr. ; A-F or Audit; Every Fall)  
Principles of Neuroscience is an introductory course to general neuroscience that will review the organization and function of the nervous system, from its cellular constituents to circuits and the emerging properties of the brain. The course will start with a description of cell types, ion channels, neurotransmitters and their receptors, and the generation of action potentials. Then, we will review the development of the nervous system and the generation of circuits. Next, we will review each of the senses and how this sensory input is transformed into how we perceive the world. The next section will focus on the motor system, including central motor neurons, relaxes, and motor control in the basal ganglia and cerebellum. The last section will be dedicated to complex functions of the brain, including consciousness, emotion, memory, hemostasis, circadian rhythms, and how genes control behavior. Throughout the course, we will review neurological and psychiatric disorders and discuss the genetic and cellular bases of this perturbation. The course will also include the review of techniques in modern neuroscience and journal club of the review of controversial topics in modern neuroscience. pre-req: PSY 3621, PSY 3061 or BIOL 3100, can be co-enrolled in PSY 3621 or PSY 3061

**BMS 5201. Topics in Biochemistry.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) In-depth coverage and expansion of selected biochemical principles introduced in introductory undergraduate courses pre-req: Chem 3322 or Chem 4341 or instructor consent

**BMS 5202. Cellular and Molecular Biology.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)  
In-depth coverage of selected topics in cellular and molecular biology. Most topics will have been introduced in undergraduate courses. pre-req: Biol 2102 or Biol 5231 or Chem 4342 or instructor consent

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and research data reflecting student's research interests and thesis research results.

**BMS 5204. Pharmacology Seminar.** (1 cr. [max 4 cr.] ; A-F or Audit; Every Fall & Spring)  
Presentation of selected research problems and current journal articles. pre-req: Grad student, instructor consent

**BMS 5211. Literature Seminar.** (1-2 cr. ; S-N or Audit; Every Fall & Spring)  
Oral presentation of written literature review

**BMS 5292. Readings in Physiology.** (1-3 cr. ; Student Option; Every Fall, Spring & Summer)  
Topics in physiology selected for each student; written reviews prepared and discussed. pre-req: instructor consent

**BMS 5294. Research in Physiology.** (1-15

cr. ; Student Option; Every Fall, Spring & Summer)  
Introduction and use of lab techniques and equipment used for research in various subspecialties of physiology, including neurophysiology, cardiovascular physiology, endocrinology, respiratory and transport process, electrophysiology, and renal physiology. pre-req: instructor consent

**BMS 5501. Neurobiochemistry.** (2 cr. ; A-F

or Audit; Every Spring)

Current concepts on anatomical and compositional properties of brain; membranes and transport; neurotransmission; receptors and signal transduction mechanisms; energy, carbohydrate, protein, lipid, and nucleic acid metabolism; development and diseases of the central nervous system. prereq: Chem 3322 or Chem 4351 or instructor consent

**BMS 5545. Immunology.** (3 cr. ; A-F or Audit; Every Fall)

The immune system including the cells and molecules which work cooperatively to resist disease and aberrations resulting in immune disorders. prereq: department consent

**BMS 5546. Immunopathology.** (3 cr. ; A-F or Audit; Every Spring)

A rigorous analysis of the immune-defense mechanisms in disease processes, including infection, inflammation and autoimmune disorders utilizing the Problem-Based Learning method to address the selected content and to study current technical literature. prereq: 5545, instructor consent

**BMS 5555. Molecular Pathogenesis:**

**Current Concepts.** (3 cr. ; A-F or Audit; Spring Even Year)

Study of current discoveries in microbial pathogenesis and the molecular techniques used in elucidating pathogenic mechanisms of viral, bacterial and parasitic agents. A survey of current literature related to human infectious disease including malignant transformation. prereq: Biol 2201 or equivalent, Biol 4501 or equivalent or instructor consent

**BMS 5591. Problems in Medical**

**Microbiology and Immunology.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)

Independent study on tutorial basis.

Emphasis on basic and clinical microbiology problems, including immunology. Investigative work and appropriate reading arranged with tutorials consistent with interests and capabilities of individual students. prereq: Open to med students or qualified upper division and grad students with instructor consent

**BMS 5601. Grand Challenges in Physiology.**

(; 3 cr. [max 4 cr.] ; A-F or Audit; Every Fall) In dept examination of current physiological problems involving the major mammalian organ systems, integrating knowledge from the molecular to system level. prereq: BIOL 3703 or BIOL 3772 or EXSC 3400 or equivalent or graduate student or instructor consent

**BMS 5602. Physiology of Organ Systems II.** (2 cr. ; A-F or Audit; Every Fall)

Advanced study of organ system functions in context of interaction of organism with environment. prereq: 5601 or instructor consent

**BMS 8151. Journal Club.** (1 cr. [max 2 cr.] ; S-N or Audit; Every Fall & Spring)

Journal Club provides students the opportunity to explore current topics and evidence-based clinical information relevant to medicine and its subspecialties. prereq: Graduate Student or Med Student

**BMS 8294. Current Research Techniques.** (1-3 cr. [max 12 cr.] ; S-N or Audit; Every Fall, Spring & Summer)

The course provides students an opportunity to be involved with current research. Students will be involved in particular areas of strength with a focus across the Medical School. Students help in finding solutions to an existing project or shedding light on an unknown domain of knowledge. Students will collaborate as a team with other researchers. prereq: Biochemistry, Chemistry or Medical Graduate Student, instructor consent

**BMS 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall & Spring) (No description) prereq: Master's student, adviser and DGS consent

**BMS 8401. Physiology of Aging.** (2 cr. ; Student Option; Every Fall & Spring) In-depth study of several theories concerning physiological processes that appear to set the limits of maximum human life span. prereq: 5601, instructor consent

**BMS 8405. Muscle Physiology.** (2 cr. ; A-F or Audit; Every Fall & Spring)

In-depth review and discussion of physiological processes involved in muscle contraction from subcellular events to neural-controlled function of whole muscle (skeletal, cardiac, and smooth muscle). prereq: 5601, instructor consent

**BMS 8415. Special Topics: (Various Titles to be Assigned).** (; 2 cr. ; Student Option; Every Fall & Spring)

Selected topics of current endocrine research interest examined in depth; historical background, questions posed by current research, and implications of current research for future development in the area. prereq: 5601, instructor consent

**BMS 8441. Transport Processes.** (2 cr. ; Student Option; Every Fall & Spring)

In-depth, quantitative approach to transport processes in biological systems. prereq: 5601, instructor consent

**BMS 8444. FTE: Doctoral.** (1 cr. ; No Grade Associated; Every Fall & Spring) (No description) prereq: Doctoral student, adviser and DGS consent

**BMS 8554. Advanced Immunology and Immunobiology.** (2 cr. ; A-F or Audit; Every

Spring)

Detailed study of mechanisms involved in immunologic defense. Emphasis on concepts and current literature. prereq: 5545 or instructor consent

**BMS 8666. Doctoral Pre-Thesis Credits.** (1-6 cr. [max 12 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Max 6 cr per semester or summer; doctoral student who has not passed prelim oral; no required consent for the first two registrations up to 12 cr; departmental consent for the third and fourth registrations up to an additional 12 cr, or 24 cr total (for doctoral students admitted summer 2007 and beyond; doctoral students admitted prior to summer 2007 may register up to 4 times totaling 60 cr)

**BMS 8777. Thesis Credits: Master's.** (1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall & Spring)

(No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**BMS 8888. Thesis Credits: Doctoral.** (1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall & Spring)

(No description) prereq: Max 18 cr per semester

**BIOL 5001. Teaching and Learning in the Life Sciences.** (1 cr. ; S-N only; Every Spring)

Exploration of learning theory and educational practices designed to help develop skills in the classroom. Topics will include: learning styles, classroom management, assessment, active and cooperative learning, and educational technology. prereq: grad student or prior teaching experience; instructor consent

**BIOL 5201. Leverage bioinformatic tools to manage big data and answer primary biology questions.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Biology has moved into a new era of big data, especially in the field of genomics. This course will introduce basic principles of bioinformatics and how to apply bioinformatic tools to process large genomic datasets. This course will emphasize how to evaluate currently available software, implement software, build pipelines for analysis, interpret outputs, apply statistics and finally produce publication appropriate figures. pre-req: BIOL 2201 or grad student

**BIOL 5232. Molecular Biology Laboratory.** (2 cr. ; A-F only; Every Spring)

Regulation of gene expression in prokaryote and eukaryotes explored through use of recombinant DNA technologies. prereq: 4231

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Examines basic concepts in population and quantitative genetics. Focus is on techniques that reveal the genetic structure and adaptive value of ecologically important traits. This course has two 50 minute lectures and one 2-hour laboratory per week., prereq: 1012, 2201, Stat 1411 or IBS grad student

or 4231 (concurrent enrollment is allowed), CHEM 3322 or Biochemistry and Molecular Biology or IBS Grad student; credit will not be granted if already received for 4232

**BIOL 5240. Ecological Genetics.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

**BIOL 5511. Virology.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Viruses and hosts; effects of viral infections on cells; expression of viral genome in prokaryotic and eucaryotic cells; epidemiology and pathogenesis of viruses, including emerging ones; viral evolution. (2 hrs lect, 3 hrs lab)

prereq: 3502 or 4501, or IBS Grad student or instructor consent

**BIOL 5515. Microbial Diversity and Phylogeny.** (3 cr. ; A-F only; Periodic Fall) Evolutionary survey and characteristics of microorganisms focusing on autotrophic and heterotrophic prokaryotes from various habitats. Isolation, examination, and identification of bacteria from field collections using microscopic, physiological, biochemical, molecular, phylogenetic, and computer database techniques. (2 hours lecture and 2 hours lab) prereq: 2101 or 3100 or 3502 or 4501 or IBS Grad student

**BIOL 5604. Plant Physiology.** (4 cr. ; A-F or Audit; Every Spring) Mechanisms underlying plant function, growth and development: metabolism, water relations, mineral nutrition, transport, internal and external regulators of growth and development, stress physiology, biotechnology. Lab exercises evaluate physiological processes that enable plants to grow under varied conditions found in nature, such as water relations, mineral nutrition, metabolism, growth and development. pre-req: BIOL 2201 or IBS grad

**BIOL 5772. Neural Systems and Behavior.** (3 cr. ; A-F or Audit; Periodic Spring) Review of the basic neurophysiological components of animal behavior. Emphasis will be on well-studied neuroethological models such as weakly electric fish, bats, owls and crayfish. prereq: 1012, 3703 or IBS Grad student or instructor consent

**BIOL 5801. Microbial Ecology.** (2 cr. ; A-F or Audit; Periodic Spring) Microorganisms in natural environments: diversity, distribution, energetics, and growth of heterotrophic and autotrophic microbes in oxic and anoxic habitats. Roles of microbial populations and communities in biogeochemical cycling, ecosystem functioning, landscapes, and industrial, agricultural, and environmental applications. prereq: (2101 or 3100) and (2801 or 3502 or 4501), or WRS or IBS Grad student

**BIOL 5805. Fisheries Ecology and Management.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) Lectures, readings and computer exercises relating to current issues in fisheries ecology. Computer exercises will emphasize techniques used by scientists working in the field and prepare the student for the use of quantitative research tools for independent research. Includes 2 one-hour lectures and 1 three-hour lab weekly. prereq: 2801, 2802, college-level course in statistics or WRS or IBS Grad student

**BIOL 5807. Mathematical Ecology.** (3 cr. ; A F or Audit; Fall Odd Year) Development and use of mathematical models to describe ecological patterns and

processes. prereq: (2801, (Math 1290 or Math 1297)) or WRS or IBS Grad student

**BIOL 5808. Landscape Ecology: Theory and Application.** (3 cr. ; A-F or Audit; Periodic Fall)

Key issues in landscape ecology including scale, measuring landscape patterns, mechanisms shaping landscapes, implications of landscape patterns on plant and animal populations, communities, and ecosystems, and implementing landscape principles for natural resource management. prereq: 2801, 2802 or WRS or IBS Grad student

**BIOL 5809. Ecological Statistics.** (3 cr. ; A F only; Every Spring) Directed toward graduate students with previous introductory statistical experience, this class covers common statistical methods used in ecology. The class includes classroom and computer lab components (using the R statistical computing environment) and provides students with the practical experience necessary to make decisions regarding the treatment and analysis of data, interpretation of statistical analyses and the presentation of study results. This course has one 2-hour lecture and one 2-hour laboratory per week. pre-req: STAT 1411 or 2411, Biology or IBS grad student

**BIOL 5818. Biotic Response to Climate Change.** (3 cr. ; A-F or Audit; Every Spring) Many species are already responding to climate change, as evidenced by earlier budburst, flowering, and arrival of insects and bird pollinators. In only a few cases can we distinguish between phenotypic responses to longer growing seasons and warmer temperatures (plasticity) and evolutionary change in response to altered patterns of natural selection. Climate change will pose strong evolutionary challenges to native populations. In this course, we will explore the fundamental response of the biota to these changes: extinction, migration, and adaptation. pre-req: grad student

**BIOL 5833. Stream Ecology.** (3 cr. ; A-F or Audit; Fall Even Year) Studies of stream communities and ecosystems as influenced by biological interactions and physical factors. Emphasis on North Shore streams. (2 hrs lect, 6 hrs lab and field) prereq: 2801 or WRS or IBS Grad student

**BIOL 5861. Lake Ecology.** (3 cr. ; A-F or Audit; Every Spring) This course offers a hands-on introduction to the ecology of lake ecosystems with a focus on lakes of the temperate and boreal regions, particularly Minnesota. We explore how factors including temperature, light, water chemistry, water motion, nutrients, and organisms interact in aquatic environments to determine the distribution, abundance, and behavior of aquatic biota. Laboratory exercises

reinforce and expand on lecture materials and include the identification of fish, zooplankton, benthos, and phytoplankton as well as field excursions to area lakes. prereq: WRS or IBS Grad student

**BIOL 5863. Ecosystems Ecology.** (3 cr. ; A-F or Audit; Every Spring) Ecosystems ecology is the integrated study of the flows of materials and energy through ecosystems, which includes both the living (biotic) and non-living (abiotic) components. Biogeochemistry is a major subfield of ecosystems ecology, and deals with the cycling of nutrients through ecosystems. In this class, we will discuss the integration of ecosystems and biogeochemistry in terrestrial environments, specifically focusing on how human activities influence ecological systems and vice versa. It is my hope that you walk away from this course with a better understanding of how large environmental issues such as climate change and invasive species affect ecological systems. pre-req: BIOL 2801, CHEM 1153 or CHEM 1173 or graduate student

**BIOL 5865. Conservation Biology.** (2 cr. ; A F or Audit; Periodic Spring) Introduction to science of species, habitat, and ecosystem conservation and management. prereq: 2801 or IBS Grad student

**BIOL 5870. Wetland Ecology.** (3 cr. ; A-F or Audit; Fall Odd Year) Hydrology, nutrient cycling, and productivity of wetland ecosystems and the adaptations and interactions of resident biota; assessment, management, conservation, restoration, and creation of wetlands. Two daylong weekend field trips required. prereq: 2801, 2802 or WRS or IBS Grad student

**BIOL 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Master's student, adviser and DGS consent

**BIOL 8777. Thesis Credits: Master's.** (1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**BIOL 8899. Seminar in Ecology.** (1 cr. [max 10 cr.] ; A-F or Audit; Every Fall & Spring) In-depth analyses of topics in ecology. prereq: Grad student in biol or related field

**BIOL 8994. Graduate Research.** (1-4 cr. [max 10 cr.] ; S-N or Audit; Every Fall, Spring & Summer) Directed research or study on an advanced topic. prereq: Grad student in biol or related field

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**BA 5410. Data Visualization.** (3 cr. ; A-F or Audit; Every Fall & Spring) Data visualization is the art and science of presenting data effectively in order to facilitate

knowledge sharing and decision making. How to present and visualize data is an important skill for business professions to develop. This course will teach the principles and techniques that empower students to understand and interpret data, as well as make effective

decisions based on data. Students will learn the benefits of effective data presentation and visualization, understand the principles and methods of visualization, and apply the principles using popular data visualization technologies. Students enrolled in the 5410

version of the course will have to fulfill an extra assignment/project to earn graduate credit. pre req: FMIS 2201 or MIS 2201, LSBE candidate or Business Analytics minor, credit will not be granted if already received for MIS 3231

**BA 5420. Data Analytics for Managerial Decision Making.** (3 cr. ; A-F or Audit; Every Spring)

This course introduces the basic elements of business analytics and how to analytically think about data and its role in business. The goal of the course is to provide students with the toolset and capabilities as they analyze data to ask the right questions that matter to businesses and help solve business problems. Topics include data preprocessing, exploratory data analysis (EDA), predictive analytics, modeling and model evaluation. The course is designed to trigger passion for analytics, develop data-analytic thinking demonstrate how analytics matter in different business domains, illustrate real-world examples in different business contexts while working hands-on using data analytics is as such an art as it is a science. Students enrolled in the 5420 version of the courses will have to fulfill an extra assignment/project to earn graduate credit. pre-req: MIS 2201, ECON 2030, LSBE candidate or Business Analytics minor. Credit will not be granted if already received for MIS 3241, MIS 4241, CIA 3760 or CIA 4761 or CIA 5761

**BA 5460. Big Data Analytics.** (3 cr. ; A-F or Audit; Every Spring)

This course is a practical introduction to managing big data in the enterprise and covers aspects of technology infrastructure, data warehousing and structuring data for use in the organization. Using state-of-the-art open source big data ecosystems and cloud resources for data acquisition, extraction, cleansing, transformation and loading, the course demonstrates how the ecosystem integrates with other analytic tools to provide solutions for practical use cases. Students enrolled in the 5460 version of the course will have to fulfill an extra assignment/project to earn graduate credit. pre-req: MIS 3220 or equivalent, LSBE candidate or Business Analytics minor or instructor consent

**BA 5490. Business Analytics Capstone.** (3 cr. ; A-F or Audit; Every Spring)

This course is a corporate practicum in the development and delivery of business analysis for strategic decision making in organizations. It involves the application of the principles and tools of business analytics to real-world problems in a business domain. The final deliverable is the development and presentation of analytical insights and recommendations. Students enrolled in this 5490 version of the course will have to fulfill an extra assignment/project to earn graduate credit. pre-req: MIS 3220, ECON 3020, BA 4410, BA 4420, BA 4440 or 4460 or a Group C

course taken concurrently, LSBE candidate

**BLAW 5301. Estate Planning Concepts and Strategies.** (3 cr. ; A-F or Audit; Periodic Spring)

Examines the basics of estate planning, including both the legal and tax aspects of developing an estate and/or incapacity plan. Topics include: probate and probate substitutes, wills and other estate planning documents, gifting and insurance strategies, use of trusts, and federal estate, gift and generation-skipping taxation. pre-req: MBA student or department consent

**CHE 5011. Process Optimization: Lean Six Sigma.** (3 cr. ; A-F or Audit; Every Fall)

Emphasis on applying Lean and 6 Sigma process design and improvement techniques, data driven decision making, cultural transformation and effective change communication. pre-req: Instructor consent required; credit will not be granted if already received for CHE 5193

**CHE 5021. Transport Phenomena.** (3 cr. ; A-F or Audit; Every Fall)

Study of the fundamentals and field equations for momentum, heat and mass transport with emphasis on the prediction of transport rates in chemical engineering applications. pre-req: 3112 or Grad student or instructor consent

**CHE 5022. Transport Processes in Wells and Pipelines.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Exposes students to various elements of fluid and heat flows that occur in oil/gas wells and pipelines. The fundamentals of multiphase flow are explained in terms of single-phase flow mechanics and configuration of the phases. Simplicity in modeling approach is retained. Field examples are used to reinforce understanding of the models. pre-req: 3111, 3112 or Grad student or instructor consent

**CHE 5031. Chemical Engineering Analysis.** (3 cr. ; A-F or Audit; Fall Odd, Spring Even Year)

Development of mathematical and statistical models for chemical engineering systems; simulation of these systems using digital computers; and system optimization and analysis of results. pre-req: 4111 or Grad student or instructor consent

**CHE 5101. Mining Policy.** (3 cr. ; A-F or Audit; Fall Odd Year)

Socioeconomic, cultural, and legal frameworks that affect mineral resources management specific to the mining industry. Historical and contemporary trends in mining policy and practice, resulting public and private governance in the United States with federal,

state and local institutional structures for minerals resource management. pre-req: CHE 4141 or 4142 or graduate student or instructor consent

**CHE 5121. Advanced Thermodynamics.** (3 cr. ; A-F or Audit; Every Fall)

Theory and application of phase equilibrium thermodynamics. Estimation and correlation of thermodynamic properties. Multicomponent systems. Solution theory. High pressure equilibria. Corresponding states. pre-req: 2121 or instructor consent

**CHE 5131. Polymer Engineering.** (3 cr. ; A-F or Audit; Every Spring)

Polymeric materials have a tremendous variety of applications in synthetic fibers, packaging, automobiles, electronic instruments, energy, sports, etc. This course will focus on theoretical and engineering applications of polymer design, processing, and production. pre-req: [(ChE 2121 or ME 3211), (ChE 3231 or ME 2105)] or Chem 4641 or instructor consent

**CHE 5250. Advanced Process Control.** (3 cr. ; A-F or Audit; Every Spring)

Investigation into the theory and practical application of the concept of process control dynamics, feedback, and stability. Emphasis will be on dynamic behavior, physical and empirical modeling, computer simulation, measurement, and control technology, basic control concepts, and advanced control strategies. pre-req: 4402 or instructor consent

**CHE 5301. Advanced Chemical Reactor Design.** (3 cr. ; A-F or Audit; Every Spring)

Theory of advanced chemical reactor design. Reaction rate theory. Heterogeneous catalysis and transport processes. Analysis of non-ideal reactors, Stability. Optimization. Multiphase systems. pre-req: 4301 or instructor consent

**CHE 5321. Theory and Practice of Scanning Electron Microscopy & X-ray Microanalysis.** (3 cr. ; A-F or Audit; Every Fall)

Students will be introduced to the basic physics of scanning electron microscopy, including electron beam generation, beam sample interactions, signal detection and image formation. Students will also learn how characteristic x-rays are produced in a sample and how they are measured and quantified. In the laboratory sessions students will practice basic sample preparation methods and various techniques of scanning electron microscope to produce quality images and data. pre req: minimum 75 credits, CHEM 1155/56 or CHEM 1175/76, PHYS 2012 or 2015/2016 OR Graduate student; instructor consent

**CHE 5555. Project Credits: MEng - Chemical Engineering.** (3-6 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Master of Engineering project work as determined by faculty adviser and student with approval by the department director of

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graduate studies. pre-req: MEng candidate, instructor consent

**CHE 5601. Biochemical Engineering I.** (3 cr. ; A-F or Audit; Spring Even Year)

Application of chemical engineering principles

to design and operation of industrial biological processes, emphasizing enzyme and cell growth kinetics. pre-req: 2111 or 2211, grad student and instructor consent; credit will not

be granted if already received for 4601

**CHE 5612. Hazardous Waste Process Engineering.** (3 cr. ; A-F or Audit; Every Spring)

Identification of hazardous substances and their effects. Federal, State and International regulations. Green Engineering - modification of processes to avoid hazardous waste formation. Life Cycle Management of hazardous substances. Design of waste treatment processes. prereq: Grad student or BSChE candidate with ChE 2111 or 2211, 3112 and 4111

**CHE 5621. Particle Technology.** (3 cr. ; A-F or Audit; Fall Odd Year)

Applications of particle technology, especially in the chemical and minerals industry context. Particle concepts including: particle characterization, slurry characterization, size reduction, size enlargement, particle separation, and multi-phase processes. The major unit operations common to solids processing: mining, crushing, concentration by sedimentation, filtration, flotation, and pyrometallurgy. prereq: 3111 and Grad Student; credit will not be granted if already received for 4621

**CHE 5701. Biochemical Engineering II.** (3 cr. ; A-F or Audit; Every Spring)

Continuation of ChE 4601/5601. Advanced design and operation of bioreactors for varied cultivation methods, transport limitations, and reactor types. Operation and control considerations for aeration, agitation, heat transfer, and instrumentation. Unit operations for recovery and purification of products. Microbial, animal, plant, and mixed culture applications. prereq: 4601 or 5601, grad student; credit will not be granted if already received for 4701

**CHE 5711. Biomedical Engineering.** (3 cr. ; A-F or Audit; Every Fall)

Introduction to the field of Biomedical Engineering. Topics covered include cell and tissue engineering, transport phenomena in biological systems, biomaterials, bioelectricity and neural engineering, development of biomedical devices, and government regulations in the biomedical industry. prereq: 3111, 3112 or grad student or instructor consent; credit will not be granted if already received for CHE 4711.

**CHE 5991. Graduate Independent Study in Chemical Engineering.** (1-3 cr. [max 6 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)

Directed study of special interest topics not available in the standard curriculum. Must be arranged with instructor before registration. May include readings, research and/or special projects. prereq: graduate student and instructor consent

**CHE 5995. Special Topics in Chemical Engineering: (Various Titles to be Assigned).** (1-4 cr. [max 12 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer) Topics not available in the regular department

curriculum. Topics may include specialties of the department or visiting faculty. prereq: Graduate student or instructor consent

**CHE 8150. Seminar.** (1 cr. [max 2 cr.] ; S-N or Audit; Every Fall & Spring)

Practice in preparation and oral presentation of reports on articles from the literature or on graduate research. prereq: graduate ChE major or instructor consent

**CHE 8777. Thesis Credits: Master's.** (1-10 cr. ; No Grade Associated; Every Fall, Spring & Summer)

. prereq: graduate student

**CHEM 5150. Organic and Stable Isotope Biogeochemistry.** (3 cr. ; A-F or Audit; Periodic Spring)

Production and chemical composition of natural organic matter (OM), diagenesis and catagenesis of OM; stable isotopic fractionation processes of C, H, O, N, and S in natural systems, fractionation theory, isotopic indicators of climate, oceanographic/ limnologic processes, trophic structure, microbial processes. prereq: BIOL 1012 and (CHEM 1152 or 1155 and 1156 or 1162 or 1175 and 1176) and (CHEM 2222 or 2212 or 2242) OR instructor consent

**CHEM 5350. Research Topics for High School Chemistry Teachers.** (2-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)

Experimental work and philosophy associated with a selected research topic. prereq: Ed MA or MEd student, department consent required.

**CHEM 5373. Physical Biochemistry: Statistical Bio-Thermodynamics.** (3 cr. ; A-F or Audit; Every Fall)

This course is a quantitative treatment of physical principles and theories in physical biochemistry with a focus on applications of statistics bio-thermodynamics to primary literature-based approaches in the field. Developing expertise in the application of theory to real-world problem solving in the field is emphasized. In addition to the lecture and exams, students in this graduate course will prepare and present an original research proposal in the format of an NSF Graduate Research Fellowship (GRF) application. prereq: CHEM 4632 or 4634 or and CHEM 4351 or 3322 and instructor consent

**CHEM 5424. Advanced Inorganic Chemistry I.** (3 cr. ; A-F or Audit; Every Fall)

Advanced topics in inorganic chemistry including the following: Applications of Group Theory to inorganic chemistry such as molecular orbital theory and valence bond theory as well as vibrational analysis, organometallic chemistry including structure and bonding in organometallic compounds, reactions and reaction mechanisms of organometallic compounds, and the application

of organometallic compounds as reagents and catalysts in organic synthesis, other advanced aspects of inorganic chemistry, e.g. Bioinorganic Chemistry and Aspects of Material Science. prereq: 4436 or equivalent or Grad student

**CHEM 5510. Polymer Chemistry.** (3 cr. ; A-F or Audit; Every Spring)

In this course students will study the synthesis, characterization, and chemical structure-related properties of polymers. Good knowledge of Organic Chemistry is required. Chemical Kinetics and Thermodynamics will be applied. In addition to the lecture and exams, students in this graduate course will prepare an individual research report on a topic selected from recent developments in polymer chemistry. prereq: Chemistry graduate student or instructor consent

**CHEM 5524. Advanced Organic Chemistry I.** (3 cr. ; A-F or Audit; Every Fall)

Advanced topics of Organic Reaction Mechanisms and Aspects of Organic Synthesis prereq: 2542 or equivalent or Grad student

**CHEM 5624. Advanced Physical Chemistry I.** (3 cr. ; A-F or Audit; Every Spring)

Classical and statistical thermodynamics, chemical kinetics, other selected topics in physical chemistry. prereq: 4642 or equivalent or Grad student

**CHEM 5650. Computational Chemistry.** (3 cr. ; A-F or Audit; Periodic Spring)

Molecular Mechanics, Quantum Mechanics, semiempirical and ab initio molecular orbital calculations, density functional theory, and selected additional topics in computation chemistry such as biochemical applications, QSAR, and ligand modeling and docking. prereq: 4642 or equivalent or Grad student

**CHEM 5659. Fluorescence Methods in Life Science.** (3 cr. ; A-F or Audit; Spring Even Year)

Theoretical fundamentals, experimental design considerations, and applications of a wide range of fluorescence methods in chemistry, biochemistry, biology, medicine, and related fields. Each fluorescence method is designed to optimally answer specific questions quantitatively at the molecular level. Requires basic knowledge in related fields such as chemistry, biochemistry, physics, mathematics, and/or biology. prereq: grad student or instructor consent

**CHEM 5714. Applications of Spectroscopy.** (4 cr. ; A-F or Audit; Every Fall)

Application of spectroscopic techniques to structure elucidation, including NMR, FTIR, MS, UV-Vis, X-ray, EPR spectroscopy. Includes practical component. prereq: 4436 or equivalent or Grad student

**CHEM 5725. Advanced Analytical Chemistry I.** (3 cr. ; A-F only; Every Fall)

Intended for advanced undergraduate and beginning graduate students in chemistry and

related fields. Augment basic coursework in wet and instrumental analytical chemistry. Topics include statistical and chemometric methods for experimental design and data analysis, electronics and computers in chemical instrumentation, and selected techniques of instrumental analysis such as mass spectrometry, inductively coupled optical emission spectroscopy and analytical gas chromatography. prereq: Grad student or 4242 or equivalent

**CHEM 5795. Special Topics in Chemistry: (Various Titles to be Assigned).** ( ; 1-4 cr. [max 12 cr.] ; A-F or Audit; Periodic Fall & Spring)

Topics not available in standard curriculum. prereq: graduate student or instructor approval

**CHEM 5994. Directed Research in Chemistry.** (1-3 cr. [max 9 cr.] ; Student Option; Every Fall, Spring & Summer) Directed laboratory or theoretical research in the chemical sciences. prereq: Min 90 cr or grad in the sciences or engineering or instructor consent

**CHEM 8184. Seminar.** (1 cr. ; S-N or Audit; Every Fall & Spring) Practice in preparation and oral presentation of reports on articles from the literature or on graduate research. prereq: Grad chem major or instructor consent

**CHEM 8224. Advanced Analytical Chemistry II.** (4 cr. ; A-F or Audit; Periodic Spring) Advanced treatment of selected methods in analytical chemistry. prereq: Grad student or instructor permission

**CHEM 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall & Spring) (No description) prereq: Master's student, adviser and DGS consent

**CHEM 8424. Advanced Inorganic Chemistry II.** (4 cr. ; A-F or Audit; Periodic Fall & Spring) Discussion of structure, reactions, and bonding in inorganic and organometallic compounds in terms of valence bond, molecular orbital, and ligand field theories. prereq: grad student or instructor permission

**CHEM 8444. FTE: Doctoral.** ( ; 1 cr. ; No Grade Associated; Every Fall & Spring) (No description) prereq: Doctoral student, adviser and DGS consent

**CHEM 8524. Advanced Organic Chemistry II.** (4 cr. ; A-F or Audit; Every Fall & Spring) Advanced treatment of synthetic methods and reaction mechanisms in organic chemistry. prereq: grad student or instructor permission

**CHEM 8666. Doctoral Pre-Thesis Credits.** ( ; 1-6 cr. [max 12 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 6 cr per semester or summer; doctoral student who has not passed prelim oral; no required consent for the first two registrations up to 12 cr; departmental consent for the third and fourth registrations up to an additional 12 cr, or 24 cr total (for doctoral students admitted summer 2007 and beyond; doctoral students admitted prior to summer

2007 may register up to 4 times totaling 60 cr)  
**CHEM 8720. Modern Mass Spectrometry.** (3 cr. ; A-F or Audit; Fall Odd Year) Current instrumentation and techniques in mass spectrometry of molecular and atomic species. Discussion to include ionization techniques, mass analysis methods and detection of gas phase ions in the context of structural and elemental analysis. Interfacing of mass spectrometers to chromatographic systems is considered. Gas phase unimolecular and ion-molecule reaction kinetics and energetics are stressed as they relate to the information content observed in the mass spectrum. prereq: Grad student

**CHEM 8750. Special Topics: (Various Titles to be Assigned).** ( ; 1-4 cr. [max 8 cr.] ; Student Option; Every Fall & Spring) Topics not available in standard curriculum. prereq: Grad student or instructor consent

**CHEM 8777. Thesis Credits: Master's.** ( ; 1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**CHEM 8888. Thesis Credits: Doctoral.** ( ; 1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall & Spring) (No description) prereq: Max 18 cr per semester or summer; 24 cr required

**CE 5027. Advanced Infrastructure Materials.** (3 cr. ; A-F or Audit; Every Spring) This course will cover advanced topics related to the behavior of Portland cement concrete and other special concretes. Topics to be covered include: Portland cement production and chemistry; supplementary cementitious materials, mixture design, concrete durability and repair techniques, and other special concretes. prereq: Graduate status or instructor consent

**CE 5115. Structural Dynamics.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) Response of single degree-of-freedom and multiple degree of freedom systems to vibrations, earthquakes, blast and impact. prereq: 3115 or grad student

**CE 5116. Seismic Design and Analysis.** (3 cr. ; A-F or Audit; Every Fall) This course focuses on characterizing seismic hazards, analyzing structural systems under seismic loading, and designing structural systems to resist earthquakes. Topics include characterization of seismic hazards, simplified modal and lateral force analysis procedures, and application of seismic building code provisions. pre-req: CE 4115, 4126 and pre or co-enrolled in CE 5115

**CE 5127. Bridge Analysis and Design.** ( ; 3 cr. ; A-F or Audit; Periodic Fall & Spring) This course will present AASHTO LRFD based highway bridge analysis, design and evaluation. prereq: CE 4115 and CE 4128 or Grad student

**CE 5128. Prestressed Concrete Structures.** ( ; 3 cr. ; A-F or Audit; Periodic Fall & Spring)

Design and behavior of prestressed concrete structures: materials and systems (including specifics for precast and post-tensioned members), losses, flexure, shear, bond, deflections, partial prestressing, continuous beams. prereq: CE 4126 or grad student

**CE 5129. Post-Tensioned Concrete Structures.** (3 cr. ; A-F or Audit; Spring Odd Year)

This course covers analysis and design of post tensioned concrete members including mono strand unbonded systems, grouted multi-strand systems, and post-tensioning as a rehabilitation technique. Design for safety, durability, and economy are included for each type of system following the ACI 318 Building Code as well as post-tensioning specific publications. Anchorage design and strut-and-tie models are covered, and post-tensioned bridges are also discussed. pre-req: CE 4128 or 5128 or equivalent with instructor consent

**CE 5131. Design of Wood & Masonry Structures.** (3 cr. ; A-F or Audit; Fall Even Year)

This course addresses the design of wood, masonry and cold-formed steel structures and components based on applicable civil engineering design codes. For wood the course covers the design of flexural and compressive members, fasteners and connections, shear walls and diaphragms. For masonry, topics include the components and hardware of masonry buildings, behavior and design of masonry wall types, design of beams, columns, reinforcement details, shear walls, roof and floor diaphragms and anchor bolts. For Col formed steel, topics include elastic buckling properties and subsequent strength prediction for beams and columns, roof and wall systems, bracing details and connections. prereq: 3115, 4126 or grad student

**CE 5134. Advanced Steel Design.** (3 cr. ; A-F or Audit; Every Fall & Spring)

This course focuses on advanced design of steel structures. Topics covered in this course include: steel members subjected to torsion, bolted and welded steel connections, braced frames with gusset plate connections, stability of steel frames, steel plate girders, and fatigue and fracture. pre-req: CE 4115

**CE 5135. Advanced Reinforced Concrete Design.** (3 cr. ; A-F or Audit; Every Spring)

This course focuses on advanced design of concrete structures, with some applications for steel-concrete composite systems. Topics covered in this course include: slender concrete columns, development length of reinforcement, two-way slabs, torsion in concrete, and steel-concrete composite systems. pre-req: CE 4126

**CE 5137. Advanced Structural Analysis and Design.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Advanced topics in both structural analysis and design. Topics include: matrix analysis, introduction to finite elements, design of prestressed concrete, design of two way concrete slabs, and design of steel plate girders. prereq: 4115, 4126; grad student

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### **CE 5201. Water Policy.** (3 cr. ; A-F or Audit; Every Fall)

Socio-cultural, legal, and economic factors that affect water resources management. historical trends in water policy, resulting water laws in the United States. Federal, state and local institutional structures for water management. prereq: graduate student or instructor consent

### **CE 5203. Stream Crossing and Culvert Design.** (3 cr. ; A-F or Audit; Fall Odd Year)

Overview of road-stream crossing design with emphasis on stream simulation for aquatic organism passage. Includes field data collection, analysis, and design of road-stream crossings, and traditional culvert hydraulic analysis and design. Meets concurrently with 2 cr. GEOL course (GEOL 5603) that excludes culvert hydraulic analysis and design. pre-req: CE 3225 or grad student; instructor consent

### **CE 5216. Applications in Environmental Modeling.** (3 cr. ; A-F or Audit; Periodic Spring)

Theory and application of environmental chemodynamics. Transport processes and equilibrium across natural phases including water, air, and soil using analytical and numerical modeling approaches. Economic and reliability analysis for hydrosystems using linear and non-linear programming with applications to water supply and water excess engineering. prereq: graduate status or instructor consent

### **CE 5226. Water Resources Engineering.** (3 cr. ; A-F or Audit; Every Spring)

Application of engineering economics, risk analysis, and operations research to the planning and management of water systems; major topics include flood control, hydroelectric power, water supply, multiobjective planning, sustainability and climate change. prereq: 3225, grad student

### **CE 5237. Water Quality Engineering.** (3 cr. ; A-F or Audit; Every Fall)

Applied analysis of water quality in natural systems. Review of mass-transport processes and approaches for solving water quality problems in lakes, estuaries, rivers, groundwater, and soil-sediment with TMDL (Total Maximum Daily Load) and remediation design applications. Applications in water and wastewater treatment. prereq: 3025 or CHE 2001 or grad student or instructor consent

### **CE 5241. Water Chemistry.** (3 cr. ; A-F or Audit; Every Fall)

Water is critical component of environmental systems, and the chemistry that occurs in water is a rich subject. This class focuses on water chemistry in both natural and engineered systems. Topics include a review of thermodynamics and equilibrium, acids and bases, titrations, the carbonate system, solubility of minerals, metal ion complexation, oxidation/reduction chemistry, and descriptions of adsorption. Principles are applied to chemistry in water treatment, nutrient cycling, organic matter, and organic pollutants. Both chemical equilibrium and chemical kinetics are

explored. Students will be introduced to software that can be used to solve water chemistry problems. The class is targeted at seniors and graduate students. pre-req: CE 3025 or CHEM 1155, or graduate student or instructor consent

### **CE 5246. Environmental Remediation Technologies.** (3 cr. ; A-F or Audit; Spring Odd Year)

The course examines the principal applications and limitations of technologies designed for source control and removal of contaminants from soil, groundwater, and surface water. Topics include: introduction to hazardous waste, contaminant characteristics, a review of mass transport, partitioning and fate of contaminants, site characterization/assessment, regulatory requirement, the design and operation of current remediation technologies, advances in technological design, and emerging remediation technologies including biotechnology and nanotechnology. pre-req: CE, WRS, IBS graduate students or instructor consent

### **CE 5251. Design of Chemical Physical Unit Operations in Water Treatment.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Detailed design of chemical/physical unit operations in municipal water treatment. Classic surface water treatment, ion exchange, activated carbon, membrane systems, and chlorination will be covered at a design level. Labs will provide pilot scale experience with selected unit operations. prereq: 4256 or instructor consent

### **CE 5315. Design of Traffic Systems.** (; 3 cr. ; A-F or Audit; Every Spring)

This course provides an in-depth knowledge of design principles and methodologies for traffic control systems to optimize operational efficiency and safety of traffic flows. The theories of traffic flow modeling, simulation and control are introduced as the basis for designing traffic systems. The process to analyze traffic systems performance is applied with computer-based tools. The design methodologies for traffic control systems for arterials and freeways are discussed and applied to real roadways in a simulated environment. A process to assess the effectiveness of design strategies on different types of highways is evaluated and applied to sample corridors. prereq: 3316 or grad student

### **CE 5316. Pavement Analysis and Design.** (3 cr. ; A-F or Audit; Every Fall)

Analysis, behavior, performance, and structural design of pavements for highways and airfields will be discussed. Prominent pavement distress mechanisms, their causes, and remedial measures will be presented. Other topics include climate factors, rehabilitation, sustainability, and renewability in pavement engineering, life cycle design economics, and traffic loadings. prereq: 3027, 3316; grad student

### **CE 5317. Traffic Flow Theory and Modeling.** (; 3 cr. ; A-F or Audit; Periodic Fall & Spring)

Vehicle detection and traffic data collection methods. Measure for traffic system

effectiveness, drive behavior theory, and microscopic modeling. Macroscopic traffic flow theory and modeling methodologies, simulation models and optimal calibration methods. Application of simulation models. prereq: 4315 or grad student

### **CE 5318. Pavement Maintenance, Rehabilitation, and Management.** (; 3 cr. ; A F or Audit; Periodic Fall)

Students will learn to evaluate the existing condition of the pavements, designing and selecting the appropriate rehabilitation strategy. Broadly, this course will include (i) assessment of the functional and structural conditions of pavements, (ii) pavement maintenance, repair and rehabilitation techniques, (iii) design of overlays, (iv) life cycle cost analysis of pavement overlays, and (v) introduction to pavement management. Different software such as BAKFAA, AASHTOW are Pavement ME Design, DRIP, BCOA-ME and MnPAVE will be utilized, wherever applicable. prereq: 3027, 3316 or CE graduate student

### **CE 5320. Advanced Pavement Materials, Design and Construction.** (3 cr. ; A-F or Audit; Periodic Fall)

This course contains both lecture and lab classes. in the lecture class, students will learn the following: (i) mixture design procedures for concrete and asphalt pavements with and without the application of recycled materials; (ii) mechanistic design of pavement using 'MnPAVE' and 'AASHTOW are Pavement ME Design' procedures, and (iii) pavement construction procedures. In the laboratory class, students will learn the following: (i) perform the mixture design for asphalt and concrete pavement materials for a real-world pavement project, (ii) conduct performance tests on the samples prepared with their own mixture designs, and (iii) participate field trips to monitor recent trends in the material mixture design and pavement construction procedures. Students will prepare a project report and present to the class towards the end of the semester. The lab report and project report will a group work. Students will need to interact with the experts from the pavement industry for completing the project report. This course will also be offered as 4320; the student taking this course as CE 5320 will need to do more homework assignments than those who are taking it as CE 4320. pre-req: CE 3027

### **CE 5326. Highway Planning and Design.** (; 3 cr. ; A-F or Audit; Every Fall)

This course aims to provide an in-depth knowledge on highway network planning and design methodologies. Current planning and design methods for roadways will be introduced and used for class projects. The potential interrelationship between design parameters and traffic operation/safety will also be introduced for each design element. prereq: 3316 or graduate student

### **CE 5420. Advanced Soil Mechanics.** (; 3 cr. ; A-F or Audit; Spring Odd Year)

This course will cover advanced topics related to the behavior of cohesive and cohesionless soils. Topics to be covered include: stress and strength concepts; measurement devices;



shear strength of sands, gravels, and rockfills;

shear strength of saturated clay; and shear

strength of silts. Will require development

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of graduate project level project, in addition to the undergraduate level requirements of the course. prereq: 3426, 4415 (concurrent registration is acceptable) or CE graduate student

**CE 5421. Applied Geostatistics.** (; 3 cr. ; A-F or Audit; Spring Even Year)

The course teaches theoretical and practical aspects of geostatistics; with primary focus on analysis of information gathered in site investigations for civil engineering projects, although the concepts taught in the course also have direct application in economic geology and ore-mining investigations. Theoretical aspects of the course center on description and modeling of spatial variability and interpolation attributes of interest at unsampled locations; they also focus on sampling design and incorporation of different types of information (continuous, categorical) in geostatistical prediction. Practical implementation of concepts taught involves use of geostatistical packages in the software R and Matlab (also commercial software packages commonly used in the civil and mining engineering industry such as ArcGIS, Vulcan, etc., will be addressed.) Will require development of a graduate level project, in addition to the undergraduate level requirements of the course. prereq: MATH 1297 or STAT 2411 or 3411 or CE graduate student

**CE 5422. Numerical Modeling in Geotechnical Engineering.** (3 cr. ; A-F or Audit; Spring Even Year)

This course covers theoretical and practical aspects of numerical modeling of problems in geotechnical engineering, using the finite element and finite difference methods, as implemented in commercial packages such as Abaqus and FLAC. The emphasis is on the solution of typical soil mechanics and geotechnical design problems. These include determining stresses in soils; solving shallow and deep foundation problems; seepage and consolidation problems; lateral earth pressure, retaining wall and slope stability problems; and seismic wave propagation in soils. Will require development of a graduate level project in addition to the undergraduate level requirements of the course. prereq: 3426 or CE Graduate Student or instructor consent

**CE 5426. Rock Mechanics.** (3 cr. ; A-F or Audit; Every Fall)

Study of rock as an engineering material, including physical and mechanical characterization of intact rock and rock masses as they relate to civil and mining engineering applications. This also includes the study of effect of jointing and water in a rock mass, foundations of civil and mining engineering structures in rock, stability of cuts in rock, and excavation and support of surface and underground and openings in rock. prereq: 3426, Grad Student

**CE 5515. Sustainable Design and Construction (SUSTAIN).** (; 3 cr. ; A-F or Audit; Every Spring)

Introduction to sustainable design and construction including LEED, materials, construction/transportation/production, life-cycle/service, rating systems, codes, regulations, economical issues and social issues. prereq: BSCE or BSCHE or BSECE or BSIE or BSME or Grad student and instructor consent; meets DLE req of Sustainability

**CE 5525. Decision, Risk and Reliability.** (3 cr. ; A-F or Audit; Periodic Spring)

An introduction to modeling uncertainty in engineering applications. Tools for risk based design and decision making including uncertainty modeling and decision analysis applied to civil engineering systems pre req: STAT 3411 or grad student or instructor consent

**CE 5545. Design of Structures with Advanced Materials.** (3 cr. ; A-F or Audit; Every Fall)

This course focuses on the design of structures utilizing advanced materials such as composites and polymeric materials. Topics covered in this course include: Material properties of composites, polymers, and other advanced materials; Mechanical properties of composites, polymers, and other advanced materials; Accounting for creep and stress relaxation in design; Design of various structures with advanced materials including pipes, chambers, and other buried structures. pre-req: CE 3027

**CE 5555. Project Credits: Master of Engineering (Civil).** (; 3-6 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Master of Engineering project work as determined by faculty advisor and student with approval by the department director of graduate studies. prereq: Civil Engineering MEng Student

**CE 5991. Graduate Independent Study in Civil Engineering.** (1-12 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Directed study of special interest topics not available in the standard curriculum. Must be arranged with instructor before registration. May include readings, research and/or special project. prereq: CE MEng candidate, instructor consent

**CE 5995. Special Topics in Civil Engineering:(Various Titles to be Assigned).** (; 1-4 cr. [max 12 cr.]; A-F or Audit; Periodic Fall & Spring)

Topics not available in the regular department curriculum. Topics may include specialties of the department or visiting faculty. prereq: grad student

**CE 8020. Graduate Seminar.** (1 cr. ; S-N only; Every Fall & Spring)

The course will be required course for graduate students in the CE program. Students will participate in seminars organized by the department on contemporary technical topics of research and practice of civil engineering. invited speakers will address technical topics and also topics related to ethics, leadership, and cultural global issues in civil engineering. The course requires students to complete

assignments related to the outcomes of the course and give a presentation on their research or project topics. pre-req: Graduate student

**CE 8094. Civil Engineering Master's Project.** (; 1-6 cr. [max 24 cr.]; S-N or Audit; Every Fall, Spring & Summer)

Master's project: Research or independent study in geotechnical, structural, transportation, and water resources and environmental engineering. Investigations, reports, tests, or designs are acceptable. prereq: Graduate student

**CE 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

Advanced masters in graduate school. pre-req: Master's students, adviser and DGS consent

**CE 8777. Thesis Credits: Master's.** (; 1-12 cr. [max 24 cr.]; No Grade Associated; Every Fall, Spring & Summer)

Master's thesis credits. prereq: graduate student; max 12 cr per semester or summer, 10 cr total required (Plan A only)

**COMM 5000. Senior Seminar.** (; 3 cr. [max 6 cr.]; A-F or Audit; Every Fall, Spring & Summer)

Advanced study and individual research on a selected topic or theme in communication; senior seminar course for communication majors. prereq: 1000, 1112 or 1115, 2025, 2030 with a C or better; Min 90 cr, Comm major, instructor consent

**COMM 5391. Independent Study in Communication.** (1-6 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Individual research project written under supervision of communication graduate examining faculty member, to result in a research project. pre-req: instructor consent

**CSD 5091. Independent Study.** (; 1-3 cr. [max 18 cr.]; Student Option; Every Fall & Spring)

Directed study, readings, and/or projects of student interest in communication disorders. prereq: CSD candidate with 90 cr or CSD Grad student

**CSD 5095. Special Topics: (Various Titles to be Assigned).** (; 0.5-3 cr. [max 18 cr.]; Student Option; Periodic Fall, Spring & Summer)

Special topics of interest to speech-language pathologists, audiologists, special educators, and related professionals. Workshop and seminar format.

**CSD 5097. Off campus Professional Practicum in Communication Sciences and Disorders.** (2-6 cr. [max 12 cr.]; A-F or Audit; Every Summer)

Speech-language pathology practicum in an off-campus setting under an ASHA-certified

language pathologist. This experience focuses on special interests of the individual student,

and allows for comparison of practice settings to prior clinical experiences. prereq: instructor

consent

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### **CSD 5100. Research Methods in Communication Disorders.** ( ; 1-3 cr. ; A-F only; Every Fall & Spring)

Especially designed for new CSD graduate students to introduce them to the research process. Topics will include generating a research question, experimental designs, data collection, analysis, and interpretation, and writing the research paper. Students will conduct a guided class research project and begin their Plan B project. prereq: CSD Grad

### **CSD 5142. Introduction to Diagnosis of Communication Disorders.** ( ; 3 cr. ; A-F or Audit; Every Fall)

General issues of evaluation and diagnosis of communication disorders pertinent to all age groups and disorders. prereq: CSD Graduate or instructor consent; credit will not be granted if already received for 4142

### **CSD 5200. Dysphagia.** ( ; 3 cr. ; A-F only; Every Spring)

Anatomy and physiology of normal and disordered deglutition. Etiology, diagnosis, and management of swallowing disorders, including head and neck cancer. prereq: CSD grad or instructor consent

### **CSD 5205. Pediatric Dysphagia.** (1 cr. ; A-F or Audit; Every Summer)

Students will learn the anatomy and physiology of normal pediatric swallowing; study etiology, assessment, diagnosis, and management of pediatric swallowing and feeding disorders. prereq: CSD Graduate Student or instructor consent

### **CSD 5230. Advanced Applications in Communication Modalities.** (4 cr. ; A-F or Audit; Every Summer)

Advanced seminar and clinical practicum of augmentative and alternative communication (AAC) systems, assistive technologies and visual communication modalities. The decision making process for identifying AAC candidates, selecting appropriate communication modality systems and developing effective communication programs and strategies involving visual communication modalities. prereq: CSD grad or instructor consent

### **CSD 5250. Seminar in Augmentative and Alternative Communication.** (1 cr. ; A-F only; Every Fall)

Examines the assessment and treatment issues for speech language pathologists working with individuals requiring augmentative and alternative communication systems. prereq: CSD grad student or instructor consent

### **CSD 5260. Seminars in Orofacial Disorders.** (2 cr. ; A-F only; Every Summer)

This course will focus on the origin and potential effects of craniofacial disorders on an individual's feeding, communication, and psychosocial development. Surgical procedures aimed at repairing craniofacial disorders and at improving velopharyngeal function will be discussed. The role of the speech language pathologist on the

interdisciplinary team that cares for the individual with craniofacial disorders will be reviewed. This will include describing the primary responsibilities of the SLP as well as important interactions with other team members. The role of the other team members in the management of care for the individual with craniofacial disorders will also be described. prereq: 3103

### **CSD 5301. Language Disorders in Infants, Toddlers, and Preschoolers.** ( ; 2 cr. ; A-F or Audit; Every Fall)

Advanced study of language disorders in individuals birth to 6 years old. The course includes an examination of etiology, diagnosis, clinical techniques, and study of relevant research. prereq: CSD grad student or instructor consent

### **CSD 5302. Language Disorders in School Age Children.** ( ; 2 cr. ; A-F or Audit; Periodic Spring & Summer)

Advanced study of language disorders in individuals 6 to 21 years old. The course includes an examination of etiology, diagnosis, clinical techniques, and study of relevant research. prereq: CSD grad student or instructor consent

### **CSD 5400. Rehabilitative Procedures for the Hard of Hearing.** ( ; 3 cr. ; A-F only; Every Spring)

Theories, principles, and methods regarding current approaches to aural rehabilitation of hard-of-hearing children and adults. prereq: 4400, CSD candidate or CSD grad or instructor consent

### **CSD 5500. Voice Disorders.** (3 cr. ; A-F or Audit; Every Summer)

Theoretical and practical study of voice and voice disturbances in children and adults. The purpose of this course is to provide students with an introduction to the anatomical, physiological, acoustic, and theoretical aspects of voice disorders. Current diagnostic and therapeutic techniques will also be introduced. prereq: 3103, 3150 or instructor consent

### **CSD 8099. Projects in Communication Disorders.** (1 cr. [max 3 cr.] ; A-F only; Every Fall & Spring)

Plan B project or individual research under faculty supervision. prereq: CSD grad student or instructor consent

### **CSD 8205. Advanced Fluency Disorders.** ( ; 3 cr. ; A-F or Audit; Every Fall)

Differential diagnosis, assessment, and treatment considerations for developmental stuttering and other fluency disorders. prereq: CSD grad student or instructor consent

### **CSD 8211. Professional Issues in Communication Disorders I.** (1 cr. ; A-F or Audit; Every Summer)

Identify and discuss issues in speech-language pathology related to professional organizations, certification, licensure, and professional entry. prereq: CSD Graduate student or instructor consent

### **CSD 8212. Professional Issues in Communication Disorders II.** (1 cr. ; A-F or Audit; Every Fall)

Identify and discuss current professional issues in speech-language pathology practice related to politics, education and health regulations, ethics, and advocacy. prereq: 8211 or instructor consent

### **CSD 8230. Neurogenic Language Disorders.** ( ; 4 cr. ; A-F or Audit; Every Fall)

Advanced study of diagnosis, treatment, and research of acquired language disorders resulting from neurological impairment: aphasia, right brain damage, dementia, and traumatic head injury. prereq: CSD Grad student or instructor consent

### **CSD 8231. Neurogenic Speech Disorders.** (3 cr. ; A-F or Audit; Every Spring)

Advanced study of neuroanatomical bases for motor speech disorders; diagnostic and therapeutic procedures used in speech disorders related to central and peripheral nervous system damage. prereq: CSD grad student or instructor consent

### **CSD 8232. Mgmt of Communication Disorders in Persons with Tracheostomy, Ventilator Dependency, & Laryngectomy.** (1 cr. ; A-F only; Periodic Spring & Summer)

Advanced study of the effects of tracheostomy tubes, ventilators and laryngectomies on the production of speech; diagnostic and therapeutic procedures used in working with individuals with trach vents, or laryngectomies. prereq: CSD grad student or instructor consent

### **CSD 8235. Counseling Applications in Communication Disorders.** ( ; 2 cr. ; A-F or Audit; Every Fall)

Applications of interviewing and counseling theories and behaviors to field of speech language pathology. prereq: CSD grad student, at least 4 cr of 8497 or instructor consent

### **CSD 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (no description) prereq: Master's student, adviser and DGS consent

### **CSD 8350. Applied Clinical Methods in CSD.** (1 cr. ; A-F or Audit; Every Fall)

Course addresses application of advanced clinical methods in communication disorders, with special emphasis on using evidence based practice and cultural competence in clinical case management. Subject matter complements CSD 8397: On-Campus Graduate Internship in CSD I. prereq: grad student in CSD and instructor consent

### **CSD 8397. On-Campus Graduate Internship in Communication Disorders I.** ( ; 1-4 cr. ; A F or Audit; Every Fall)

Supervised clinical internship in on-campus clinic under supervision of an ASHA-certified speech-language pathologist. prereq: CSD grad student, instructor consent

### **CSD 8497. On-Campus Graduate Internship in CSD II.** ( ; 1-5 cr. ; A-F or Audit; Every Spring)

Supervised clinical internship in on-campus clinic under supervision of an ASHA-certified speech-language pathologist. prereq: 8397, instructor consent

**CSD 8597. Part-Time CSD Graduate Internship in Education Settings.** (5 cr. ; A-F or Audit; Every Fall)

Part-time speech-language pathology internship in an education setting under an

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ASHA-certified speech-language pathologist with focus on expanding application of principles of clinical practice to working with children in the school system. prereq: 5260, 8497 and instructor consent

**CSD 8697. Part-Time CSD Graduate Internship in Medical Setting.** (5 cr. [max 10 cr.] ; A-F or Audit; Every Fall)

Part-time speech-language pathology internship in a medical setting under an ASHA certified speech-language pathologist with focus on expanding application of principles of clinical practice to working with patients in medical settings. Depending on placement, internship may involve working with children and/or adults. prereq: 5205, 5260, 8232, 8497 and instructor consent

**CSD 8797. Full-Time CSD Graduate Externship in Education Settings.** (6 cr. ; A-F or Audit; Every Spring)

Full-time speech-language pathology externship in an education setting under an ASHA-certified speech-language pathologist. This full-time placement allows the student to experience the rigors of full-time service delivery and actively participate in all aspects of clinical practice in education settings. Special focus is on refining social/cultural competence and formative assessment in clinical practice. prereq: 5260, 8697 and instructor consent

**CSD 8897. Full-Time CSD Graduate Externship in Medical Settings.** (6 cr. ; A-F or Audit; Every Spring)

Full-time speech-language pathology externship in a medical setting under an ASHA-certified speech-language pathologist. This full-time placement allows the student to experience the rigors of full-time service delivery and actively participate in all aspects of clinical practice in medical settings. Special focus is on refining social/cultural competence and formative assessment in clinical practice. prereq: 5205, 5260, 8232, 8597 and instructor consent

**CSD 8997. Graduate Practicum in Communication Disorders.** (1 cr. [max 2 cr.] ; A-F or Audit; Every Summer)

Supervised graduate clinical practicum under the supervision of an ASHA-Certified speech language pathologist. Focus in on increasing proficiency to provide students with an opportunity to develop increased independence with clinical skills and establish a breadth and depth of knowledge in providing diagnostic and treatment services under the guidance of ASHA certified professionals. Focus is on increasing speed and efficiency of clinical performance and justifying clinical services. prereq: CSD grad student, instructor consent

**CS 5112. Advanced Theory of Computation.**

(4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Mathematical theory of computation and complexity. Deterministic and nondeterministic Turing machines, Church-Turing Thesis, recursive and recursively enumerable languages. Lambda calculus. Undecidable problems, Rice's Theorem, undecidability of first-order logic and Gödel's incompleteness theorem. Time and space complexity, reducibility, completeness for complexity classes, Cook's Theorem, P versus NP, Savitch's Theorem, complexity hierarchy. pre-req: Grad student, CS 3512 or 3531 or instructor consent

**CS 5122. Advanced Algorithms and Data Structures.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Survey of advanced data structures and algorithms such as heaps and heapsort, quicksort, red-black trees, B-trees, hash tables, graph algorithms, divide and conquer algorithms, dynamic programming, and greedy algorithms. Methods for proving correctness and asymptotic analysis. pre-req: grad student; CS 2511, 2531 or 3512 or MATH 3355 or instructor consent; a grade of C- or better in all prerequisite courses

**CS 5212. Computer Graphics.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Introduces the fundamentals of computer graphics to create 2D images from 3D data representations, the graphics pipeline, 3D representations of objects such as triangles and triangle meshes, surface material representations, color representation, vector and matrix mathematics, 3D coordinates and transformations, transport of light energy, global illumination, graphics rendering systems, ray tracing, rasterization, real-time rendering, OpenGL and computer graphics hardware. prereq: graduate student, CS 2511, (2531 or 3512 or MATH 3355), (MATH 3280 or 3326) or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5222. Artificial Intelligence.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Principles and programming methods of artificial intelligence. Knowledge representation methods, state space search strategies, and use of logic for problem solving. Applications chosen from among expert systems, planning, natural language understanding, uncertainty reasoning, machine learning, and robotics. Lectures and labs will utilize suitable high-level languages (e.g., Python or Lisp). prereq: grad student, 2511, (2531 or 3512 or MATH 3355) or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5232. Introduction to Machine Learning and Data Mining.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Introduction to primary approaches to machine learning and data mining. Methods selected from decision trees, neural networks, statistical learning, genetic algorithms, support

vector machines, ensemble methods, and reinforcement learning. Theoretical concepts associated with learning, such as inductive bias and Occam's razor. This is a potential Master's project course. prereq: grad student, 2511, 2531 or 3512 or MATH 3355, Stat 3611 or 3411, Math 3280 or 3326 or instructor consent; a grade of C- or better is required in all prerequisite courses

**CS 5242. Natural Language Processing.** (4 cr. ; A-F or Audit; Periodic Fall)

Techniques for creating computer programs that analyze, generate, and understand written human language. Emphasizes broad coverage of both rule-based and empirical data-driven methods. Topics include word level approaches, syntactic analysis, and semantic interpretation. Applications selected from conversational agents, sentiment analysis, information extraction, and question answering. Significant research project that includes experimental results, written report, and clear grasp of ethical considerations involved. prereq: CS 2511, (2531 or 3512 or MATH 3355). grad student or instructor consent; a grade of C- or better is required in the prerequisite course; credit will not be granted if already received for CS 4242 or 5761

**CS 5312. Operating Systems.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Operating system as resource manager. Modern solutions to issues such as processor management and scheduling, concurrency and related problems including deadlocks, memory management and protection, file system design, virtualization, distributed and cloud computing. Concepts including concurrency are illustrated via laboratory assignments. This is a potential Master's project course. prereq: grad student, 2511, 2521, (2531 or 3512 or MATH 3355) or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5322. Database Management Systems.**

(4 cr. ; A-F or Audit; Every Fall & Spring)  
Entropy and the underlying characteristics of text. Encryption-basic techniques based on confusion and diffusion and modern day encryption. Access, information flow and inference control. Program threats and intrusion detection/prevention. Network and Internet security. Firewalls, trusted systems, network authentication. Privacy and related social issues. Planning, Incidents, and Recovery. prereq: grad student, 2511, 2521, (2531 or 3512 or MATH 3355) or instructor consent; a grade of C- or better is required in all prerequisite courses

**CS 5332. Computer Security.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Entropy and the underlying characteristics of text. Encryption-basic techniques based on confusion and diffusion and modern day encryption. Access, information flow and inference control. Program threats and intrusion detection/prevention. Network and

Internet security. Firewalls, trusted systems, network authentication. Privacy and related social issues. Planning, Incidents, and Recovery. prereq: grad student, 2511, 2521, (2531 or 3512 or MATH 3355) or instructor consent; a grade of C- or better is required

in all prerequisite courses

**CS 5342. Compiler Design.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
A selection from the following topics: finite-state grammars, lexical analysis, and implementation

of symbol tables. Context-free languages and parsing techniques. Syntax-directed translation. Run-time storage allocation. Intermediate languages. Code generation methods. Local and global optimization techniques. prereq:

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grad student, 2511, 2521, 2531 or 3512 or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5412. Computer Architecture.** (4 cr. ; A-F or Audit; Periodic Spring)  
Broad coverage of computer architecture, with a focus on the development of the stored program computer and the historical evolution of architectures. Includes coverage of significant architectures based on vacuum tubes, transistors, and integrated circuits. Impact of Moores Law and possible paradigms for the future including quantum and molecular computing. prereq: 2521, (2531 or 3512 or MATH 3355), grad student or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5422. Computer Networks.** (4 cr. ; A-F or Audit; Every Fall & Spring)  
Introduction to computer networking, network programming, networking hardware and associated network protocols. Layered network architecture, network services, and implementation of computer networking software. prereq: grad student, 2511, 2521, (2531 or 3512 or MATH 3355) or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5551. User Interface Design.** (4 cr. ; A-F or Audit; Periodic Fall)  
Design and layout of interactive programs using components, containers, events, menus, and dialogs. The use of graphics primitives, color and images; giving user feedback and help. Rapid prototyping and interface management systems. Design for accessibility and usability. prereq: 2511, (2531 or 3512 or Math 3355) (MATH 3326 or 4326) or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5571. Principles of Programming Language.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Introduction to the fundamental concepts in programming languages. Introduction to the intellectual tools needed to use, evaluate, design and choose programming languages, and reason about programs. Lambda calculus, different programming paradigms such as functional programming and logic programming. Programming in a functional language such as ML and OCAML, and in a logic language, e.g., Prolog. Using these languages as case studies to examine each basic concept of programming languages (values, bindings, types, abstraction etc.). Syntax analysis (syntax, parsing, interpreting, and compiling). Includes a project, e.g., implementing a working interpreter for a small language. prereq: 2511, (2531 or 3512 or MATH 3355) or instructor consent, a grade of C- or better is required in all prerequisite

**CS 5612. Advanced Computer Graphics.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Contemporary computer graphics techniques. Focus on advanced graphics algorithms and programming, curve and surface representations, physically based rendering, visible surface determination, illumination, texturing, and real time rendering. prereq: graduate student, CS 5212 or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5642. Advanced Natural Language Processing.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Advanced techniques for creating computer programs that analyze, generate, and understand written human language. Emphasizes current empirical data-driven methods. Topics include sentence level representations, vector semantics, and models of document understanding. Applications selected from word sense discovery, machine translation, sentiment and opinion mining, and social computing. Significant research project that includes experimental results, written report, and clear grasp of ethical considerations involved. pre-req: CS 4242 or 5242, grad student or instructor consent; a grade of C- or better is required in the prerequisite course.

**CS 5652. Human Computer Interaction.** (; 4 cr. ; A-F only; Every Fall)  
Introduction and exploration of software algorithms, hardware components, and concepts for building and evaluating augmented and virtual reality environments. Focus will be on effective human-computer interaction (visual, auditory, haptic, and mechanical aspects). Includes the perceptual components for constructing effective human computer interaction with a virtual environment. prereq: graduate student, CS 5212 or instructor consent, a grade of C- or better is required in all prerequisite courses

**CS 5722. Advanced Database Management Systems.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Advanced course on database management systems that will introduce students to advanced topics on both centralized and distributed database management. More specifically, this course will teach students the theoretical and practical issues of distributed database design, distributed concurrency control, and distributed query optimization and processing. Other key topics that will be covered in this course are non-relational databases, data warehousing, cloud and big data management, and data stream management. prereq: Graduate student or instructor consent; CS 4322 or CS 5322 or instructor consent; a grade of C- or better is required in all prerequisite courses

**CS 5732. Advanced Computer Security.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Broad, active, hands-on and implementation based approach to computer security. Fundamental cryptographic theory, advanced techniques and application. Complexity, cryptanalysis, and impact of technological change. Core security theory; confidentiality, integrity, availability. Security models. Risk assessment and decision-making. Issues for general -purpose, trusted and ?cloud? operating system security including hardware requirements, authentication, access control, information flow and assurance. Program and network security fundamentals and best practices including coding principles, firewalls and network design. Exploits, defenses and remediation for multiple issues pertaining to software, hardware, databases and networks. Political, social and engineering issues relating to security and privacy. prereq: CS 4821, grad student and instructor consent

**CS 5991. Independent Study.** (1-4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)  
Directed study of special interest topics not available in the standard curriculum. Must be arranged with the instructor in advance of registration. May include readings, research, or special projects. prereq: instructor consent

**CS 5994. Advanced Topics in Computer Science.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Research-oriented study of topics of current academic or industrial interest, such as parallel algorithms, VLSI design, computational geometry, logic programming languages, program correctness, information retrieval systems, and decision support systems. prereq: Grad student or instructor consent

**CS 5995. Special Topics: (Various Titles to be Assigned).** (; 1-4 cr. ; A-F or Audit; Periodic Fall & Spring)  
Study of selected topic announced in Class Schedule.

**CS 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Every Fall & Spring)  
(No description) prereq: Master's student, adviser and DGS consent

**CS 8777. Thesis Credits: Master's.** (; 1-24 cr. [max 50 cr.] ; No Grade Associated; Every Fall & Spring)  
(No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**CS 8794. Project Credits: Master's.** (1-4 cr. ; A-F or Audit; Every Fall & Spring)  
Project credit requirements for the Master's Degree with Project Plan B. Independent research performed under Advisor's

supervision. pre-req: graduate student, advisor's consent

**CS 8993. Seminar.** (1 cr. [max 3 cr.] ; A-F or Audit; Every Fall & Spring)

Presentation and discussion of basic ethical theories, case studies dealing with ethical issues facing the computing professional in his/her life as a practitioner, and the

development of research proposal which meets the requirements and standards of the department and serves as the foundation of and guideline for the development of the graduate research project (i.e., thesis). prereq: instructor consent

**CIA 5761. Fundamental Consumer Analytic Techniques.** (3 cr. ; A-F or Audit; Every Spring)

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Course develops core quantitative skills necessary to convert large amounts of consumer data into actionable information for businesses. The course builds knowledge and understanding of the essential business and consumer metrics as well as the statistical techniques necessary for students to be able to competently summarize data, appropriately classify data and use data to make predictions. Marketing research is a constantly evolving field. In this course, we explore some of the current development and new application areas of marketing research. Emphasis is placed on the application of skills and techniques to data sets and using the analysis to answer business questions and formulate consumer focused recommendations. Students enrolled in the 5761 version of the course will have to fulfill an extra assignment/project to earn graduate credit. pre-req: CIA 3760, MBA student or department consent

**CIA 5762. Advanced Consumer Analytics.** (3 cr. ; A-F or Audit; Every Fall)

Course introduces customer relationship management and advanced analytical techniques. Emphasis is placed on understanding and calculating the metrics behind profit enhancing customer level management, including RF< Analysis, attrition and churn prediction, customer value and profitability, and customer lifetime value. Students will be asked to calculate these metrics during classroom scenarios and assigned case studies to gain an understanding of how these metrics can be used to select, retain and grow profitable customer segments. Having mastered the basic concepts and tools of marketing research, we move on to study three more advanced and specialized tools most commonly used by qualitative marketing researchers. We study the application of these techniques to optimize the marketing mix (pricing, promotion, product design, positioning). Students enrolled in the 5762 version of the course will have to fulfill an extra assignment/project to earn graduate credit. pre req: MKTG 3761; credit will not be granted if already received for MKTG 4762 or 5762

**CRIM 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Master's student, adviser and DGS consent

**CRIM 8593. Directed Study.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)

Individualized graduate study under supervision of a faculty member in the Criminology Program. pre-req: grad student, instructor consent

**CRIM 8600. Practicum in Criminology.** (1-15 cr. ; S-N or Audit; Every Fall, Spring & Summer)

Supervised direct experience in a criminal justice agency and a concurrent seminar which focus on identification, application, and evaluation of the implementation of concepts, principles, theories and best practices in criminal justice. Experience in law enforcement agencies, juvenile courts, probation and parole departments, correctional institutions, delinquency control programs and public or voluntary agencies. Orientation sessions precede placement. Student must submit internship application during the first 30 days of the preceding spring or fall semester. prereq: Grad student or instructor consent

**CRIM 8777. Thesis Credits: Master's.** (; 1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**CRIM 8900. Directed Readings.** (1-6 cr. ; A-F or Audit; Periodic Fall & Spring)

Students conduct intense and detailed reading in a topic area of their choice under the guidance of a professor. prereq: Grad student or instructor consent

**CUE 5002. Managing Cultural Organizations.** (; 3 cr. ; A-F only; Periodic Fall & Spring)

This course provides students with the knowledge and skills needed to play a leadership role in a cultural organization. Using case methodology students will know theories, methods, and practices for managing cultural organizations, gain the skills to participate strategically in the governance of such organizations and be able to design and assess the effectiveness of governance models, volunteer programs, organizational capacity, and inter-organizational relationships. Student will also know the legal requirements affecting cultural organizations and approaches to finance the programming and operations. pre-req: graduate student

**CUE 5201. Leadership Theory and Practice.**

(; 3 cr. ; A-F or Audit; Every Fall & Spring) This course examines theories and practices of leadership at the individual, group and cross-sector initiatives often found in the context and cultural enterprises. Students' ability to understand, apply, integrate and

develop intellectual curiosity regarding diverse approaches to leadership is emphasized through projects and case studies. Through class assignments students will develop and refine understanding of themselves and their approach to leadership. They will also enhance appreciation of others leadership approaches and their own abilities to work effectively with others. The emphasis is on building a sound grasp of good practice, and on developing the ability to connect those practices comprehensively to contemporary social, cultural, environmental and organization problems. pre-req: grad student

**DN 5991. Independent Study in Dance.**

(1-3 cr. [max 6 cr.] ; A-F or Audit; Every Fall & Spring)

Advanced directed readings and projects arranged between student and faculty mentor. Work may be scholarly or creative, but should be planned with a faculty mentor the semester prior to registration. prereq: instructor consent; undergrads max 6 cr in 3991 and 5991 combined

**DN 5997. Internship in Professional Dance.**

(1-12 cr. ; A-F or Audit; Every Fall & Spring) Internship with a cooperating professional, commercial, or regional dance company. prereq: department approval; 1 cr for each 45 hrs of work

**ECON 5040. Econometrics II.** (3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Development and application of tools of economic research and analysis; emphasis on critical thinking using computer-based statistical methods. Econometrics (theory and practice), applied research techniques, economic forecasting, and time series analysis. Research report. pre-req: MBA student or department consent

**ECON 5213. Mathematical Economics.** (3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Application of fundamentals of differential and integral calculus and linear algebra to static, comparative static, and dynamic topics in microeconomics and macroeconomics. pre-req: MBA student or department consent

**ECON 5410. International Economics.** (3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Classical and modern theory of international trade. Extension, empirical verification, and applications of modern theory. Alternative theories of international trade. Concept and

measurement of balance of payments.  
Methods of balance of payments adjustments.  
Alternative international monetary systems.  
Selected current issues. pre-req: MBA student or department consent

**ECON 5590. Economic and Business Forecasting.** (3 cr. ; A-F or Audit; Fall Odd Year)

The course seeks to provide students with the statistical and computational tools required to

conduct economic forecasting applied to economic and business decision-making. Topics include time series analysis, Box Jenkins and ARIMA processes, Exponential Smoothing, Estimation and Forecasting, Forecast Evaluation, Nonlinear Time Series, Time Series Topics. Forecasts will be applied to economic and business examples, including sales, financial decisions and policy. Econometric software will be taught. pre-req:

MBA student or department consent

**ECON 5613. Oligopoly and Monopoly.** (3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Alternatives open to a free-enterprise economy when economic goals have not been satisfactorily achieved by the private sector. Public regulation and antitrust legislation and

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enforcement examined as a means of social control when unacceptable market failures exist. pre-req: MBA student or department consent

**EDUC 5227. Number Theory for Teachers in Grade 5 - 8.** (; 3 cr. ; A-F or Audit; Every Fall & Summer)

The development of number concepts and theories through investigations and applications of discrete mathematics strategies provides the basis for examining the teaching and learning of number theory in grades 5 - 8. pre-req: Math 1141 or 1296 or 1596

**EDUC 5230. Indigenous Peoples and the Environment.** (; 2-3 cr. ; A-F or Audit; Every Fall)

This course will examine the intersection of Indigenous peoples, traditional and contemporary practices of sustainability, planetary ecological issues, the impact on Indigenous peoples and the possibilities provided by Indigenous place-based/ environmental education. Indigenous peoples cultural relationship to place will also be explored along with a critical examination of the impact colonization, patriarchy and capitalism has had on Indigenous homelands and centers of power. Attention will be given to Indigenous initiatives that are working toward the healing of their homelands and the planet. pre-req: instructor consent

**EDUC 5340. Interacting With Diverse Families.** (3 cr. ; A-F or Audit; Every Fall)

Issues relating to working with and advocating for families from diverse backgrounds and/or with diverse needs. Emphasis on linguistically diverse families, immigrant families, families headed by single parents, families with members with a disability, families headed by lesbian/gay parents. pre-req: 90 cr or instructor consent

**EDUC 5412. The Computer in Education.** (4 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Introduction to computer use in instructional settings. PC and Mac platforms. Develops basic skills using software commonly used by educators. Teaching strategies using computer-assisted instruction.

**EDUC 5413. Teaching With Technology.** (; 4 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Develops basic computer and educational technology skills focusing on using microcomputers for communications. pre-req: 3412 or 5412, min 60 cr or coll grad or instructor consent

**EDUC 5414. Using Technology for the Administrative Tasks of Teaching.** (; 4 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Develops basic computer and educational technology skills focusing on using microcomputers for administrative tasks of teaching. pre-req: Min 60 cr or coll grad; 3412 or 5412, 5413 or instructor consent

**EDUC 5415. Teaching Online and Hybrid Courses.** (; 4 cr. ; A-F or Audit; Periodic Spring & Summer)

Designing completely online courses and hybrid (partially face-to-face and partially online) courses. Instructional design, methods of teaching, creating learning activities, technology tools, social dimensions, assessment of student learning. pre-req: Min 60 cr or coll grad, 3412 or 5412, 5413, 5414 or instructor consent

**EDUC 5990. Research Project.** (1-6 cr. [max 36 cr.]; S-N only; Every Fall, Spring & Summer)

Faculty-supervised research project required for MEd pre-req: Instructor consent

**EDUC 5991. Independent Study.** (; 0.5-4 cr. [max 8 cr.]; A-F or Audit; Every Fall, Spring & Summer)

Directed independent study, readings, and/or projects of interest to students in education.

**EDUC 5995. Special Topics: (Various Titles to be assigned).** (; 0.5-4 cr. [max 16 cr.]; A-F or Audit; Periodic Fall & Spring)

Topics selected from education to meet needs and interests of different groups of students.

**EDUC 6950. Cumulative Project Design and Development.** (3 cr. ; S-N or Audit; Spring Odd Year)

This course is designed to assist MEd and other graduate students in designing educational programs with assessment and evaluation components built into the design. This course is one of three methodology courses that a student may elect to take. The course is student project based, providing students support in completing project design and initial evaluation for their capstone projects. Students will review multiple methods for building education programs based on their review of literature and needs analysis and multiple evaluative frameworks in order to choose and incorporate evaluation into their design. pre-req: M.Ed student in final semester of coursework and instructor consent

**EDUC 7001. Introduction to Graduate Study.** (; 3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Expectations of graduate study, scholarly

writing and online learning. Develop skills in using the Internet for scholarly research and writing, culminating in writing of a literature review. pre-req: MEd candidate or instructor consent; credit will not be granted if already received for EHS 7001

**EDUC 7002. Human Diversity and Exceptionality.** (; 3 cr. ; A-F or Audit; Periodic Fall & Spring)

Stresses the importance of diversity and exceptionality in educational settings, and its relevance to teaching and learning strategies, assessment, and professional community building. The concepts of privilege and power will be explored from the standpoint of the educator and his/her role in the educational setting. pre-req: MEd candidate or instructor consent; credit will not be granted if already received for EHS 7002

**EDUC 7004. Foundations of Educational Research.** (; 3 cr. [max 4 cr.]; A-F or Audit; Periodic Fall & Spring)

Provides foundational knowledge in being a consumer of and conducting scholarly educational research. Designed to provide an orientation to existing educational research and research methods, with a focus on defining a topic, writing a problem statement, and investigating current literature and research on that topic. Includes emphasis on ethical and responsible research protocol with underlying foundations in social justice and reform. pre-req: M.SpEd student or MEd student or instructor consent; credit will not be granted if already received for EHS 7004

**EDUC 7006. Ethics and Professionalism in Education.** (; 2 cr. ; A-F or Audit; Periodic Fall & Spring)

Offers a synthesis of previous courses, reviewed from the context of ethics and ethical dilemmas that touch on diversity, systems change, educators' roles, professional competencies, and leadership roles. pre-req: MEd cand or instructor consent; credit will not be granted if already received for EHS 7006

**EDUC 7008. Foundations of Teaching and Learning: Curriculum Theory and Design.** (; 3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Broad-based foundational course designed to study advanced learning theory and curriculum design, and develop skills in critical analysis of teaching application and student outcomes. Focuses on the importance of working in the context of a professional community. pre-req: MEd student or instructor consent; credit will not be granted if already received for EHS 7008

**EDUC 7009. Assessment of Learning.** (; 3 cr. [max 12 cr.]; A-F or Audit; Periodic Fall, Spring & Summer)

Focuses on the design and application of appropriate learning assessment strategies that consider the pedagogical intent, state, federal, and subject standards, and the diversity for all learners. Teaching theory and practice will be viewed in the context of learning assessment. prereq: MEd candidate; credit will not be granted if already received for EHS 7009

**EDUC 7011. Integrated Research in Practice.** (; 3 cr. ; A-F or Audit; Every Fall & Spring)

Provides in depth knowledge and skills in quantitative, qualitative and mixed methods research methodology, and is designed to guide students through the process of designing and conducting a scholarly research project. prereq: 7004 or instructor consent

**EDUC 7016. Qualitative Methods for Educational Research.** (; 3 cr. ; S-N or Audit;

Every Fall, Spring & Summer)

The course is designed to assist MEd and other graduate students in the use of qualitative data collection, analysis, and reporting methods in qualitative and mixed methods designs for research in education and related fields. The course is student project based, providing students support in completing data collection and analysis for their capstone or thesis projects. Students will review multiple methods for data collection and analysis, with a

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primary focus on the methods identified in their own project design. pre-req: instructor consent

**EDUC 7018. Statistics for Educational Research.** (; 3 cr. ; S-N or Audit; Every Fall, Spring & Summer)

The course is designed to assist MEd and other graduate students in the use of quantitative data collection, analysis, and reporting in quantitative and mixed methods designs for research in education and related fields. The course is student project based, providing students support in completing data collection and analysis for their capstone or thesis projects. Students will review multiple methods for data collection and analysis, with a primary focus on statistical analysis for quantitative data identified in their own project design. prereq: instructor consent

**EDUC 7040. Principles of Adult Education.** (; 3 cr. ; A-F or Audit; Every Summer)

Philosophy and application of adult education principles.

**EDUC 7130. Indigenous Knowledge and Worldview.** (; 2-3 cr. ; A-F or Audit; Periodic Summer)

This course focuses on how different Indigenous peoples know and learn about the world. The diverse metaphysical experiences of various tribal peoples are explored as a means of demonstrating the range of beliefs and ways of knowing within Indigenous life. Perspectives on language, experience, and philosophical views of language, culture, and land are considered with respect to both contemporary and traditional environments. Indigenous research paradigms and methodologies are explored as a means of helping students contextualize research interest. prereq: grad student

**EDUC 7150. Culturally Based Education.** (; 2-3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Explores the historic, social, cultural, and political-legal contexts of the education of Native American peoples in the United States and the developing role of culturally based curricular, pedagogical, and educational development strategies for Native American students, communities, and tribal societies. Examines theoretical approaches and research on the role and impact of culturally based education on academic and social cultural outcomes for Native American learners and communities. pre-req: grad student

**EDUC 8001. Historical, Social, and Philosophical Foundations of Education.** (; 3 cr. ; A-F only; Summer Even Year)

Survey of the historical, social, and philosophical issues in education, in order to prepare and build a foundation for doctoral level students in education. prereq: Ed.D. majors or instructor consent

**EDUC 8016. Theory and Practice of Qualitative Research Methods.** (; 3 cr. ; A-F only; Fall Even Year)

Qualitative research traditions and methods, and practice with the skills and attitudes necessary to successfully conduct qualitative research. prereq: 8015 or equivalent, Ed.D. majors or instructor consent

**EDUC 8020. Doctoral Seminar.** (; 1 cr. [max 6 cr.]; S-N only; Every Fall, Spring & Summer)

Review of current research around best practices, or focused strategies for progression with the program or the dissertation. prereq: Ed.D. majors

**EDUC 8444. FTE: Doctoral.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Doctoral student, adviser and DGS consent

**EDUC 8666. Doctoral Pre-Thesis Credits.** (; 1-6 cr. [max 12 cr.]; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Max 6 cr per semester or summer; doctoral student who has not passed prelim oral; no required consent for the first two registrations up to 12 cr; departmental consent for the third and fourth registrations up to an additional 12 cr, or 24 cr total (for doctoral students admitted summer 2007 and beyond; doctoral students admitted prior to summer 2007 may register up to 4 times totaling 60 cr)

**EDUC 8888. Thesis Credit: Doctoral.** (; 1-24 cr. [max 100 cr.]; No Grade Associated; Every Fall, Spring & Summer)

(no description) prereq: Max 18 cr per semester or summer; 24 cr required

**EDSE 5000. Introduction to Post-Secondary Teaching.** (; 2 cr. ; A-F or Audit; Every Fall)

Introduction to Teaching will provide a brief overview of learning theory, student and teacher expectations, development of a syllabus, lesson planning goals, rubrics, assignments, student evaluation/assessment,

how to submit grades, online teaching using electronic course platforms, classroom management and other topics pertinent to teaching adult learners. This class will provide support for new graduate teaching assistants and new faculty at community colleges. prereq: grad student or community college faculty

**EDSE 5204. Designing Learning Environments.** (; 3 cr. ; A-F or Audit; Every Fall & Spring)

A comprehensive course that describes the characteristics of effective teachers, introduces teaching strategies using the Universal Backward Design framework, how to design effective learning environments, how to develop goals and action plans, manage data, review student work, plan lessons, and teach with technology. prereq: Grad student or new faculty at a community college; instructor consent

**EDSE 5255. Teaching Science Grades 5 - 12.** (3 cr. ; A-F or Audit; Every Spring)

The course serves to help teacher candidates focus on important elements to teaching of science in secondary and post-secondary education settings. Topics include: historical development of science education, goals and purposes of science education in secondary schools and post-secondary education settings; inquiry, methods and materials' evaluation procedures; current trends; and compare adolescent learning to adult learning of science education. prereq: 5000, 5204, 5501, 5525

**EDSE 5501. Adolescent/Adult Development and Learning Theory.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Principles of psychology applied to teaching; examination of adolescent growth and development and classroom management. Graduate students will include adult learning theory in terms of growth and development and how to organize and manage post-secondary classroom. prereq: Grad student or faculty at post-secondary institution or instructor consent

**EDSE 5525. Assessment for Secondary Education.** (; 3 cr. ; A-F or Audit; Every Fall & Spring)

An exploration of topics in responsive and responsible assessment of student learning. Topics include types and appropriate uses of classroom assessment strategies, large scale and high stakes testing, backwards design, rubrics, checklists, and other evaluative tools and techniques. Graduate students will complete an adult based project to develop a model of assessment to measure adult learners

in their classes. prereq: graduate student, faculty at community college or instructor consent

**EDAD 5911. Leadership and Personal Growth.** (; 3 cr. ; A-F or Audit; Every Summer)  
An overview of leadership from a theoretical perspective. Learners will begin to see the role and styles of leadership in relationship to the culture of schools and communities. prereq: EdAd lic program or collegiate grad program admission or instructor consent

**EDAD 5912. Supervision of Teachers and**

**School Staff.** (; 3 cr. ; A-F or Audit; Every Fall)  
Includes applications and philosophies of supervision of teachers/principals, staff development, motivation, attention to diversity, evaluation, MN teacher tenure rules and process for hiring and for dismissal, interpersonal communications, and human resource management. prereq: EdAd lic program or collegiate grad program admission or instr consent; no Grad School cr

**EDAD 5913. Communication and Community Relations.** (; 3 cr. ; A-F or Audit; Every Summer)  
Schools' public and media relations, communication needs of internal/external

publics, processes to solicit support for initiatives, review of crises plans. prereq: EdAd lic program or collegiate program admission or instructor consent

**EDAD 5914. Education Policy.** (; 3 cr. ; A-F or Audit; Every Spring)  
Decision-making and school governance based on current laws and mandates. Rules, reporting, and regulations governing private, public, parochial, BIE, Community Education, and Alternative schools will be studied including special education, data privacy,

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right to know, liability. Tribal school policy and relations with independent districts will be examined. prereq: EdAd lic program or collegiate graduate program admission instr consent; no Grad School cr

**EDAD 5915. Operations Resource Management and Scheduling in Education.** (; 3 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Focus on skills, knowledge and dispositions that enable administrators to plan and schedule work in ways that ensure that resources are used appropriately and goals are met. prereq: EdAd lic program or collegiate graduate program admission or instr consent; no Grad School cr

**EDAD 5916. Curriculum and Instruction and Assessment.** (; 3 cr. ; A-F or Audit; Every Fall)  
Overview of curriculum design. Both traditional and backwards design with practice in mapping, scope and sequence, large-scale testing, assessment of individual and systemic growth, early child education, and providing opportunities for all students. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5917. EdAd Technology Seminar.** (; 1 cr. [max 10 cr.]; S-N or Audit; Every Summer)  
Showcases school management systems and innovation in educational technology, research in area schools, and current trends in leadership and educational administration.

**EDAD 5918. Continuous Improvement Processes for Schools.** (; 3 cr. ; Student Option; Every Summer)  
Examines effective data-driven continuous improvement best practices in schools. Learners will examine strategic planning, accreditation processes, state and federal accountability, AYP, reporting in order to continue funding flow and establishment of effective leadership terms. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5919. Superintendency.** (; 3 cr. ; A-F or Audit; Every Fall)  
Examine the level of decision making that differentiates district administration and responsibility unique to the position including creating district level mission, vision, and strategic planning; contract negotiation; working with local, state, and federal agencies,

program coordination at all levels, school board relations, and clear establishment of expectations. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5920. Problem Solving for Principals: Student Discipline and Behavior Management.** (; 3 cr. ; A-F or Audit; Every Fall)

Case-study based course will examine theories of behavior management and evaluate the effectiveness of discipline approaches through lenses of development, culture, leadership styles and legal aspects of discipline for all students. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5921. Principalship.** (; 3 cr. ; A-F or Audit; Every Fall)  
Orients individuals to the responsibilities of the principal's positions in schools and districts. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5922. Problem Solving for Superintendents.** (; 3 cr. ; A-F or Audit; Every Summer)

Presents solutions and pathways for superintendents, including labor relations, contract negotiations, bonds and referenda, policy creation and relationships with school boards and communities. prereq: EdAd lic program or collegiate grad program admission or instructor consent

**EDAD 5923. Field Exploration.** (; 2 cr. ; S-N only; Every Summer)

Candidates for licensure as educational administrators will experience working in school systems that do not follow the traditional American model of delivery of programs and instruction. Travel is required and 20 hours of internship will be coordinated through the office of the Educational Administration Program Coordinator. prereq: EdAd lic program or collegiate grad program admission or instructor consent

**EDAD 5997. Professional Competency Assessment: Principals.** (; 1 cr. ; A-F or Audit; Every Fall)  
Capstone for the educational administrative program for principals. Learners will complete an electronic portfolio which includes valid evidence of competency for each core leadership and principal's competencies required for certificate approval. Candidates

will prepare for final panel presentations. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EDAD 5998. Professional Competency Assessment: Superintendents.** (; 1 cr. ; A-F or Audit; Every Fall)

Learners will complete an electronic portfolio which includes valid evidence of competency for each Core Leadership and Superintendent's Competencies required for certificate approval. Candidates will prepare for final panel presentations. prereq: EdAd Lic program or collegiate graduate program admission or instructor consent

**EDAD 6990. Internship in Teaching for Administrators.** (; 3 cr. [max 9 cr.]; A-F or Audit; Every Fall & Spring)

Intended to assist the candidate in meeting the requirements of the Rules of the MN State Board of Education, Chapter 352.0700 ADMINISTRATIVE LICENSURE WITHOUT TEACHING EXPERIENCE. Subp. 3a. Teaching knowledge and skills. An applicant shall demonstrate basic teaching knowledge and skills as required by part 8710.2000. prereq: Admission to the Ed Ad program

**EDAD 6997. Internship: Principals.** (6 cr. ; S N only; Every Fall)

To place the candidate for licensure with practicing, licensed principals for a minimum of 320 total hours. Candidates must serve 80 hours of internship with a mentor and students that are not at the level of the candidate's teacher licensure. prereq: EdAd lic program or collegiate graduate program or instructor consent

**EDAD 6998. Internship: Superintendents.** (; 6 cr. ; S-N only; Every Fall)

Candidates for licensure will be working with a practicing, licensed superintendent for a minimum of 320 total hours. University of Minnesota Duluth candidates are also encouraged to serve additional hours in a situation of alternative delivery. prereq: EdAd lic program or collegiate graduate program admission or instructor consent

**EE 5151. Digital Control System Design.** (; 3 cr. ; A-F or Audit; Periodic Spring)

Digital control system characteristics: transient and steady-state responses, frequency response, stability. Digital control system



design using transform techniques.

Controllability and observability. Design of digital control systems using state-space methods: pole placement and observer design, multivariable optimal control. Implementation issues in digital control prereq: 3151; credit will not be granted if already received for 4151

**EE 5161. Linear State-Space Control Systems.** (3 cr. ; A-F or Audit; Fall Even Year) State space representations of control systems and analysis and design. Stability, controllability, observability, realizations, state estimator or observer design and state feedback design. pre-req: 3151 or instructor consent

**EE 5311. Design of Very Large Scale**

**Integrated Circuits.** (4 cr. ; A-F or Audit; Every Fall)

Philosophy of and techniques for designing VLSI circuits in CMOS technology. Full-custom and semi-custom design techniques for VLSI circuits. Digital, analog and mixed-signal VLSI circuits and systems. Substantial design project required. (3 hrs lect and 3 hrs lab). pre-req: EE 2212 or grad student

**EE 5315. Multiprocessor-Based System Design.** (3 cr. ; A-F or Audit; Periodic Fall) Parallelism, interconnection networks, shared memory architecture, principles of scalable performance, vector computers, multiprocessors, multicomputers, dataflow architectures, and supercomputers. pre-req:

2325; credit will not be granted if already received for 4315

**EE 5351. Introduction to Robotics and Mobile Robot Control Architectures.** (3 cr. ; A-F or Audit; Periodic Spring) Basic concepts and tools for the analysis, design, and control of robotic mechanisms. Topics include basic robot architecture and applications to dynamical systems, mobile mechanisms, kinematics, inverse kinematics, trajectory and motion planning, mobile robots, collision avoidance, and control architectures. pre-req: 3151

**EE 5477. Antennas and Transmission Lines.** (3 cr. ; A-F or Audit; Periodic Spring)

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Theory and performance of antennas and transmission lines. Topics: Allocation of RF spectrum, radiation theory, EM wave propagation, ground effects, interference, antenna performance metrics, transient and sinusoidal transmission line behavior, bounce diagrams, Smith chart, waveguide theory, modeling with the numerical electromagnetics code (NEC), unlicensed wireless applications, specific antenna designs and applications, class demonstrations. pre-req: 3445; credit will not be granted if already received for 4477

**EE 5479. Antennas and Transmission Lines Laboratory.** (1 cr. ; A-F or Audit; Every Spring)

This laboratory course provides hands-on experience with designing, constructing, and measuring the performance of radio frequency (RF) antennas and transmission lines. Concepts include velocity factor, propagation factors, characteristic impedance, tuning stubs and matching sections, resonance, parasitic elements, gain, directivity, return loss and RF safety. This course supports the theory presented in EE 5477 (Antennas and Transmission Lines) and is optional for those enrolled in or having completed EE 5477. pre-req: 5477 pre or co-req

**EE 5501. Energy Conversion System.** (3 cr. ; A-F or Audit; Every Fall)

Theory, design and operation of conventional and alternative electrical energy conversion systems. Carbon dioxide cycle, Earth/Sun radiation balance, and environmental impacts. Power delivery systems and integration of conversion systems with the grid. Development of generation portfolios. Impact of energy policies and current energy issues. Case studies. pre-req: Chem 1151 or 1153 and 1154

**EE 5522. Power Electronics I.** (; 3 cr. ; A-F or Audit; Every Spring)

Power semiconductor devices; traditional power converters; ac-dc converters: half-wave and full-wave rectifiers; dc-dc converters: traditional and transformer derived choppers; dc-ac converters: single-phase and three phase inverters; ac-ac converters; pulse-width modulation; applications. pre-req: 3235

**EE 5533. Grid- Resiliency, Efficiency and Technology.** (3 cr. ; A-F or Audit; Every Fall) Concepts and architecture of grid, smart grid

and microgrid; resiliency under physical and cyber attacks; grid efficiency via sensors, networks and control; technology including standards and protocols for cybersecurity and protection of the grid; case studies and testbeds. pre-req: 2006 or instructor consent

**EE 5611. Microelectronics Technology.** (; 3 cr. ; A-F only; Periodic Fall)

Various fabrication processes in silicon based microelectronic circuits and devices: lithography, oxidation, diffusion, thin film deposition, etching and integration of various technologies; material defects analysis and device characterization skills; design of fabrication process with SUPREME IV simulator; fabrication technologies involved in other devices: optical devices, MEMS and semiconductor nanostructures. pre-req: 3235

**EE 5741. Digital Signal Processing.** (3 cr. ; A-F or Audit; Periodic Spring)

Discrete linear shift-invariant systems, z- & Fourier transform, sampling, discrete time processing of signals, reconstruction of analog signals, filters and filter structures in direct, parallel, and cascaded forms, FIR & IIR digital filter design, impulse-invariant, bi linear transform & window functions, FFT, introduction to image processing. pre-req: 2111; credit will not be granted if already received for 4741

**EE 5742. Pattern Recognition and Machine Learning.** (4 cr. ; A-F or Audit; Fall Even, Spring Odd Year)

Various methods of pattern recognition, non parametric techniques, linear discriminant functions, support vector machines, statistical classification, min-max procedures, maximum likelihood decisions and case studies. pre-req: STAT 3611, senior or graduate standing in science or engineering or instructor consent; some basic concepts in linear algebra and probability theory.

**EE 5745. Medical Imaging.** (; 3 cr. ; A-F or Audit; Spring Odd Year)

Introduction to the methods and devices for medical imaging, including x-ray imaging, x-ray computer tomography (CT), nuclear medicine (single photon planar imaging, single photon emission computer tomography (SPECT), and positron emission tomography (PET), magnetic resonance imaging (MRI), and ultrasound imaging. The physics and design of systems, typical applications, medical image

processing, and tomographic reconstruction. pre-req: EE (ECE) 2111, Math 3298 or instructor permission

**EE 5765. Modern Communication.** (4 cr. ; Student Option; Every Fall)

Design and analysis of modern communication systems; evaluation of analog and digital modulation techniques. (3 hrs lect, 3 hrs lab) pre-req: 2111; credit will not be granted if already received for 4765

**EE 5801. Introduction to Artificial Neural Networks.** (3 cr. ; A-F or Audit; Periodic Fall)

General techniques and theory of neural networks, their applications and limitations. The course particularly addresses the design issues and learning algorithms for diverse areas of applications. pre-req: CS 1521, Math 3280, Stat 3611 or instructor consent; credit will not be granted if already received for 4801

**EE 5995. Special Topics: (Various Titles to be Assigned).** (; 1-3 cr. ; A-F or Audit; Periodic Fall & Spring)

Current problems and research. Discussions, selected reading, and/or invited speakers. pre-req: instructor consent

**EE 8001. Graduate Professional Communication Seminar.** (1 cr. ; S-N or Audit; Every Fall)

The course will help students to improve oral and written technical communication skills needed by electrical engineering professionals. The course is a required course for MSEE degree. The course includes lectures on oral and written professional communications, instructions on resume writing, attending graduate seminars and giving technical presentations. During the course, the student will submit a written and oral technical report and receive feedback from the instructor and/or an instructor from the Communication and/or Writing departments at UMD. pre-req: graduate student

**EE 8151. Optimal Control Systems.** (; 3 cr. ; A-F or Audit; Fall Odd, Spring Even Year)

Calculus of variations. Pontryagin minimum principle. Linear quadratic optimal control. Dynamic programming, Hamilton-Jacobi Bellman equation. Constrained optimal control. Linear Quadratic Gaussian control. Kalman filter. pre-req: EE 5161; instructor consent

**EE 8222. Master's Plan B Research and**

**Design Project.** (1-3 cr. ; S-N only; Every Fall & Spring)

Provides ECE Plan B graduate students with experience in applying research, analysis, and design skills to a project of current interest to industry. Through the chosen project, the student should demonstrate the ability to achieve results in a fixed time frame and present the results to the department orally and via a technical report. prereq: Graduate student, instructor consent; credit will not be granted if already received for 8777

**EE 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Periodic Fall & Spring)  
(No description) prereq: Master's student, advisor and DGS consent

**EE 8741. Digital Image Processing.** ( ; 4 cr. ;

A-F or Audit; Fall Odd Year)

Mathematical foundations and practical techniques to process and manipulate images. Students will acquire the ability to analyze two dimensional images, dealing with mathematical representation of images, image sampling and quantization, Image Transforms, Image Enhancement, Image Restoration, Image Coding, Edge Detection, Texture Analysis, and Compression. prereq: 4741

**EE 8765. Digital Communications.** (3 cr. ; A F or Audit; Spring Even Year)

Overview of digital data transmission, performance analysis of digital modulation, quadrature multiplexed signaling schemes, signal-space methods in digital data transmission, information theory and block coding, convolutional coding, repeat-request

system, spread-spectrum systems, satellite communications. prereq: 5765

**EE 8777. Thesis Credits: Master's.** ( ; 1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall & Spring)

(No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**EMGT 5110. Management of Engineers and Technology.** ( ; 3 cr. ; A-F only; Fall Even Year)

Managing the synergism of people and technology. Overview of management

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functions, tools, methods. Planning, organization, leadership, motivation, control, quality, human resources, effective decision making. prereq: EMgt student or department approval

**EMGT 5120. Advanced Project Management.** ( ; 3 cr. ; A-F only; Spring Odd Year)

The course discusses the project life cycle, the project management process, and the skills of a project manager. The traditional approach to project management and modern approaches to project management under uncertainty including Critical Chain Project Management and Agile Project Management will be both covered. prereq: EMgt student or department approval

**EMGT 5130. Operations Modeling and Analysis.** ( ; 3 cr. ; A-F only; Spring Even Year)

This course will prepare students to analyze, formulate, and solve optimization problems under different conditions to facilitate managerial decision-making. Topics covered include data collection, linear programming, network analysis, integer linear programming, goal programming, multi objective programming, nonlinear programming, and their application in the field of engineering and technology management field. Communicating results from quantitative analysis in an effective manner will also be covered. prereq: EMgt student or department approval

**EMGT 5160. Quality Management.** ( ; 3 cr. ; A-F only; Fall Odd Year)

Global competitiveness, organizational culture, management role responsibilities, concepts for customer value, strategic management, measurement of customer value, organizing to improve systems, employee involvement, culture change and organizational learning. ISO 9000, quality awards. prereq: EMgt student or department approval

**EMGT 5220. Innovation Management.** ( ; 3 cr.

; A-F only; Periodic Fall & Spring) Key success factors of technological innovation will be identified by looking at the diverse economic, social, cultural, psychological and technical phenomena that comprise innovation. Questions that will be answered include why certain inventions successfully make it to the

market but some others died; why some organizations keep coming up with innovations with tremendous business value but some others stay as followers; how to enhance creativity at individual, team, organizational, and national levels; what the emerging trend is in today's business innovation environment and how organizations should cope with it, etc. prereq: EMgt student or department approval

**EMGT 5230. Technical Forecasting.** (3 cr. ; A-F only; Spring Even Year)

Statistical review, data sources, choosing a forecasting technique, moving averages, smoothing, regression analysis, time series analysis, the Box-Jenkins (ARIMA) methodology. prereq: EMgt Student or department approval

**EMGT 5240. Advanced Operations Management.** (3 cr. ; A-F only; Every Spring)

Emphasis on quantitative methods for designing and analyzing manufacturing and service operations, simulation, and recent paradigms in manufacturing including just-in-time production, synchronous manufacturing, and agile manufacturing. Current competitiveness-enhancing techniques like continuous improvement, benchmarking, and business process re-engineering will also be covered. prereq: EMgt student or MBA student or department approval

**EMGT 5250. Legal, Ethical and Environmental Issues in Engineering.** (3 cr. ; A-F only; Fall Even Year)

Covers topics in basic law, contracts, intellectual property, professional ethics, the responsible engineer, moral thinking, risk/safety/liability, employer responsibilities, product liability, and environmental responsibilities. Provides a historical perspective on society's environmental concerns, and discusses federal environmental statutes, our regulatory system, approaches to preventing and mitigating environmental problems, and the elements of an effective environmental management system. prereq: EMgt student or engineering candidate or department approval

**EMGT 5260. Advanced Decision Making for Engineering Managers.** ( ; 3 cr. ; A-F or Audit; Spring Even Year)

This course introduces students to a variety of

tools that help them sharpen the judgment and improve the decision making process. The rational basis behind decisions under certainty, uncertainty, risk and conflicts will be evaluated. The analytical approach to decision making will be presented by combining the qualitative and quantitative aspects of management decisions. Mathematical foundations for conflict resolution in multi-criteria decision making will be introduced. Quantification of subjective judgment, the development of Hierarchical Decision Models and their sensitivity analysis will be covered. Methods to measure inconsistencies in individual and group decisions will also be discussed. prereq: EMGT student or departmental consent

**EMGT 5991. Independent Study in Engineering Management.** (1-4 cr. [max 6 cr.] ; Student Option; Every Fall, Spring & Summer)

Directed study of special interest topics not available in standard curriculum. Must be arranged with instructor before registration. May include readings, research and/or special projects. prereq: MSEM cand, department approval

**EMGT 8310. Project Methodology and Practice.** (3 cr. ; A-F only; Every Fall & Spring)

Applying research, analysis, and management skills to a topic or situation of current interest to industry. Demonstrating the ability to achieve results in a fixed time frame with limited resources. prereq: 5110, 5120, 5130, 5160

**EMGT 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Periodic Fall & Spring)  
(No description) prereq: Master's student, advisor and DGS consent

**EMGT 8777. Thesis Credits: Master's.** ( ; 1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer)  
(No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**EMGT 8993. Engineering Management Seminar.** (1 cr. [max 2 cr.] ; S-N only; Every Fall & Spring)

Reports on recent developments in engineering management and on research projects in the department. prereq: Grad student, department approval

**EMGT 8994. Directed Research.** (1-8 cr. ;

Student Option; Every Fall, Spring & Summer)  
Directed research or study on an advanced topic. prereq: MSEM or grad student, department approval

**ENGL 5097. Graduate Internship.** (; 1-3 cr. ; S-N only; Every Fall, Spring & Summer)  
Supervised practical experience in an approved business, agency, or organization seeking student interns with strong skills and/or knowledge in English. Placement is in a variety of work fields including publishing, museumship, librarianship, theatre and public service. prereq: 8906, instructor consent

**ENGL 5116. Advanced Writing of Fiction.** (; 4 cr. [max 8 cr.] ; A-F or Audit; Periodic Spring)

Writing of original fiction beyond the beginning stages; some experience required.  
prereq: instructor consent

**ENGL 5122. Advanced Writing of Poetry.** (4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall & Spring)

Study of poetics and poetry, with emphasis on student poems. prereq: 3121 or instructor consent

**ENGL 5222. Shakespeare.** (4 cr. ; A-F or Audit; Periodic Fall)

Concentrated study of selected plays, with attention to Shakespearean criticism and scholarship. Recommended as the second course in Shakespeare. prereq: 6 credits literature

**ENGL 5270. Digital Literature, Video Games and Online Culture.** (; 4 cr. ; A-F or

Audit; Spring Odd Year)

Introduction to the genres and history of digital literature, and to the literary dimensions of online games, social media, and other network forms. Students will learn the theories, tools, and practices of digital literary study and criticism. pre-req: 8 credits of literature preferred

**ENGL 5295. Special Topics in Early Period Literature (Various Titles to be Assigned).** (; 4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)

Topics in early period literature (pre-1800 for British and global literatures, and pre-1865 for American literature) that are not included in regular curriculum.

**ENGL 5312. Chaucer.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Courses listed in this catalog are current as of 2020-09-08. For up-to-date information, visit [www.catalogs.umn.edu](http://www.catalogs.umn.edu). 17

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Introduction to Middle English. Reading and analysis of Chaucer's works, primarily Canterbury Tales and Troilus and Criseyde. prereq: 6 credits literature

**ENGL 5375. Modern Poetry.** (4 cr. ; A-F or Audit; Periodic Spring)

Study of modern poetry written in English. prereq: 6 credits literature

**ENGL 5395. Special Topics in Late-Period Literature (various titles to be assigned).** (; 4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)

Topics in later-period literature (post-1800 for British and global literature and post-1865 for American literature) that are not included in regular curriculum.

**ENGL 5444. Childhood in Literature, History and Culture.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Examines traditional kinds of children's literary texts, as well as literary and pedagogical theory, advertising, movies, and television to consider childhood as an historical, aesthetic and social construct in Western culture from the eighteenth century to the present. prereq: Junior or senior or grad student or instructor consent

**ENGL 5495. Special Topics in Genre and Media Studies (various titles to be assigned).** (; 4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)

Topics in genre and media studies that are not included in the regular curriculum.

**ENGL 5533. Studies in English Literature Before 1800.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Intensive study of a theme, literary school or circle, literary genre in historical and cultural context. Topics vary. prereq: 6 credits literature

**ENGL 5541. Restoration and 18th-Century Literature.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Study of controversies and cultural change evident in English literature, 1660-1800. Such authors as Dryden, Behn, Pope, Fielding, Johnson prereq: 6 credits literature

**ENGL 5562. Studies in 19th-Century British Literature.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Advanced study of British literature and culture of the Romantic and Victorian periods. Authors and historical focus will vary according to instructor interest.

**ENGL 5564. Studies in British Literature after 1900.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Advanced study of British literature written after 1900. Topic, genre, and historical focus vary according to instructor interest. pre-req: none

**ENGL 5572. American Renaissance.** (4 cr. ; A-F or Audit; Periodic Fall)

American Romanticism and the flowering of American literature from early 19th century to the Civil War (authors and topics vary; e.g., Thoreau, Fuller, Hawthorne, Dickinson, Whitman). prereq: 6 credits literature

**ENGL 5574. Studies in American Literature to 1914.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Study of selected North American authors from the Colonial Era to the end of WWI. Literature studied will vary in relation to what kind of literary or cultural study instructor intends or what kind of critical approach to literature is used. prereq: 6 credits literature

**ENGL 5575. Studies in American Literature after 1914.** (4 cr. ; A-F or Audit; Every Fall & Spring)

Study of selected North American authors after 1914. Literature studied will vary in relation to what kind of literary or cultural study instructor intends or what kind of critical approach to literature is used. prereq: 6 credits literature

**ENGL 5577. Major American Authors.** (4 cr. [max 8 cr.] ; A-F or Audit; Every Fall & Spring)  
Concentrated study in one to three authors, who are announced before course is offered. prereq: 6 credits literature

**ENGL 5580. The Novel.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Explores the novel in its cultural, intellectual, and aesthetic contexts. Topics addressed may include issues of authorship, print culture and the literary marketplace, narrative style, and how what we think of as "the novel"

has changed over time and in various parts of the world. Authors and topics vary. pre-req: Preferred 6 credits in ENGL or instructor consent

**ENGL 5584. Mapping Postcolonial Literature.** (; 4 cr. ; A-F or Audit; Spring Odd Year)

Interdisciplinary study of postcolonial literatures of Africa, Asia, and Latin America in their cultural and historical contexts. Critical examination of the postcolonial condition, including colonial constructions of knowledge and power and anti-colonial struggles against subordination. Exploration of key concepts, geography, history, theory, and future of postcolonial studies. prereq: minimum 6 credits of Literature

**ENGL 5591. Independent Study.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)

Students choose projects in consultation with their instructor. prereq: instructor consent; maximum 6 credits may be applied to grad program

**ENGL 5595. Special Topics: (Various Titles to be Assigned).** (; 4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer)  
Topics not included in regular English curriculum. prereq: Primarily for majors, minors, or graduate students

**ENGL 5661. Publishing the Middle Ages.** (4 cr. ; A-F or Audit; Periodic Fall)

Study of the ways in which the middle ages were defined and canonized in print culture. Instruction on the processes of medieval manuscript production and editing, followed by analysis of rhetorical framework within which "medievalism" was constructed in the 19th century. prereq: Junior or senior or grad student or instructor consent

**ENGL 5662. The Making of a Major Author: The Scholarly Edition in 17th- and 18th Century England.** (4 cr. ; A-F or Audit; Periodic Fall & Spring)

Study of the ways in which writers such as Shakespeare and Milton were transformed into "major authors" and "national poets" through the publication of scholarly editions of their works subsequent to their deaths. Textual analysis of the editions is combined with study of their publication histories, including the roles

of editors and publishers who produced them. prereq: Junior or senior or grad student or instructor consent

**ENGL 5663. Readers and the History of Books.** (4 cr. ; A-F or Audit; Periodic Fall) History of reading, primarily in the United States and England. Study of factors affecting literacy in late 18th through early 20th centuries, including technological advances, educational reform and changes in authorship and literature. prereq: Junior or senior or grad student or instructor consent

**ENGL 5665. The American Literary Marketplace.** (4 cr. ; A-F or Audit; Spring Odd Year)

Study of the making, marketing, and selling of American literature. Close attention to history of American publishing industry, emergence of popular genres such as the romance and popular forms such as the dime

novel, and material and technological changes in book production. prereq: Junior, senior or graduate student or instructor consent

**ENGL 5802. English Language for Educators.** (4 cr. ; A-F or Audit; Every Fall) Application of linguistic and language learning theories to the teaching of communication arts, with emphasis on preparation of secondary school English teachers. Includes a focus on first and second language acquisition, approaches to language and grammar instruction, and the roles of language and dialect in culture and youth development. prereq: graduate student; credit will not be granted if already received for ENGL 4802

**ENGL 5821. History of the English Language.** ( ; 4 cr. ; A-F or Audit; Every Fall) History of sounds, word stock, and structures of English language from earliest

records to present.

**ENGL 5902. Teaching Writing.** (4 cr. ; A-F only; Every Fall) Theory and practice of teaching composition. Includes cognitive theories of the composition process, teaching, and writing across genres and purposes, and assessment of writing. For prospective teachers, grade 5 to community college level. prereq: graduate student or instructor consent; credit will not be granted if already received for ENGL 4902

**ENGL 8094. Plan B Research (DRS).** (1 cr. [max 3 cr.] ; S-N only; Every Fall & Spring) Directed research to complete Plan B Project as required by the English MA program. prereq: instructor consent

**ENGL 8171. Seminar in Pre-1800 British Literature.** ( ; 4 cr. ; A-F or Audit; Periodic Fall & Spring)

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Selected topics in the study of British literature written prior to 1800. prereq: Graduate Student

**ENGL 8181. Seminar in British Literature, Late 18th - 20th Century.** ( ; 4 cr. ; A-F or Audit; Periodic Fall & Spring) Graduate seminar on selected topics in the study of British literature written from the late 18th century through the 20th century.

**ENGL 8191. Seminar: American Literature.** ( ; 4 cr. ; A-F or Audit; Periodic Fall & Spring) Intensive study of selected authors and topics announced ahead of time; historical, cultural, and literary contexts; methodology; relevant scholarship and criticism.

**ENGL 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Every Fall & Spring) (No description.) prereq: Master's student, adviser and DGS consent

**ENGL 8444. FTE: Doctoral.** ( ; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: doctoral student, adviser and DGS consent

**ENGL 8888. Thesis Credits: Doctoral.** (1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: [max 18 credits per semester or summer]; 24 credits required

**ENGL 8906. Introduction to Critical Theory.** ( ; 4 cr. ; A-F or Audit; Every Fall) Core course required for all English M.A. (Plan B) students. Seminar in critical theory and methods of literary research. prereq: Grad Student

**ENGL 8931. Practicum in Teaching Literature.** (1-4 cr. ; A-F or Audit; Every Fall & Spring) Teaching in sophomore literature courses; experience preparing supplementary materials, consulting with students, and assisting instructors in grading student work. prereq: 8 credit grad-level literature or instructor consent

**ENED 5100. Research Design and Methods in the Social Sciences.** (3 cr. ; A-F or Audit; Every Fall)

An overview of the designs, methods, and processes used in social science research. Course content includes the following topics: Developing a purpose statement and research questions; conceptualization, operationalization, and measurements of variables' choosing and using human research subject; experimental research' survey research prereq: graduate student or instructor consent

**ENED 5163. Outdoor Education Methods.** ( ; 3 cr. ; A-F or Audit; Every Fall) Methods and theoretical basis for teaching outdoor education. Emphasis on application at outdoor sites. Weekend experience at a regional nature center required prereq: MEd candidate or instructor consent

**ENED 5164. Environmental Education In Service Training.** (0.5-10 cr. ; A-F or Audit; Periodic Fall) Environmental education methods, materials, and curricula for educators wishing to enhance their environmental education training. prereq: instructor consent; credit will not be granted if already received for Educ 5164

**ENED 5165. Theories and Models in Outdoor Education.** (2 cr. ; A-F or Audit; Every Fall) Overview of theoretical foundations of outdoor education. Definitions of terms related to outdoor education, historical antecedents, future adventure education, social and psychological benefits of outdoor education. prereq: instructor consent; credit will not be granted if already received for Educ 5165

**ENED 5325. Sustainability Issues Investigation.** (2 cr. ; A-F or Audit; Every Spring) The study of resolving environmental problems that affect sustainability. This includes issue identification; building an effective team of investigators; and, study of the issue to the point of making recommendations to resolve the issue of sustainability management and education.

**ENED 5343. Advanced Field Interpretive Techniques.** (3 cr. ; A-F or Audit; Every Summer) Techniques and methods used to interpret the natural and cultural history of unique field sites; For example, Isle Royale National Park. Specific, in-depth topics of natural and cultural history will be emphasized. Techniques for field site investigation and field based interpretation as an educational approach will be investigated. prereq: ENED 3341 or ENED 3342 or instructor consent

**ENED 5560. Current Research and Issues.** (3 cr. ; A-F or Audit; Every Spring) Examines research literature and related issues pertaining to outdoor education including disciplines of science, environmental experiential, and adventure education. Trends in research, teaching, plus research design and methods. prereq: grad student or instructor consent

**ENED 5565. Young Children, Nature, and Sustainability.** (3 cr. ; A-F or Audit; Every Spring) Focus on education for sustainability in an early childhood (infant-preschool age) context. Study of rational for merging education for sustainability and early childhood education, as well as recommended practices and possibilities for doing so. Also emphasized are skills for developing and implementing developmentally appropriate learning experience that support health development of young children and further education for sustainability goals. pre-req: graduate or post-baccalaureate student; credit will not be granted if already received for ENED 4565

**ENED 5625. Program Development and Evaluation.** ( ; 3 cr. ; A-F or Audit; Every Spring) A comprehensive approach to program development will be applied to youth-based environmental education programs. Course is designed for those working in supervisory capacities to gain skills in designing, implementing, and evaluating environmental education programs.

**ENED 5800. Sustainability Education:**

**Methods and Strategies.** (3 cr. ; A-F or Audit; Every Summer)

Methods and lesson strategies connected to current definitions, theories, and practices of teaching sustainability practices and management. Sustainability of the natural environment from the effects of outdoor education and nature-based tourism is an underestimated aspect of sustainability practices. Pedagogical approaches to teach sustainable practices for the natural environment will be the primary focus of this course. Students will be able to apply this course to other sustainability practices such as sustainable energy or food practices. prereq: Minimum 60 credits or Environmental Education Certificate or Graduate student or instructor consent

**ENED 5850. Classroom Applications.** (2 cr. ; A-F or Audit; Every Fall)  
Understanding the formal classroom environment: scope and sequence,

management, assessment, and standards for applications pertinent to audience and setting in environmental education. prereq: MEd candidate or instructor consent

**ENED 5855. Programming for School Systems.** (3 cr. ; A-F or Audit; Every Spring)  
The relationship between environmental education and the formal school system (P-12) will be examined. Instructional approaches that use the environment as a context for helping students develop essential content and skills in the core academic disciplines will be emphasized. prereq: 5850, Educ 5850 or instructor consent

**ENED 5990. Research Project.** (1-6 cr. ; S-N only; Every Fall, Spring & Summer)  
Faculty-supervised research project required for MEd prereq: Instructor consent

**ENED 5991. Independent Study.** (1-6 cr. ; A F or Audit; Every Fall, Spring & Summer)  
Directed independent study or projects in a

particular area of interest. Approved degree program plan should be completed before course is taken by graduate students. prereq: Certificate or Masters Environmental Education student, instructor consent

**ENED 5992. Readings in Environmental Education.** (1-6 cr. ; A-F or Audit; Every Fall, Spring & Summer)  
Special complementary readings and discussion in advanced or graduate student's field of interest in environmental or outdoor education. Readings exceed the scope and/or offering of regular courses. prereq: Certificate or Master Environmental Education student or instructor consent

**ENED 5998. Outdoor Education Seminar.** (1 cr. [max 3 cr.] ; S-N or Audit; Every Fall & Spring)  
Facilitated discussions and presentations of contemporary recreation research, curricula, and/or issues. prereq: instructor consent, credit

Courses listed in this catalog are current as of 2020-09-08. For up-to-date information, visit [www.catalogs.umn.edu](http://www.catalogs.umn.edu). 19

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will not be granted if already received for Rec 4998

**ESCI 5201. Introduction to Watershed Hydrology.** (3 cr. ; A-F or Audit; Every Spring)  
This is an upper-division hydrology course covering the hydrologic cycle in the context of wildland watersheds. The course will cover the major components of the hydrologic cycle, including precipitation, snow hydrology, canopy interception, evapotranspiration, infiltration, soil water storage, runoff, streamflow and groundwater flow. The impacts of watershed management on water quantity and quality will be discussed using regional, national, and global examples, with an emphasis on solving real-world problems using hydrologic datasets. This course includes a 2-hour lab that meets once per week. pre-req: MATH 1290 or 1296 or grad student; no credit granted if already received for ESCI 4201

**ESCI 5450. Structural Geology.** (5 cr. ; A-F or Audit; Every Fall)  
Introduction to brittle and ductile deformation, including joints, faults, shear zones, and folds; deformation mechanism; elementary stress and strain theory. Labs include geometric, structural and kinematic analysis, and a group project. Course fee assessed. pre-req: graduate student or instructor consent

**ESCI 5863. Ecosystems Ecology and Biogeochemistry.** (3 cr. ; A-F or Audit; Every Spring)  
Ecosystems ecology is the integrated study of the flows of materials and energy through ecosystems, which includes both the living (biotic) and non-living (abiotic) components. Biogeochemistry is a major subfield of ecosystems ecology, and deals with the cycling of nutrients through ecosystems. In this class, we will discuss the integration of ecosystems and biogeochemistry in terrestrial environments, specifically focusing

on how human activities influence ecological systems and vice versa. It is my hope that you walk away from this course with a better understanding of how large environmental issues such as climate change and invasive species affect ecological systems. pre-req: BIOL 2801, CHEM 1153 or CHEM 1173 or graduate student

**FMED 5591. Independent Study.** (0 cr. ; No Grade Associated; Every Fall, Spring & Summer)  
Intensive, independent study project of student's interest in medical research, interdisciplinary fellowship, preceptorship in rural health care delivery, or another medical area approved by Department of Family Medicine. Reflective summary upon completion (paragraph). prereq: department consent

**FMED 6441. Community Clinical Medicine.** (; 1 cr. ; P-N only; Every Fall)  
Clinical practicum, hospital based, covering core material in family practice, internal medicine, obstetrics, pediatrics, surgery. Patient work-ups with discussion by preceptor. prereq: Regis med student

**FMED 6442. Community Clinical Medicine.** (; 2 cr. ; P-N only; Every Spring)  
Clinical practicum, hospital based, covering core material in family practice, internal medicine, obstetrics, pediatrics, surgery. Patient work-ups with discussion by preceptor. prereq: Regis med student

**FMED 6462. Family Medicine Preceptorship.** (2 cr. [max 3 cr.] ; P-N or Audit; Every Fall)  
Students spend periods of time with a physician in family practice in rural/small communities of Minnesota and Wisconsin observing methods by which health care is delivered. prereq: Regis med student

**FMED 6501. Clinical Pathology Conferences I.** (; 1 cr. ; P-N or Audit; Every Spring) Applying knowledge gained in pathology and laboratory medicine to an unknown clinical case in order

to work through a differential diagnosis. prereq: Regis med student

**FMED 6957. Medical Education for Diversity and Service.** (; 1 cr. ; P-N only; Every Fall)  
Students will explore key topics in global health. Topics include health risks; determinants of health; environment and health; barriers to health and healthcare; medical interpreters; cultural, political and economic influences on health; and ethics and international health experience. prereq: UMD Med School student

**FMED 6967. The Healer's Art.** (1 cr. ; P-N or Audit; Every Fall)  
Provides a basis for inquiry and discussion between medical students and clinical faculty on topics that are entwined within the practice of medicine. Due to course content, enrollment is limited. prereq: Regis med student

**FMED 6987. Obstetrical Longitudinal Course.** (1 cr. ; P-N or Audit; Every Fall)  
Students will follow a pregnant mother through prenatal visits, labor and delivery, postpartum and newborn care with her family physician or OB specialist. Students attend small group lectures where you will learn about prenatal care, labor and delivery, postpartum care and newborn care. prereq: Preregis med, instructor consent, cannot be concurrently registered for FMed 6977

**FMED 7100. Clinical Family Medicine.** (13 cr. [max 117 cr.] ; P-N or Audit; Every Fall, Spring & Summer)  
Supervised care of patients of all ages emphasizing continuous, primary, preventive, acute, and chronic care in all general diagnostic categories. prereq: department consent

**FIN 5615. Derivative Securities.** (3 cr. ; A-F or Audit; Every Fall & Spring)  
Nature and functions of derivative security markets such as options, futures, options on

futures, swaps, and financial engineering. Emphasizes their use as tools for risk reduction, portfolio management, and speculative medium for aggressive investor. pre-req: MBA student or department consent

**FIN 5616. Security Analysis.** (3 cr. ; A-F or Audit; Every Fall)

Introduction to theory, concepts, and practices of security analysis and investment practices. Common stock, fixed income securities, derivative securities, and mutual funds will be analyzed. Other topics include sector analysis, financial statement analysis, ratio analysis, diversification, and hedging. pre-req: MBA student or instructor consent

**FIN 5617. Management of Financial Institutions.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Techniques for managing commercial banks and other financial institutions through asset/liability management. pre-req: MBA student or instructor consent

**FIN 5620. Portfolio Theory and Analysis.** (3 cr. ; A-F or Audit; Every Fall & Spring) Portfolio

management in a modern portfolio theory (MPT) framework. Risk measurements, risk-return relationships, and portfolio models are developed. Topics include Markowitz portfolio theory, risk-return models, bond portfolio management, evaluating portfolio performance, and outperforming the market. pre-req: MBA student or instructor consent

**FIN 5624. Applied Portfolio Management.** (3 cr. ; A-F or Audit; Every Fall)

Gives students in the financial markets program "hands on" learning experience by analyzing and managing a real-money investment fund. Students will be responsible for managing all aspects of the investment fund pre-req: MBA student or instructor consent

**FIN 5644. Portfolio Management.** (3 cr. ; A-F or Audit; Every Spring)

Portfolio analysis in the mean-variance framework of Markowitz. Portfolio management strategies. The CAPM, APT, and other capital market theory implications. Portfolio performance evaluation. prereq: MBA student or instructor consent

**FIN 5645. Financial Modeling and Valuation.** (3 cr. ; A-F or Audit; Every Fall)

The objective of this course is to introduce students to financial modeling in Microsoft Excel. In particular, the course will focus on exploring the techniques and tools used to by industry professionals to produce valuations for businesses. The course will first explore commonly-used valuation approaches such as dividend discount models, discounted cash flow analysis, and valuation-by-comparables and then use these models to value publicly-traded companies and situations such as initial public offering or a corporate merger. pre-req: MBA student or instructor consent

**FIN 5646. Financial Plan Development.** (3 cr. ; A-F or Audit; Every Spring)

Financial planning is the process of managing resources to achieve personal financial goals. It involves the steps of determining current financial situations, developing financial goals, identifying alternative courses of actions, evaluation alternatives, creating financial action plans, and finally evaluating and revising plans.

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cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5013. Arth 5391, Directed Study Renaissance and Baroque.** (; 1-15 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5014. Math 5280, Partial Differential Equations.** (; 1-20 cr. ; Student Option; Every Fall & Spring)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office.

**FST 5021. Engl 5591, Independent Study.** (; 1-20 cr. [max 1 cr.]; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad program, required consent from the International Education Office.

**FST 5022. Writ 5220, Document Design and Graphics.** (; 1-20 cr. ; Student Option; Every Fall & Spring)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5023. Writ 5230, Web Design and Digital Culture.** (; 1-20 cr. ; Student Option; Every Fall, Spring & Summer)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5024. Arth 5191, Directed Study Ancient/MedievArt.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad program, required consent from the International

This course provides the systematic framework for implementing these activities pre-req: MBA student or instructor consent

**FST 5002. Psy 5501, Counseling**

**Theories and Skills.** (; 1-20 cr. [max 1 cr.]; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5003. Educ 5804, Programs for Young Children: Global Perspective.** (; 1-20 cr. [max 1 cr.]; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5009. Engl 5821, History of English Language.** (; 1-20 cr. [max 1 cr.]; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad program, required consent from the International Education Office.

**FST 5010. Biol 5121, Plant Biochemistry and Molecular Biology.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5011. Biol 5833, Stream Ecology.** (; 1-20 cr. [max 30 cr.]; Student Option; Periodic Fall & Spring)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5012. Biol, 5861, Lake Ecology.** (; 1-20

Education Office.

**FST 5025. Biol 5601, Plant Physiology.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad program, required consent from the International Education Office.

**FST 5026. Biol 5602, Plant Physiology Lab.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad program, required consent from the International Education Office.

**FST 5027. Engl 5122, Advanced Writing of Poetry.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5028. Art 5902, Graphic Design Theory & Criticism.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5029. Art 5991, Independent Work in Graphic Design.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5030. Art 5999, Special Projects in Design.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study Abroad Course prereq: Admitted to an approved Study Abroad Program, required consent from the International Education Office.

**FST 5031. Engl 5566, Irish Literary Revival.**

(; 1-20 cr. ; Student Option; Periodic Fall) Study Abroad Course prereq: Admitted to an

approved Study Abroad Program, required consent from the International Education Office.

**FST 5033. Jour 5197, Journalism Internship.** (; 1-20 cr. ; Student Option; Periodic Fall, Spring & Summer)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office.

**FST 5034. Psy 5155, Forensic Psychology.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5035. Math 5900, Team Modeling Project.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Study Office

**FST 5036. Ling 5802, Applied Linguistics.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course. prereq: Admission to an

approved study abroad program, required consent from the International Education Office

**FST 5037. CS 5541, Artificial Intelligence.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5038. CS 5631, Operating Systems.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5039. Writ 5197, Internship in Writing.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5040. Engl 5040, Chaucer.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5041. Arth 5591, Directed Study in**

**American Art.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5042. Stat 5511, Regression Analysis.** (; 1-20 cr. ; Student Option; Periodic Fall)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5043. Art 5016, 2-D Digital Studio II.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5044. Art 5030, Art in Technologies II.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5045. Art 5916, Type Lab.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

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consent from the International Education Office

**FST 5046. Art 5991, Independent Study in Graphic Design.** (; 1-20 cr. ; Student Option; Every Fall & Spring)

Study abroad course prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5047. Geol 5095, Legends of the Flood.** (; 1-20 cr. ; Student Option; Every Fall & Spring)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5048. Geog 5446, Water Processes and Management.** (; 1-20 cr. ; Student Option; Every Fall & Spring)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5049. Educ 5340, Interacting with Diverse Families.** (; 1-20.1 cr. ; Student Option; Every Fall & Spring)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5050. CS 5721, Computer Graphics.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5051. CS 5621, Computer Architecture.** (; 1-20 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5052. CS 5651, Computer Networks.** (; 1-20 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Study abroad course. prereq: Admission to an approved study abroad program, required

**FST 5053. CS 5551, User Interface Design.**

(; 1-20 cr. ; A-F or Audit; Every Fall, Spring & Summer) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5054. CS 5641, Compiler Design.** (; 1-20 cr. ; A-F or Audit; Every Fall, Spring & Summer) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5055. Biol 5811, Plant Autecology.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5056. Biol 5831, Plant Pop and Community Ecology.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5057. Biol 5862, Advanced Lake Ecology.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5058. Biol 5865, Conservation Biology.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program, required consent from the International Education Office

**FST 5059. Math 5371, Abstract Algebra I.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office.

**FST 5060. Art 5030, Art in Technologies II.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office.

**FST 5061. Geol 5200, Geological Field Studies.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office.

**FST 5062. Folk Song and Dance in Britain.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program, required consent from the International Education Office. No Graduate School Credit.

**FST 5063. MicB 5555 Molecular Pathogenesis: Current Concepts.** (; 1-20 cr. ; Student Option; Every Fall, Spring & Summer) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5064. Biol 5240 Ecological Genetics.** (; 1-20 cr. ; Student Option; Every Fall, Spring & Summer) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5065. Biol 5401 Coevolution of Plants, Animals and Microbes.** (; 1-20 cr. ; Student Option; Every Fall, Spring & Summer) Study abroad course. prereq: Admission to an approved study abroad program. Required

consent from the International Education Office.

**FST 5066. Engl 5444, Childhood in Literature, History and Culture.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad course. Required consent from the International Education Office.

**FST 5068. Scotland and Empire.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office. No Grad School cr

**FST 5069. Global Engagement in Puerto Vallarta, Mexico.** (; 3 cr. ; Student Option; Every Fall & Spring) Study abroad program. Puerto Vallarta Global Service Learning program. prereq: Required consent from the International Education Office.

**FST 5070. Geol 5200, Geological Field Study (in Poland).** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to

an approved study abroad program. Required consent from the International Education Office.

**FST 5071. Art 5909, Interactive Design.** (; 1-20 cr. ; Student Option; Every Fall) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5072. Voice.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad course. Required consent from the International Education Office. (No Grad School cr)

**FST 5073. Opera Coaching.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office. (No Grad School cr)

**FST 5074. Hlth 5341, Death Education.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required

consent from the International Education Office. No Grad School cr.

**FST 5075. SW 5091, Independent Study.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office. No Grad School cr

**FST 5076. Stat 5411, Analysis of Variance.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5077. Engl 5562, Victorian Literature.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5078. Engl 5561, English Romanticism.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring)

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Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5079. Engl 5222, Shakespeare.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5080. Art 5795 Intermedia Studio Problems.** (; 1-20 cr. ; Student Option; Every Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5081. CSD 5195, T: Service-Learning in Mexico.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course. prereq: Admission to an approved study abroad program. Required consent from the International Education Office.

**FST 5082. CSD 5195 Special Topics: Second China International Conference for Speech Therapy.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study Abroad Course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5083. MATH 5280 Partial Differential Equations.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study Abroad Course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5085. Engl 5541 Restoration and 18th Century Literature.** (; 1-20 cr. ; Student Option; Periodic Fall & Spring) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5086. Natural Language Processing.** (; 1-20 cr. ; Student Option; Periodic Fall) Study Abroad Course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5087. Engl 5533 Studies in British Literature Before 1800.** (; 5 cr. ; Student Option; Periodic Spring) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FST 5088. PHYS 5052.** (; 1-20 cr. ; Student Option; Periodic Fall) Study abroad course prereq: Admission to an approved study abroad course. Required consent from the International Education Office.

**FORS 5201. MU 5201 Advanced Music History.** (GLOBAL PER; 1-20 cr. ; Student Option; Periodic Summer) Study Abroad pre-req: Requires approval from International Programs and Services Office

**FORS 5202. MU 5201 Adv Music History.** (1-20 cr. ; Student Option; Periodic Summer) Study Abroad pre-req: Admission to an approved study abroad program requires consent from the International Programs and Services Office

**FORS 5333. New Zealand Engaging and Empowering Maori Youth in Community**

**Change.** (GLOBAL PER; 3 cr. ; A-F or Audit; Periodic Summer) Through a short-term study abroad program in New Zealand, this course will provide students with an international perspective on community-engaged strategies to address social justice issues, youth development, and human rights through culturally responsive practice with indigenous and diverse communities. through site visits and seminars with local experts in several cities and communities in New Zealand, students will learn approaches used by organizations engaged in collaborative work with indigenous youth to empower and promote social change through community development, macro practice, and advocacy. pre-req: graduate student, GPA of 2.5 or higher, instructor consent;

**FORS 5500. International Education.** (; 1-20 cr. ; Student Option; Periodic Fall, Spring & Summer) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5501. International Education.** (; 1-20 cr. ; Student Option; Periodic Fall, Spring & Summer) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5502. International Education.** (; 1-20 cr. ; Student Option; Periodic Fall, Spring & Summer) Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5503. International Education.** (; 1-20 cr. ; Student Option; Periodic Fall, Spring &



Summer)

Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5504. International Education.** ( ; 1-20 cr. ; Student Option; Periodic Fall, Spring & Summer)

Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5591. Hlth 5991 Independent Study.** ( ; 1-20 cr. ; Student Option; Periodic Summer)

Admission to an approved study abroad program requires consent from the International Education Office. prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**FORS 5990. HLTH 5100 History of Health in Italy.** (GLOBAL PER; 1-20 cr. ; Student Option; Periodic Summer)

Study abroad course prereq: Admission to an approved study abroad program requires consent from the International Education Office.

**GIS 5533. Distributed Geographic Information Services: Mobile and Web Based Solutions.** (4 cr. ; A-F or Audit; Every Fall)

There are currently over 1 million GIS users worldwide producing nearly 15,000 maps daily. The vast majority of these users utilize the internet and mobile devices to collect, manage, process and store the geospatial data necessary to create and distribute these maps. As such, GIS is shifting from a system where the focus lies almost entirely on the data itself, to a geographic information service where the focus lies on the distribution of spatial context to stakeholders and end users via the internet. The aim of this course is to expose students to the practical and theoretical applications of distributed geographic information services including web and mobile apps, virtual and physical servers, APIs, and scripting languages (JavaScript CSS, HTML5, SVG). Labs and a group semester project will focus on distributed GIS for a stakeholder within the region. Software used will vary, but may include ArcGIS Online, ArcGIS Pro, or open-source

software. pre-req: Grad student, GIS 3563 or 4565; credit will not be granted if already received for GIS 4533

**GIS 5571. Geographic Information Science in Urban Analysis.** (4 cr. ; A-F only; Spring Even Year)

This advanced course provides students with an opportunity to explore the many applications of geographic information systems in local government, transportation development, and sustainable community planning. Students learn how GIS can be used to effectively carry out urban and regional planning tasks and gain a basic understanding of GIS project planning and data management. Labs focus on land use planning, transportation development, green infrastructure, and population dynamics from across the globe, with a particular focus on the Duluth area. Software used will be ESRI ArcGIS. prereq: 3563 and 3564 or 4565 (preferred) or instructor consent; credit will not be granted if already received for GEOG 5571

**GIS 5572. Environmental Application of GIS.** (4 cr. ; A-F only; Every Fall)

Explore GIS applications to the environmental issues such as natural hazards, forest management, contaminated sites, soil erosion, habitat assessment, and regional planning.

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granted if already received for GEOG 4580 or GEOG 5581

GIS. prereq: instructor consent

Prereq: 3563 or 4565 or grad student or instructor consent; credit will not be granted if already received for GEOG 5572.

**GIS 5573. GIScience in Regional Sustainability Applications.** (4 cr. ; A-F only; Spring Even Year)

This course provides students with an opportunity to explore the many applications of geographic information science in environmental and societal sustainability, renewable energy, and community planning. This course is based on the idea that in order to successfully transition toward sustainability, a better understanding of coupled human and natural systems in critical, and that because of the unique challenges and conflicts present within northern Minnesota between human and natural systems, it is an ideal location to attempt to mitigate these challenges through the use of Geographic Information Science. Labs focus on current topics relevant to the region including energy use calculations, food deserts, LEED certification, water pollution, and transit planning. Software used will be ESRI ArcGIS. Prereq: 3563 and 3564 or 4565 (preferred) or instructor consent; credit will not be granted if already received for GEOG 5573

**GIS 5581. Digital Image Processing and Analysis.** (4 cr. ; A-F only; Spring Even Year)

This advanced remote sensing course focuses on theories and applications of digital image processing and provides students with knowledge and skills of advance digital image processing and a variety of analytical techniques. Topics include image display and visualization, methods for geometric and radiometric corrections, image enhancement, image classification, change detection, and Principal Component Analysis (PCA). prereq: 3580 or instructor consent; credit will not be

**GIS 5585. Applied Statistics in GIS - graduate level.** (4 cr. ; A-F or Audit; Spring Odd Year)

The aim of this course is to provide graduate students interested in spatial data analysis with skills needed to analyze spatial data. Many of the methods covered in this course are commonly used in various fields of social or environmental studies, in economy and management, in sciences and engineering; statistics are a lingua franca that is often a key element of interdisciplinary work. However, there will be an emphasis on the specificity of data that vary in space and on methods specific to spatial analysis. The class will focus on both theory and application, through a problem solving approach. We will use a variety of software, mostly ArcGIS, QGIS and MS Excel. pre-req: grad student, GIS 4565 or GIS 3563; credit will not be granted if already received for GIS 4585

**GIS 5586. Geoprocessing with Python.** (4 cr. ; A-F or Audit; Every Spring)

Python has become the main scripting language used for geoprocessing. In this class, building on previous GIS experience, students learn how to automate geoprocessing workflows with Python and how to turn their code into tools and ads-ins for the main commercial and open-source GIS software system. pre-req: Grad student, GIS 3563 or 4565; credit will not be granted if already received for GIS 4586

**GIS 5591. Independent Study in GIS.** (1-3 cr. [max 6 cr.] ; A-F only; Every Fall, Spring & Summer)

Independent problems for postbaccalaureate students interested in doing additional work in selected fields in

**GEOG 5101. Water Policy.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Socio-cultural, legal, and economic factors that affect water resources management. Historical trends in water policy, resulting water laws in the United States. Federal, state and local institutional structures for water management. pre-req: Grad student or instructor consent

**GEOG 5991. Independent Study in Geography.** (1-4 cr. ; A-F only; Every Fall, Spring & Summer)

Independent problems for postbaccalaureate students interested in doing additional work in selected fields in geography. prereq: Maximum 4 credits can be applied to graduate program; instructor consent

**GEOL 5091. Geologic Problems.** (1-2 cr. [max 4 cr.] ; Student Option; Every Fall, Spring & Summer)

Individual research in lab or field problems. prereq: Graduate Student or instructor consent

**GEOL 5095. Special Topics: (Various Titles to be Assigned).** ( ; 1-3 cr. [max 12 cr.] ; A-F or Audit; Every Fall & Spring)

Topics not covered in regular curriculum. Topic announced before course offered.

**GEOL 5100. Seminar.** (1-2 cr. [max 4 cr.] ; Student Option; Periodic Fall & Spring)

Oral and written presentation on topics of current significance to geoscientists. Participation by department staff. prereq: instructor consent

**GEOL 5103. Geological Paleolimnology.** (3

cr. ; A-F or Audit; Fall Even Year)

Geological aspects of freshwater systems: origins, tectonic and climatic settings of lakes, geophysical mapping, physical sedimentary processes, sedimentary geochemistry, and geochronology. Particular focus on paleolimnology, the analysis of lake sediment to reconstruct past climate and environment  
prereq: MATH 1296 or 1596, PHYS 1002 or 2015 or 2018, CHEM 1155 or 1175 or grad student

**GEOL 5201. Introduction to Watershed Hydrology.** (3 cr. ; A-F or Audit; Every Spring)

This course provides an introduction to the hydrologic cycle and water processes in the context of wildland watersheds. The course will cover the major components of the hydrologic cycle, including precipitation, canopy interception, evapotranspiration, infiltration, soil water storage, runoff, streamflow, and groundwater flow. The impacts of watershed management on water quantity and quality will be discussed using regional, national, and global examples, with an emphasis on solving real-world problems using hydrologic datasets. pre-req: CHEM 1153, MATH 1290 or 1296, or grad student

**GEOL 5210. Glacial and Quaternary Geology.** (4 cr. ; A-F or Audit; Spring Even

Year)

Physics of glacier flow, processes of erosion and deposition, survey of glacial landforms, history and chronology of glaciation. Survey of geological and biological responses to changing environment resulting from climatic fluctuations during last three million years of Earth history. Field studies on the glacial deposits of Minnesota. (2 hrs lect, 2 hrs field lab) prereq: GEOL 1110 or 1610 or GEOG 1414 and PHYS 1001 or 2013 or 2017 and MATH 1290 or 1286; or instructor consent; credit will not be granted if already received for 4210

**GEOL 5220. Advances in Paleoclimatology.**

(3 cr. ; A-F or Audit; Spring Odd Year) Analysis of past global change from climate proxy records in glacial ice, tree rings, ocean and lake sediments, ocean corals. Impact of ocean and atmospheric circulation on global climate; climate cycles; El Nino; human impact on global climate. Offered alternate years. prereq: instructor consent

**GEOL 5240. Physical Hydrogeology.** (4 cr. ; A-F or Audit; Spring Even Year)

Introduction to concepts of fluid movement in Earth's crust and the interaction of rocks and water. Introduction to the hydrologic cycle, theory of flow through porous media,

crustal scale flow systems, role of fluids in the plate tectonic cycle. prereq: 2110, Phys 2011 or 2013 and 2014, Math 1296 or Math 1290 or grad student or instructor consent; credit will not be granted if already received for 4240

**GEOL 5250. Hydrogeology.** (4 cr. ; A-F or Audit; Every Fall)

A quantitative introduction to hydrogeology and aquifer mechanics with emphasis on environmental applications, including, unsaturated flow, interaction between surface water and groundwater, wellhead protection, well hydraulics, inverse methods, and solute transport. Offered alternate years. prereq: Math 1296 or Math 1290 and (Phys 2011 or 2013 and 2014) or grad student or instructor consent; credit will not be granted if already received for 4250

**GEOL 5251. Well Hydraulics.** (3 cr. ; A-F or Audit; Spring Odd Year)

Hydraulics of groundwater flow to wells: equations of flow; analysis of steady and non steady radial flow; aquifer response to stress; analysis of monitoring well networks, pumping tests, and single-point aquifer performance tests. prereq: PHYS 1001 or 2013 or 2017 and MATH 1290 or 1296 or instructor consent or grad student

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**GEOL 5260. Fluvial Geomorphology.** (4 cr. ; A-F or Audit; Fall Even Year)

Focuses on the physical processes operating in stream channels and watersheds including watershed-scale hydrology and topography in GIS; reach-scale fluid mechanics and sediment transport; and channel patterns, forms, and classification systems. Other topics included will be river history, human alterations to rivers, and river restoration efforts. prereq: GEOL 2010 or 3210 or 3420 and MATH 1290 or 1296 and PHYS 1001 or 2013 or 2017 or graduate student

**GEOL 5310. Advanced Petrology.** (3 cr. ; A-F or Audit; Fall Odd Year)

Physico-chemical principles applied to origin of igneous and metamorphic rocks. Phase equilibria in important mineral systems. Lab study and interpretation of igneous and metamorphic rocks using petrographic microscope. (2 hrs lect, 2 hrs lab) prereq: 2312 or grad student

**GEOL 5311. Igneous Petrogenesis.** (3 cr. ; A-F or Audit; Fall Odd Year)

This course will investigate igneous processes including formation, differentiation, and crystallization of magmas. Thermodynamics of phase equilibria between silicate melts, minerals, and magmatic fluids will be emphasized. pre-req: GEOL 2312, MATH 1297; credit will not be granted if already received for GEOL 4311

**GEOL 5321. Theory, Practice of Scanning Electron Microscopy and X-Ray Microanalysis in Lectures.** (3 cr. ; A-F or Audit; Every Spring)

Presents the basic physics of scanning electron microscopy, including electron beam

generation, image formation, signal detection, and beam-sample interactions. Basic sample preparation methods for scanning electron microscopy will be presented and demonstrated in laboratory sessions. How characteristic x-rays are produced in a sample and how they are measured and quantified will also be presented. Use of the SEM to collect data and instruction on how to organize collected data in a logical manner. prereq: Minimum 75 credits, Chem 1155 or 1175, Phys 1002 or 2015 and 2018, or Grad student or instructor consent

**GEOL 5355. Economic Geology.** (4 cr. ; A-F or Audit; Fall Odd Year)

Geologic description, distribution, and genesis of economic mineral deposits; processes leading to their formation; relationship to plate tectonics; exploration techniques and criteria for finding new deposits. Course fees assessed. prereq: 3326, 3150 or graduate student or instructor consent

**GEOL 5356. Ore Deposits and Economic Geology.** (3 cr. ; A-F or Audit; Summer Even Year)

Geologic description, distribution, and genesis of economic mineral deposits; physical processes leading to deposit formation; relationship of mineral deposits to plate tectonics; exploration techniques and criteria for finding new deposits. pre-req: Graduate student or instructor consent; credit will not be granted if already received for GEOL 4350, 4355, 5350, or 5355.

**GEOL 5360. Geologic, Geophysical, and Geochemical Methods of Exploration.** (4 cr. ; A-F or Audit; Spring Odd Year)

Team-taught course will introduce various geologic, geophysical, and geochemical exploration methods used to locate and

evaluate the economic viability of metallic ore bodies in a variety of geologic settings. In labs, students will develop skills in ore microscopy, drill core logging, and geophysical field methods. Case studies will be used to highlight various exploration methods and ore deposit types. prereq: 4350 or 5350, (Math 1290 or 1296) or grad student or instructor consent; credit will not be granted if already received for 4360.

**GEOL 5400. Astrogeology.** (3 cr. ; A-F or Audit; Every Spring)

In this astrogeology course we will explore the formation and evolution of celestial bodies in our solar system such as planets and their moons, asteroids, comets, and meteorites. Topics will include determining internal structure of planetary bodies, dynamical processes, how to read the surface record (geology) of various bodies and leverage that record to understand internal processes and planet evolution, and comparative planetology with the goal to understand first-order cause and effect of planetary dynamics. pre-req: Minimum 60 credits and Astronomy minor or Geology major or minor or Physics major or minor or graduate student or instructor consent

**GEOL 5480. Tectonics.** (3 cr. ; A-F or Audit; Spring Even Year)

Ancient and active plate-tectonic processes. Topics include tectonic theory, plate motions, evolution of divergent, convergent and transform margins, anatomy of orogenic belts, and neotectonics. Examines tectonic phenomena in the context of geological, geophysical and surficial processes. Offered alternate years. prereq: 2120, 4450, or grad student or instructor consent; credit will not be granted if already received for 4480

**GEOL 5601. Introduction to Stream**

**Restoration.** (3 cr. ; A-F or Audit; Fall Even Year)

This course provides an interdisciplinary overview of the background science essential to participate in a stream restoration project. Students will learn how to assimilate geologic hydrologic, and ecological data at the watershed and research scales to plan a restoration project and evaluate/critique existing stream restoration projects. prereq: Math 1290 or 1296 or 1596, PHYS 1001 or 2013 or 2017, minimum 60 credits or graduate student or instructor consent

**GEOL 5603. Stream Crossing Design.** (2 cr. ; A-F or Audit; Fall Odd Year)

Overview of road-stream crossing design with emphasis on stream simulation for aquatic organism passage. Includes field data collection, analysis, and design of road-stream crossings. Meets concurrently with CE 5203.

CE 5203 includes additional work on traditional culvert hydraulics and design. pre-req: GEOL 3210 or 3420 or 5260 or 5601 or BIOL 5833 or CE 3225 and instructor consent

**GEOL 5711. Geochemistry.** (4 cr. ; A-F or Audit; Spring Odd Year)

What geochemical processes occur at the intersection of the biosphere, lithosphere, and hydrosphere? How did earth's surface

geochemistry change over geologic time and how can we tell? In this course, we will investigate questions that relate to the co-evolution of life and Earth through a geochemical lens. Overall, the course will divide into two parts: (1) the geochemical structure of Earth from the core to the surface; and (2) practical applications for geochemistry and geochemical techniques. Discussion will begin with an overview of the discipline of geochemistry, which will serve as a framework to interpret the geochemical evolution and structure of the internal and external components of Earth. Following this portion, we will examine modern advances of analytical techniques and applications in geochemistry. Prereq: Math 1290 or MATH 1296 or Math 1297 and Chem 1153 or CHEM 1173 or grad student or instructor consent.

**GEOL 5730. Geochronology.** (3 cr. ; A-F or Audit; Spring Odd Year)

Covers both radiometric and non-radiometric methods of dating primarily Earth but also solar-system materials (meteorites). The chronometers discussed will cover a range of timescales, from early solar-system history to recent human-influenced history. Offered alternate years. prereq: 2311, one year of college chemistry or grad student

**GEOL 5815. Exploration Geophysics.** (4 cr. ; A-F or Audit; Fall Odd Year)

Review of principle geophysical techniques used in the exploration industries. Emphasizes the application of these techniques for solving near-surface problems. Includes review of case histories and group projects. prereq: 1110, Math 1297 or grad student or instructor consent; credit will not be granted if already received for 4805 or 4815

**GEOL 5820. Global Geophysics.** (3 cr. ; A-F or Audit; Fall Even Year)

Build upon material presented in 2120, exploring the contribution of geophysics to our understanding of the Earth and the processes that control its appearance and behavior. Offered alternate years. prereq: 2120, Math 1290 or 1296 or grad student, instructor consent; credit will not be granted if already received for 4820

**GEOL 8094. Geologic Research.** (1-6 cr. ; A F or Audit; Every Fall & Spring)

Individual research. prereq: instructor consent

**GEOL 8100. Seminar.** (1-2 cr. [max 6 cr.] ; S N or Audit; Every Fall & Spring)

Oral and written presentations on topics of current significance to geoscientists. prereq: Graduate geology major or instructor consent

**GEOL 8200. Professional Issues in Earth and Environmental Science.** (1 cr. ; S-N or Audit; Every Fall)

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Introduces the incoming graduate student in geological sciences to professional practice, standards and ethics, including peer review, proposal writing, ethical problems, the purpose of a university. prereq: Graduate student or instructor consent

**GEOL 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Master's student, adviser and DGS consent

**GEOL 8444. FTE: Doctoral.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: prereq doctoral student, adviser and DGS consent

**GEOL 8602. Stream Restoration Practice.** (2 cr. ; S-N or Audit; Periodic Spring)

Practicum course provides the capstone for the Stream Restoration Science & Engineering post-baccalaureate certificate program. Students synthesize previous coursework on stream restoration, apply basic hydraulic and geomorphic analyses on a reach of a stream, and complete a group design for a stream restoration site. prereq: 5601 and instructor consent

**GEOL 8666. Doctoral Pre-Thesis Credits.** (1-6 cr. [max 12 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Max 6 cr per semester or summer; doctoral student who has not passed prelim oral; no required consent for the first two registrations up to 12 cr; departmental consent for the third and fourth registrations up

to an additional 12 cr, or 24 cr total (for doctoral students admitted summer 2007 and beyond; doctoral students admitted prior to summer 2007 may register up to 4 times totaling 60 cr)

**GEOL 8777. Thesis Credit: Master's.** (1-10 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Max 10 cr total required (Plan A only)

**GEOL 8888. Thesis Credits: Doctoral.** (1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: [max 18 cr per semester or summer]; 24 cr required

**HLTH 5100. Historical Perspectives of Community Health Through Culture & Art in Italy.** (GLOBAL PER; 3 cr. ; A-F or Audit; Every Summer)

Investigating the foundations of public and community health using primary historical sites in the area now unified as Italy. Analyze the impact of social and cultural factors on community health from early civilizations through the Renaissance, with emphasis of effects of the Black Death. Examine the role of arts used to convene health information for non-literate populations. Relate to aspects of preventative health care and promoting healthy communities in the present. prereq: minimum 30 credits and instructor consent

**HLTH 5991. Independent Study.** (1-6 cr. ; A F or Audit; Every Fall & Spring)

Directed independent study, readings, research, or projects in a particular area of

interest. Degree program plan and project proposal should be approved before course is taken by graduate students. prereq: instructor consent, non-degree seeking or grad student; maximum of 6 credits can be applied toward degree

**HLTH 5992. Readings in Health.** (1-4 cr. ; A F or Audit; Every Fall & Spring)

Special complementary readings and discussion in advanced or graduate student's field of interest in health and health education. prereq: instructor consent

**HCM 5530. Legal Aspects of and Ethics in Health Care.** (3 cr. ; A-F or Audit; Every Fall)

Introduction to the legal and ethical environment of health services administration and offers a current and historical overview of legal regulation of the health care industry. prereq: MBA student or department consent

**HCM 5550. Health Care Finance.** (3 cr. ; A-F or Audit; Spring Odd Year)

Covers finance issues related to healthcare organizations. Topics include: reimbursement analysis, understanding the nature of costs, uncertainty, forecasting, service line profitability analysis, and preparation of operating and capital budgets. pre-req: MBA student or department consent

**HCM 5570. Health Care Quality Management.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Covers basic principles of quality and patient safety measurement and improvement in health care. Methods for measuring health

outcomes and satisfaction as well as regulatory and accreditation requirements affecting quality of care in hospitals, nursing homes, and other areas of healthcare will be discussed. pre-req: MBA student or department consent

**HCM 5580. Health Services Data and Analysis.** (3 cr. ; A-F or Audit; Every Fall) Introduction to the types, use, and analysis of data in health services delivery and research. This includes electronic health record, claims, and patient satisfaction data, as well as publicly available data sets. Topics include data organization, data sources available in the health services, conceptualizing analysis, sampling, data validity and reliability, qualitative and quantitative data analysis, applying research results, and communicating findings. pre-req: MBA student or department consent

**HIST 5094. Directed Research.** (4 cr. [max 12 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Directed Research pre-req: instructor consent, maximum 4 credits may be applied to grad program

**HIST 5905. History Seminar.** (4 cr. [max 8 cr.] ; A-F or Audit; Periodic Fall & Spring) Advanced study and individual research on a selected historical topic or theme; senior capstone course for history majors. (2.5 hrs

lect, 1 hr student/faculty consultation) pre-req: instructor consent

**IE 5305. Supply Chain Management.** (3 cr. ; A-F or Audit; Fall Even Year)

Concepts essential to understanding supply chain management, including strategy and design, as well as operational, managerial, technological, and implementation issues. It provides an integrated perspective of the supply chain, including purchasing, production, transportation, distribution and information systems. pre-req: 4020, BSIE candidate or MSEM student or instructor consent

**IE 5315. Organizational Control Methods.** (3 cr. ; A-F or Audit; Spring Odd Year)

Roles of the engineer in managing organizational resources. Budgeting, cost volume relationships, product costing, annual reports, audits. Project estimating and reporting. pre-req: BSIE or MSEM candidate or department consent

**IE 5325. Advanced Engineering Economics.** (3 cr. ; A-F or Audit; Spring Even Year)

Fundamentals of engineering economics: decision trees, time value of money, analysis of alternatives for project investments, taxes, inflation. Applications to engineering services and manufacturing. pre-req: 3125, BSIE or MSEM candidate or department consent

**IE 5335. Engineered Products and Services.**

(3 cr. ; Student Option; Fall Odd Year) Development, production, and distribution of engineered products and services. Strategies for positioning engineered products and services to successfully compete in a global market. Sales, purchasing, qualification, and service. Standards, regulations. pre-req: BSIE or MSEM candidate, instructor consent

**IE 5345. Life Cycle Assessment.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Students will learn how to assess environmental impact, economic costs, and social impacts for the entire life cycle of materials, products, processes, and infrastructure using industry life cycle assessment (LCA) software SimaPro. Topics include sustainability, cradle to cradle design, functional unit definition, materiality, discount rates, worker health and safety, and how to utilize LCA in decision-making. Students will work in teams on a LCA project with a presentation and written report that will be given to a client upon completion. pre-req: CHEM 1153, BS or MS SCSE candidate or instructor consent

**IE 5991. Independent Study in Industrial Engineering.** (1-4 cr. [max 6 cr.] ; Student Option; Every Fall, Spring & Summer)

Directed study of special interest topics not available in standard curriculum. Must be arranged with instructor before registration.

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May include readings, research and/or special projects. pre-req: MSEM candidate, department consent

**IBS 8011. Integrated Biological Systems I.** (; 2 cr. ; A-F only; Every Fall)

This course introduces the student to integrating principles in biology to develop the type of integrated thinking expected in their thesis. Integrating principles to be covered include energy flow, information, stoichiometry, and feedbacks. This course will be delivered largely in lecture format. It will prepare the student for IBS 8013, an extension of this course in spring semester. In IBS 8013, the class will involve applications of these principles to problems and themes that cut across biological sciences and the applications of these principles to their thesis problem. pre-req: open to first year IBS Graduate Students only, calculus

**IBS 8012. Integrated Evolutionary Processes.** (; 2 cr. ; A-F or Audit; Every Spring)

Review of advanced topics in evolutionary biology, including coevolution, evolution of disease organisms, ecosystem consequences of evolution, evolutionary stable strategies, and game theory. Required for all IBS students. pre-req: IBS Grad student

**IBS 8013. Integrated Biological Systems II.** (; 2 cr. ; A-F or Audit; Every Spring)

This course follows IBS 8011. In IBS 8011, the students were introduced to four principles of integrative thinking in biology (energy, information, stoichiometry, feedbacks) that apply to all levels of biological organization. IBS 8013 will apply all four principles to various themes and problems in biology which cut across all levels of biological organization. Such themes include but are not limited to metabolism, disease, and movement of materials across membranes and boundaries. The course will emphasize readings and discussion of the primary literature, student led discussions, student presentations of how the integrating principles apply to their thesis research, and the preparation of a paper demonstrating this application. The papers will be handled in a mock peer-review as if they were submitted to one of the Trends journals (Trends in Ecology and Evolution, Trends in Biochemistry, etc.) pre-req: 8011, calculus

**IBS 8020. Integrated Biosciences Colloquia.** (; 1 cr. [max 4 cr.] ; S-N only; Every Fall & Spring)

Presentations by Integrated Biosciences Graduate Faculty on their research and how it is integrated with various other research programs in Duluth and worldwide. pre-req: IBS Graduate Student

**IBS 8030. IBS Research Club.** (; 1 cr. [max 5 cr.] ; S-N or Audit; Every Fall & Spring)

Readings and discussion of current literature integrating the areas of Cell, Molecular and Physiological Biology with Ecology, Organismal, and Population Biology. Current literature emphasizing the application of

novel techniques to biological problems at several levels of organization will be presented. Students will lead a discussion on at least one paper. Required for IBS students both semesters of their first two years. pre-req: IBS Graduate Student

**IBS 8094. Rotations.** (; 1 cr. ; S-N only; Every Fall & Spring)

Rotations through laboratories of faculty members of the Integrated Biosciences Program. During the rotations students will be exposed to molecular, cellular, physiological, and ecological problems and techniques. pre-req: IBS Graduate Student

**IBS 8099. The Biological Practitioner.** (; 1 cr. ; S-N or Audit; Every Fall)

A course designed to introduce the incoming graduate student in biological sciences to professional practice, standards and ethics, including peer review, proposal writing, ethical problems, the purpose of a university, and other problems. Required for all IBS students. pre-req: IBS Graduate Student

**IBS 8101. Cellular Biochemistry.** (; 3 cr. ; A F or Audit; Every Fall)

This course will introduce students to the physical and molecular basis of cellular function. Students will learn the physical characteristics of macromolecular structures comprising a cell, including polysaccharide, lipid, protein and nucleic acid structure. Students will also learn where these macromolecules occur in the cell, how they are regulated and how they facilitate the cells interaction/communication with its environment, with a focus on small

molecule/ drug distribution. prereq: Organic Chemistry, Biochemistry, Cell Biology or Molecular Biology, Calculus or instructor consent.

**IBS 8102. Cell, Molecular and Developmental Biology.** (3 cr. ; A-F only; Spring Odd Year)

Comprehensive review of contemporary topics in modern molecular biology. This will include systemic examples from cell and developmental systems. Required for CMP emphasis. prereq: 5101, Chem 4342 or equivalent, IBS grad student

**IBS 8103. Comparative Animal Physiology.** (3 cr. ; A-F only; Spring Even Year)

In depth review of selected topics in animal physiology. Lecture presentation of fundamental concepts of cardiovascular, neural, respiratory, renal, and endocrine physiology. In-depth discussion and student presentation of selected topics with particular emphasis on current advances. prereq: One year of college biology, two years of college chemistry; 8011, IBS Grad student

**IBS 8201. Ecological Processes.** (; 2 cr. ; A F or Audit; Every Fall)

In depth survey of advanced topics in ecological processes, including allometry and scaling, animal behavior, food webs, and energy and material flows through organisms and ecosystems. Required for EOP Track. prereq: 8011, IBS Grad student

**IBS 8202. Chemical Biology.** (3 cr. ; A-F or Audit; Every Spring)

This course will introduce students to the

common chemical underpinnings of biochemical and biological processes. Students will learn the chemical fundamentals of biological transformations including the synthesis of lipids, carbohydrates, amino acids, nucleotides as well as natural products. In addition, students will gain insight into the roles of metals in biology, medicine, bio-inorganic transformations, as well as energy - and electron-transfer processes associated with living organisms. prereq: Organic Chemistry, Biochemistry or Cellular Biochemistry, Cell Biology or Molecular Biology, Calculus or instructor consent.

**IBS 8203. Methods in Molecular Biosciences.** (; 2 cr. ; A-F or Audit; Every Spring)

This course will focus on the fundamental and technical background of methods used in chemical biology toward quantitative assay/ interpretation of biological structures/events/ Importantly, case studies will be chosen from current literature to highlight applications of a given technique to address biological questions. For each major technique expected experimental information and subsequent interpretation will be discussed. prereq: Organic Chemistry, Physical Chemistry, Biochemistry or Cellular Biochemistry, Cell Biology or Molecular Biology.

**IBS 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Master's student, adviser and DGS consent

**IBS 8444. FTE: Doctoral.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Doctoral student, adviser and DGS consent

**IBS 8666. Doctoral Pre-Thesis Credits.** (1-6 cr. [max 12 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(no description) prereq: Doctoral student who has not passed preliminary oral; no required consent for 1st/2nd registrations, up to 12 combined credits; department consent for 3rd/4th registrations, up to 24 combined credits; doctoral student admitted before summer 2007 may register up to four times, up to 60 combined credits

**IBS 8777. Thesis Credits: Master's.** (1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Maximum 18 credits per semester or summer; 10 credits total required (Plan A only)

**IBS 8888. Thesis Credit: Doctoral.** (1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall, Spring & Summer)

(no description) prereq: Maximum 18 credits per semester or summer; 24 credits required

**IBS 8993. Integrated Biosciences Graduate Seminar.** (2 cr. [max 4 cr.] ; A-F only; Every Spring)

The IBS Seminar course will emphasize topics that cross multiple disciplines in both Ecology, Organismal and Population (EOP), Cell, Molecular and Physiology (CMP) emphases,

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### **IICR 5003. Inter-Institutional Cross**

**Registration.** (1-9 cr. ; Student Option; Periodic Fall & Spring)

Inter-institutional cross-registration reflecting the credit hour load of University of Minnesota Duluth students enrolling under the inter institutional cross registration agreement with the College of St. Scholastica and the University of Wisconsin Superior and any other institution with whom such an agreement exists.

and Chemical Biology (CB). Example of topics include the following: human health implications of ecological change; cell and molecular techniques in ecology; impact of infectious disease on populations; community ecology, and host defense against disease. prereq: 8012, 8103

### **IICR 5001. Inter-Institutional Cross**

**Registration.** (1-9 cr. [max 36 cr.] ; Student Option; Every Fall & Spring)

Inter-institutional cross registration reflecting the credit hour load of University of Minnesota Duluth students enrolling under the inter institutional cross registration agreement with the College of Saint Scholastica and the University of Wisconsin Superior and any other institution with whom such an agreement exists prereq: instructor consent

### **IICR 5002. Inter-Institutional Cross**

**Registration.** (; 1-9 cr. [max 36 cr.] ; Student Option; Every Fall & Spring)

Inter-institutional cross-registration reflecting the credit hour load of University of Minnesota Duluth students enrolling under the inter institutional cross registration agreement with the College of St. Scholastica and the University of Wisconsin Superior and any other institution with whom such an agreement

**JOUR 5197. Journalism Internship.** (1-3 cr. ; S-N only; Every Fall, Spring & Summer)

Supervised professional experience as a working staff member with a newspaper, magazine, broadcast station or other communications organization. prereq: College Grad or grad student, instructor consent

**LIM 5010. Integrated Approaches to the Study of Inland Waters.** (3 cr. ; A-F or Audit; Every Fall)

An interdisciplinary introduction to the science of Limnology taught at the beginning graduate student level. The science of inland waters, Limnology, is built on Geology, Chemistry, Biology, and Physics and increasingly includes Social Sciences. In this course, students will experience an in-depth, integrated approach to Limnology. Lake systems are emphasized but wetland and running water systems are discussed. The course includes significant out of class time reviewing on-line modules and other materials. In-class time is devoted mainly to group work, problem solving, and student led discussions and presentations. An optional companion laboratory and practice course (LIM 5011) is associated with this course where additional foundational and fundamental limnological techniques are taught. pre-req: graduate student or instructor consent

### **JOUR 5102. Editing II: Newsroom**

**Practicum.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Experience in a working newsroom. Apply skills from other journalism classes to plan, produce and manage an online news publication. Basic principles as well as practical skills with advanced computer programs. Includes editing, managing and reporting, as well as the discussion of both journalism and leadership issues. Advance theory and practice in news selection, preparation, and display for newspaper, magazine, broadcast and photojournalism media. Emphasis on the ethical and professional responsibility of the journalist. prereq: Grad Student; credit will not be granted if already received for 5102

**LIM 5011. Laboratory and Discussion in Integrated Approaches to the Study of Inland Waters.** (2 cr. ; A-F or Audit; Every Fall)

A graduate-level laboratory and discussion course with an interdisciplinary introduction to Limnology. This class will introduce students to laboratory, field, data collection, and data analysis techniques in the study of limnology. Introductory coding will be covered. Oral and written communication skills and problem solving skills will also be developed. This course is designed to be taken in conjunction with LIM 5010, Limnology I. pre-req: pre or co-req LIN 5010, grad student or instructor consent

**LIM 5012. Integrated Approaches to the Study of Inland Waters II.** (3 cr. ; A-F or Audit; Every Spring)

Continuing from LIM 5010, this is the second semester of an interdisciplinary introduction to the science of Limnology taught at the beginning graduate student level. The science of inland waters, Limnology, is built on Geology, Chemistry, Biology, and Physics and increasingly includes Social Sciences. Students will experience an indepth, integrated approach to Limnology. Lake systems are emphasized but wetland and running water systems are discussed. The course includes significant out of class time reviewing on-line modules and other materials. In-class time is devoted mainly to group work, solving real world problems, and student-led discussions and presentations. An optional companion laboratory and practice course (LIM 5013) is associated with this course where additional foundational and fundamental limnological techniques are taught. pre-req: LIM 5010 or

instructor consent

**LIM 5013. Laboratory and Discussion in Integrated Approaches to the Study of Inland Waters II.** (2 cr. ; A-F or Audit; Every Spring)

A second semester of the graduate-level laboratory and discussion course with an interdisciplinary introduction to Limnology. This class will introduce students to laboratory, field, data collection, and data analysis techniques in the study of limnology. Introductory coding will be covered. Oral and written communication skills and problem solving skills will also be developed. The second half of this semester will be spent working with industry and non profit community partners on a capstone project, emphasizing the use of newly acquired skills and knowledge in a non-academic setting. pre-req: LIM 5010 or instructor consent

**LIM 5101. Physical Limnology.** (; 3 cr. ; A-F or Audit; Fall Odd Year)

Physical description of lake dynamics including: lake morphometry, water budget, light distribution, circulation, fronts, waves and mixing. Descriptive, mathematical, numerical and data-analysis techniques are used to investigate the various topics. pre-req: Math 1297, Phys 2012 or 2015 and 2016, or grad student

**LIM 5102. Chemical Limnology.** (; 3 cr. ; A-F or Audit; Fall Odd Year)

Organic and inorganic chemistry of natural waters, major and minor ions, pH-Eh relationships, carbon and nutrient cycles, pore water chemistry, sediment chemistry, microbial geochemistry. Offered alternate years. pre-req: Math 1296, Phys 1002 or 1202, Chem 1152 or 1162, or grad student; Credit will not be

granted if already received for 5001

**LIM 5103. Geological Paleolimnology.** (; 3 cr. ; A-F or Audit; Fall Even Year)

Geological aspects of freshwater systems: origins, tectonic and climatic settings of lakes, geophysical mapping, physical sedimentary processes, sedimentary geochemistry, and geochronology. Particular focus on paleolimnology, the analysis of lake sediment to reconstruct past climate and environment pre-req: MATH 1290 or 1296 or 1596, PHYS 1002 or 2015 or 2018, CHEM 1155 or 1175 or grad student

**LIM 5104. Geochemical, Physical, and Biological processes in Aquatic Sediments.** (2 cr. ; A-F or Audit; Spring Even Year)

The course covers the geochemical, physical, biogeochemical, and biological processes in the upper meters of aquatic sediments. Topics include biogeochemical cycles of C, N, P, S; sediment-water exchanges of nutrients, metals, and pollutants; pathways and rates of microbially catalyzed reactions; bioturbation and bioirrigation; measurement techniques and reaction-transport modeling. pre-req: Graduate student or instructor permission

**LIM 5105. Research Frontiers and New Directions in Limnology and Environmental Science.** (1 cr. ; S-N or Audit; Periodic Spring)

An interdisciplinary graduate seminar with dual goal of reviewing most significant current developments in limnological science and helping students identify most significant knowledge gaps in their disciplinary research fields. The course involves guest lectures, student presentations and discussions. It aims to provide students with guidance on choosing research directions to achieve an

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optimal balance between difficulty and scientific payoff. pre-req: Graduate student or instructor permission

**LING 5852. Practicum in Teaching Linguistics.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Supervised teaching in introductory linguistics courses. Experience in preparation for and in conduct of classes, in consultations with students, and in testing. pre-req: College Grad or Grad student

**LING 8591. Independent Study in Linguistics.** (1-3 cr. [max 6 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Directed reading and/or research. pre-req: department approval

**MIS 5220. Medical Informatics.** (3 cr. ; A-F or Audit; Every Fall)

Introduction to the convergence of computing, information systems, and healthcare with a focus on managing information and developing

systems that leads to more effective decisions and actions in healthcare. Covers the standards, ethics and security of the electronic health record. pre-req: MBA student or department consent

**MIS 5223. Systems Analysis and Design.** (3 cr. ; A-F or Audit; Every Fall & Spring) Analysis phase of systems development life cycle. Emphasizes feasibility study, requirements analysis, and system specification. Detailed study of current physical and logical systems models and specification. pre-req: MBA student or department consent

**MIS 5225. Advanced Applications Development.** (3 cr. ; A-F or Audit; Every Fall & Spring)

This course is designed to give students opportunities to apply the knowledge of business and technology that they acquired through their junior and senior year courses to real-world projects. The goal of this course is to augment the knowledge with the state-of-the-art technology in the field of information systems for the conventional and mobile platforms, while at the same time getting students involved in projects to expose them to an in-depth practical experience. Topics include: software version control; computing platform ecosystem; project management; best practices and technologies in business

applications development; and business computing, including simulation and data analysis. pre-req: MBA student or department consent

**MIS 5241. Data Analytics for Managerial Decision Making.** (; 3 cr. ; A-F or Audit; Every Spring)

This course introduces the basic concepts, techniques and technologies of data analytics and business intelligence, and their role in supporting high-level decision making in

business. The course examines fundamental principles of descriptive, predictive and prescriptive analytics, illustrates real-world examples in different business contexts using data analytics software, and develops data-analytic thinking in specific application domains. pre-req: MBA student

**MGTS 5431. Leadership Studies.** (3 cr. ; A-F or Audit; Every Fall)

A survey of the leadership literature aimed at the development of an understanding of leaders and the leadership process. An exploration of such questions as: Who as a person is the leader? How do people come to the position of a leader? What is the nature of

leadership as a process? How do leaders influence others? What is participative leadership? What is charismatic and transformational leadership? pre-req: MBA student or instructor consent

**MGTS 5463. Foundations of Sustainable Management.** (3 cr. ; A-F or Audit; Every Spring)

This course will introduce students to the concepts of sustainability in a managerial context. pre-req: MBA student or instructor consent

**MGTS 5472. Entrepreneurship.** (3 cr. ; A-F or Audit; Every Fall)

Seminar on the fundamentals of entrepreneurship, the characteristics of entrepreneurs, and the life cycle of a new venture: creating and starting a new venture; financing the new venture; managing, growing, and ending the new venture. pre-req: MBA student or instructor consent

**MGTS 5473. Management of Innovation and Technology.** (3 cr. ; A-F or Audit; Periodic Fall)

Issues related to achieving maximum leverage from innovation competencies, skills, and resources. Factors distinguishing high-innovation companies, strategies for innovation, internal and external conditions, and market consequences of innovation. Integration of technology within the strategic management process. pre-req: MBA student or instructor consent

**MGTS 5473. Management of Innovation and Technology.** (3 cr. ; A-F or Audit; Periodic Fall)

Issues related to achieving maximum leverage from innovation competencies, skills, and resources. Factors distinguishing high-innovation companies, strategies for innovation, internal and external conditions, and market consequences of innovation.

Integration of technology within the strategic management process. pre-req: MBA student or instructor consent

**MGTS 5478. Supply Chain Management.** (3 cr. ; A-F or Audit; Every Fall)

Key drivers of supply chain performance will be explored in this course along with how these drivers may be used to improve performance on a practical level during supply chain design, planning, and operations. Students will gain a solid understanding of the analytical tools necessary to solve supply chain problems. pre-req: MBA student or instructor consent

**MGTS 5821. Staffing Work Organizations.** (3 cr. ; A-F or Audit; Every Spring)

Theory and practice of staffing work organizations. Emphasis on design and implementation of staffing systems, legal requirements, and career planning. pre-req: MBA student or instructor consent

**MGTS 5831. Compensation Systems.** (3 cr. ; A-F or Audit; Every Fall)

Theory, design, and practice of employee compensation systems. Impacts of compensation, economic and institutional forces influencing employer compensation policies and practices, supplemental forms of compensation and administrative practices. pre-req: MBA student or instructor consent

**MGTS 5851. Labor Relations.** (3 cr. ; A-F or Audit; Periodic Spring)

Nature of and basis for the labor relations system in the United States. Emphasis on background of labor movement, union organizing, bargaining relationships, labor law; important issues for business, policy makers, and labor unions (e.g. workplace flexibility, employee empowerment, labor-management partnerships, and globalization); and options for labor relations reform. pre-req: MBA student

or instructor consent

**MGTS 5861. International Human Resource Management.** (3 cr. ; A-F or Audit; Every Fall)

Course combines theories of culture with HRM applications to develop students' awareness cultural issues as they apply in the workplace. pre-req: MBA student or instructor consent

**MGTS 5921. Entrepreneurial Finance.** (3 cr. ; A-F or Audit; Every Spring)

Course topics include raising seed and growth capital from venture capital, business angels, investment banking, commercial banking, and bootstrapping sources, and understanding financial problems unique to the small and medium sized firms undergoing rapid growth. The course examines proposals made to venture capital firms, particularly in terms of their financial viability as well as financial management for entrepreneurs over the life of business project. Includes financing start-ups, financial planning for the nonpublic smaller enterprise, going public, selling out, bankruptcy, sources of capital, and other related topics. pre-req: MBA student or instructor consent

**MKTG 5710. Marketing for Non-Profits.** (3 cr. ; A-F or Audit; Periodic Summer)

This course will introduce students to the dynamic world of non-profits with an emphasis placed on key marketing strategies and tactics that successful non-profits use to fulfill their mission. This course will provide an overview of various aspects and special issues related to non-profit marketing including: (1) the focus of non-profit on social impact versus maximizing

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profits; (2) the marketing of social services; (3) marketing's role in fundraising; (4) challenges of integrating marketing efforts among diverse stakeholders; and (5) external economic, legal and political factors that impact marketing of non-profit services. pre-req: MBA student or department consent

**MKTG 5721. Advertising and Marketing Communications.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Promotional planning. Emphasis on planning for advertising, sales promotion, public relations/publicity, direct marketing, and personal selling. Importance of integrated marketing communications to organizations. pre-req: MBA student or department consent

**MKTG 5731. Consumer Behavior.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Buyer behavior and implications for marketing strategy. Emphasis on information processing concepts, influences on behavior, and decision making processes from both conceptual and pragmatic perspectives. Students requiring graduate credit must complete additional coursework. pre-req: MBA student or

**MKTG 5741. Developing and Marketing New Products.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

A marketing-oriented new products management course that explores the new product development process with a focus on marketing strategies for the planning, development and launch of new products and services. pre-req: MBA student or department consent

**MKTG 5762. Marketing Analytics II: Advanced Metrics and Analytic Techniques.** (3 cr. ; A-F or Audit; Every Fall)

This course builds upon the quantitative knowledge and skills that were introduced in Marketing Analytics Fundamentals, and introduces students to important customer relationship management metrics for customer acquisition, retention and defection, and customer lifetime value measures. pre-req: MBA student or instructor consent

**MKTG 5774. International Marketing.** (; 3 cr. ; A-F or Audit; Every Fall & Spring)

Marketing across national boundaries; effects of foreign economic, legal/political, and sociocultural environments on multinational marketing strategies.

**MAPL 5309. Legal System and Public Policy.** (3 cr. ; A-F or Audit; Periodic Spring)

Prepares advocates to understand the extent to which courts or more precisely the issues confronting our legal system drive policy and social change. Students will develop practical skills to seek legal remedies for their constituencies, and strategies for knowing when to choose the courts instead of the legislative process. prereq: Grad student or instructor consent

**MTAG 5110. Principles of Tribal Sovereignty I.** (3 cr. ; A-F or Audit; Every Fall)

This course provides students with a general background of the history, development, structure, and politics associated with indigenous governments. We will examine North American indigenous governance from pre-colonial times to the present, focusing on both the evolution and alteration of these governments as well as the difficult political

decisions indigenous peoples faced when confronted by the colonizing forces of European states, the U.S., and individual states, and the modifications developed by indigenous nations in their efforts to retain and exercise their sovereign powers. prereq: MTAG or MTRES student or instructor consent

**MTAG 5120. Principles of Tribal Sovereignty II.** (3 cr. ; A-F or Audit; Every Spring) This course examines the challenges facing tribal governments as they exercise their sovereignty and involves political, economic, and intergovernmental perspectives. Part one examines tribal resource management, analyzing historical use of land, land loss, and contemporary efforts to develop sustainable environmental plans for water, timber, wildlife, and subsurface resources. Part two focuses on the various means tribal governments have devised to exercise sovereignty, such as gaming, small business development, tourism, and joint ventures with partners. Part three concentrates attention at the sub national level and pays close attention to the political, legal, and economics relationships that have developed between Native nations, state governments, county governments, and municipal entities. prereq: 5110 or instructor consent

**MTAG 5210. Administration Governance I (Strategic).** (3 cr. ; A-F or Audit; Every Fall) This course will provide an overview of the integration and application of strategic management principles in tribal governments. Topics will include the development of mission statements, goals, strategies, and approaches to implementation. The course will focus on tribal strategic plans and issues specific to tribes, such as the federal-tribal relationship, tribal constitutions, and tribal ordinances and regulations. Also, the role of federal and state government policymakers as they interrelate with administrators in strategic management

decisions will be studied. prereq: MTAG student or instructor consent

**MTAG 5220. Administration and Governance II (Operations).** (3 cr. ; A-F or Audit; Every Spring)

This course will provide an overview of organizational management theories with an emphasis on tribal governments. It will focus on the various types of tribal governments, the role of tribal managers, tribal management functions, communications processes, and management information systems design and development. It will also explore different models of delivering services on reservations, including the direct federal service model, the 638 contact model, and the self-governance compact. Also, the role of federal and state government policymakers as they interrelate with administrators in operations management decisions will be studied. prereq: 5210 or instructor consent

**MTAG 5230. Advanced Tribal Administration and Governance I (Human Resources).** (3 cr. ; A-F or Audit; Every Fall)

This course will focus on the theoretical and practical aspects of solving problems, the activity that takes up the majority of a tribal manager's day. Human resource management will be emphasized. The use of tribal hypothetical and real-life situations will be heavily relied upon. Case studies of reservations and tribal organizations will be utilized to define problems, collect and analyze data, and seek creative solutions. The use of analogy, brainstorming, the scientific method, systems analysis, and graphic representations will be studied, as well as the role of federal and state government policymakers as they interact with administrators on human resources matters. prereq: 5220 or instructor consent

**MTAG 5240. Advanced Tribal**

transactions, and the roles of tribal accountants and auditors. prereq: MTAG 5120, MTAG student or instructor consent

**MTAG 5440. Tribal Finance, Accounting and Budgets II.** (3 cr. ; A-F or Audit; Every Spring)

This course will focus on the federal laws and regulations that tribal managers are required to comply with annually. These laws and regulations include the Indian Gaming Regulatory Act, Title 31, the Single Audit Act, and auditing rules under the Tribal Self Determination Act. The course will also focus on compliance with federal grants, the preparation of year-end financial statements, and the role of circulars from the federal Office of Management and Budget. The general standards for accountants and the penalties for non-compliance will be studied. The role of federal auditors and investigators will be compared to the role of tribes' internal auditors. prereq: 5430 or instructor consent

**MTAG 5530. Federal Indian Law I.** (3 cr. ; A F or Audit; Every Fall)

This course examines the formulation, implementation, and evolution of Indian policy from pre-colonial times to the self-governance era. This course provides a chronological

**Administration and Governance II (Project).** (3 cr. ; A-F or Audit; Every Spring)

This course will focus on the theory and implementation of project management and managing personnel engaged in project management. It will provide an overview of project management principles and concepts. Each student will select an actual reservation project and an aspect of tribal management (e.g., health care, natural resources, housing, or other area) for his or her final research paper. Each student will describe the project from beginning to end through the lens of management theory, as well as critique the implementation of the project. Also, the role of federal and state government policymakers as they interact with administrators on project management matters will be studied. prereq: 5230 or instructor consent

**MTAG 5310. Foundations of Leadership and Ethics in Indigenous Community Life and Organizations.** (3 cr. ; A-F or Audit; Every Fall)

This course will develop a general understanding of leadership and ethics. Content will include a survey of basic philosophies, models, figures, and applications to community-based scenarios and institutions. Western scholarship will be contrasted with Indigenous perspectives and lived experience as a means of exploring cultural difference. The role of traditional values and beliefs, internalized oppression, and contemporary community institutional dynamics are core course topics. prereq: MTAG student or instructor consent

**MTAG 5320. Applied Leadership and Ethics in an Indigenous Organizational Context.** (3 cr. ; A-F or Audit; Every Spring)

This course explores leadership and ethics in an applied context. Students will explore

framework and theoretical context in which policies, programs, and events can be seen interacting with each other to produce the cumulative body of treaties, statutes, and court decisions. Students analyze major federal Indian policies that define indigenous/federal political relationship, examining the views and attitudes of policy-makers and gauging the reactions of indigenous nations to those policies. prereq: MTAG 5320, MTAG student or instructor consent

**MTAG 5540. Federal Indian Law II.** (3 cr. ; A F or Audit; Every Spring)

Federal Indian law has had profound affect on the lives, liberties, and properties of indigenous peoples. At times, U.S. policy and Supreme Court rulings have worked to protect aboriginal rights; at other times, these policies and decisions have had devastating consequences. This course examines the role and practice of the U.S. Supreme Court as a policy-making institution in their dealings with Indigenous nations. This examination requires us to think historically and theoretically; to question the origins and exercise of federal judicial power; and examine the application of federal law to indigenous peoples and Indian

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what it means to be an effective ethical leader from a personal and community-based perspective. This involves a critical study of organizational culture and systems-based change processes. Case studies will be used to facilitate exploration and analysis. Reflecting on theories and philosophies of ethics and leadership, students will identify a personal leadership style, and determine what it means to be a decolonized leader in contemporary community life. prereq: 5310 or instructor consent

**MTAG 5430. Tribal Finance, Accounting and Budgets I.** (3 cr. ; A-F or Audit; Every Fall) This course will provide an overview of financial terms, processes, agencies, and laws as they apply to tribal governments. It will focus on overseeing budgeting, bookkeeping, accounting, and purchasing functions; interpreting financial statements; conducting due diligence; and negotiating indirect cost rates with the federal government. Emphasis will be placed on the role of the federal government in tribal financial management, the role of tribal sovereign immunity in financial



citizens. prereq: 5530 or instructor consent

**MTAG 5997. Tribal Administration and Governance Directed Project.** (2 cr. [max 4 cr.]; S-N only; Every Summer)

The Tribal Administration and Governance Directed Project is designed to give MTAG students practical experience in the field while assisting a tribe with a project that meets their own identified priorities. prereq: 12 credits in MTAG or instructor consent

**MBA 8111. Business Ethics.** (2 cr. ; A-F or Audit; Periodic Fall, Spring & Summer) How cultural, political, global, legal, and economic factors impact business activities. Issues of business ethics and social responsibility. prereq: MBA student or college consent

**MBA 8211. Data Analysis and Statistics for Managers.** (2 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Applications of business statistics, data analysis, and presentation of results. Research process and design, data collection, measurement concepts, sampling design, use and interpretation of statistical techniques, research ethics, reporting, and evaluating research finding. Focus is on the managerial use and interpretation of research results. pre-req: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296, or equivalent; ECON 2030 or BUS 2500 or equivalent; MBA student or college consent

**MBA 8311. Decision Making in Operations.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Examines managerial decision making in operations problems, including application of quantitative analysis and use of computers for production of goods or services in any type of organization. Investigates concepts and techniques related to the design, planning, control, and improvement of manufacturing

and service operations. Covers topics in the areas of inventory management, capacity planning, forecasting, management of service systems, and quality control. prereq: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296, or equivalent; ECON 2030 or BUS 2500 or equivalent; MGTS 3301 or BUS 2300 or equivalent; MBA student or college consent

**MBA 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Periodic Fall & Spring) (no description) prereq: Master's student, adviser and DGS consent

**MBA 8501. Accounting for Decision Making and Control.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Interpreting and using accounting information for managerial decision-making. Explores motivations related to creating financial statement and an understanding appreciation of accounting information. Also examines the strengths and limitations of an organization's accounting system. pre-req: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296, or equivalent; ACCT 2001 and 2002 or BUS 2100 or equivalent; MBA student or college consent

**MBA 8512. Managerial Economics.** (2 cr. ; A-F or Audit; Periodic Fall & Spring)

Application of economic theory and economic methodology to managerial decision making. Supply and demand, production, consumer behavior, business and economic forecasting, pricing and marketing strategies under differing competitive conditions, government's role, and the global market. prereq: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296, or equivalent; ECON 1003 or ECON 1022 and ECON 1023, or BUS 2200 or equivalent; MBA student or college consent

**MBA 8611. Financial Management and Decision Making.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Overview of fundamental concepts and principles of financial management and how these analyses are implemented by financial managers in making strategic financial decisions in a corporate setting. Topics include developments in capital market theory, capital budgeting analysis in terms of the NPV and real options approaches, costs of capital, long term financing, capital structure analysis and international financial strategies. prereq: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296 or equivalent; FMIS 3601 or FIN 3601 or BUS 2600 or equivalent; MBA student or college consent

**MBA 8711. Strategic Marketing Management.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Planning, implementation, evaluation, and control of organizational marketing activities. This process includes environmental market analysis in order to achieve competitive advantage and effective resource allocation. prereq: Meet MBA mathematics foundation requirement, MATH 1160, MATH 1296, or equivalent, MKTG 3701 or BUS 2700 or equivalent; MBA student or college consent

**MBA 8811. Human Resource Challenges.** (2 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Overview of contemporary human resource issues, human resource systems, procedures, and decisions that guide effective, efficient, and equitable management of people in organizations. prereq: MGTS 3401 or BUS 2400 or equivalent; MGTS 3801 or BUS 2800 or equivalent; MBA student or college consent

**MBA 8910. Improvisational Theater for Business.** (1 cr. [max 3 cr.]; A-F or Audit; Periodic Summer)

This course is intended to provide students a platform to build a better understanding of themselves and their relationship with others

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in order to develop key soft skills that are important in the modern business environment. It applies the principles of improvisational theater to help students explore and develop their ability to face risky, uncertain situations and respond effectively and efficiently. prereq: MBA student or instructor consent

**MBA 8911. Strategic Management.** (3 cr. ; A F or Audit; Periodic Spring & Summer)

Formulation of corporate and business strategies that results in a sustainable competitive advantage through identifying opportunities and threats, as well as resources and capabilities of an organization. Develop an overview of levers to implement these strategies. Develop integrative thinking of applying knowledge of all functional areas of business to implement the strategies in order to achieve long-term performance of the overall organization. prereq: Completion of all MBA foundation requirements; MBA 8311, 8501, 8611, 8711, and 8811; MBA student or college consent; credit will not be granted if already received for MBA 8411

**MBA 8991. Independent Study.** (1-3 cr. [max 6 cr.]; A-F or Audit; Periodic Fall, Spring & Summer)

Provides opportunity for focused, integrative or interdisciplinary projects or research, under the guidance of a faculty member in various areas of business administration that extend beyond, or in greater depth than, regular courses. prereq: college consent

**MBA 8994. Directed Research.** (1-6 cr. ; A-F or Audit; Periodic Fall, Spring & Summer) Directed research. prereq: MBA student, college consent

**MBA 8995. Special Topics: (Various Titles to be Assigned).** (; 1-3 cr. [max 8 cr.]; A-F or Audit; Periodic Fall, Spring & Summer) Special topics on or integrative, interdisciplinary study of problems in accounting, economics, and business administration. prereq: MBA student or department approval

**MPS 8001. Theories, Methods and Applications of Graduate Study.** (4 cr. ; A-F or Audit; Every Fall)

Introduction to theories, methods and applications of interdisciplinary liberal studies. This course provides M.L.S. students with a thorough review of analytical writing and research methods as well as an introduction to university disciplines and interdisciplinary at the graduate level. prereq: MLS candidate or instructor consent

**MPS 8501. Seminar: Community Engagement.** (; 4 cr. ; A-F or Audit; Spring Even Year)

Examination of various community issues and means of addressing them through issue identification, description, policy, and political organization. Depending on the instructor's pedagogical goals, this course may require students to engage in work off-campus with community partners. prereq: graduate student and instructor consent

**MPS 8502. Seminar: International Perspectives.** (; 4 cr. ; A-F or Audit; Spring

Odd Year)

Topics related to opportunities and problems emerging from the steady increase in globalization that shapes our communities in the present-day. prereq: graduate student

**MPS 8591. Directed Study.** (1-8 cr. ; A-F or Audit; Every Fall, Spring & Summer)  
Individualized study under supervision of the director of the liberal studies program. prereq: MLS candidate or department consent

**MATH 5201. Real Variables.** (; 4 cr. ; A-F or Audit; Every Fall)  
Limits, sequence and series of real numbers, tests for convergence, rearrangements, summability, and the class L-SQUARED. Metric spaces; continuous functions, connectedness, completeness, compactness. Banach fixed-point theorem and Piccard existence theorem for differential equations. prereq: 4201 with a grade of C- or better

**MATH 5202. Applied Functional Analysis.** (3 cr. ; A-F or Audit; Spring Odd Year)  
Basic concepts, methods, and applications of functional analysis. Complete metric spaces, contraction mapping, and applications. Banach spaces and linear operators. Inner product and Hilbert spaces, orthonormal bases and expansions, approximation, and applications. Spectral theory of compact operators, including self-adjoint and normal operators. pre-req: MATH 5201, MATH 4326 or 5327; MATH 5327 can be taken concurrently

**MATH 5233. Mathematical Foundations of Bioinformatics.** (3 cr. ; A-F or Audit; Every Spring)  
Mathematical, algorithmic, and computational foundations of common tools used in genomics and proteomics. Topics include: sequence alignment algorithms and implementations (Needleman-Wunsch, Smith-Waterman, BLAST, Clustal), scoring

matrices (PAM, BLOSUM), statistics of DNA sequences (SNPs, CpG islands, isochores, satellites), and phylogenetic tree methods (UPGMA, parsimony, maximum likelihood). Other topics will be covered as time permits: RNA and protein structure prediction, microarray analysis, post-translational modification prediction, gene regulatory dynamics, and whole-genome sequencing techniques. prereq: MATH 3355, CS 1xxx or above, STAT 3411 or 3611

**MATH 5260. Dynamical Systems.** (; 3 cr. ; Student Option; Fall Odd Year)  
Fundamentals of differential equations (existence, uniqueness, continuation of solutions); linear systems, autonomous systems, and Poincare-Bendixon theory; periodic systems; discrete dynamical systems; bifurcation theory; chaos. prereq: 3280 with a grade of C- or better

**MATH 5270. Modeling with Dynamical Systems.** (; 3 cr. ; Student Option; Spring Even Year)  
Application and analysis of continuous and discrete dynamical systems. Model construction, simulation, and interpretation. prereq: 3280 with a grade of C- or better

**MATH 5280. Partial Differential Equations.** (; 3 cr. ; A-F or Audit; Fall Even Year)  
Introduction to partial differential equations, emphasizing use of Fourier series, Green's functions, and other classical techniques. prereq: A grade of at least C- in 3280 and 3298 or grad standing

**MATH 5327. Advanced Linear Algebra.** (3 cr. ; A-F or Audit; Every Spring)  
Vector spaces over fields, subspaces, linear transformations, matrix representations, change of basis, inner-product spaces, singular value decomposition, eigenspaces, diagonalizability, annihilating polynomials, Jordan form. prereq: Graduate student or instructor consent

**MATH 5330. Theory of Numbers.** (3 cr. ; A-F or Audit; Spring Odd Year)  
Properties of integers, primes, divisibility, congruences, and quadratic reciprocity. Computational aspects include factoring algorithms and RSA cryptosystem. prereq: 3355 with a grade of C- or better or instructor consent

**MATH 5347. Applied Algebra and Cryptology.** (3 cr. ; A-F or Audit; Fall Even Year)  
Applied algebra topics include mathematical origami, permutation games, and the Rubik's cube. Cryptology topics include monoalphabetic substitution ciphers, RSA, primality testing, and elliptic curve cryptology, and recent advancements in the field. Only one of either MATH 4274 or MATH 5374 may be allowed for undergraduate mathematics electives. pre-req: grad student or instructor consent

**MATH 5365. Graph Theory.** (3 cr. ; A-F or Audit; Every Fall)  
Finite graphs, including trees, connectivity, traversability, planarity, colorability, labeling, and matchings. prereq: 3355 with a grade of C or better or instructor consent

**MATH 5366. Enumerative Combinatorics.** (; 3 cr. ; A-F or Audit; Spring Odd Year)  
Permutations, combinations, binomial coefficients, inclusion-exclusion, recurrence relations, ordinary and exponential generating functions, Catalan numbers, selected topics from designs, finite geometries, Polya's enumeration formula. prereq: 3355 with a grade of C- or better

**MATH 5371. Abstract Algebra I.** (3 cr. ; A-F or Audit; Every Fall)  
Introduction to groups and rings and their applications. prereq: 3355 or 4326 with a grade of C- or better or grad standing or instructor consent

**MATH 5372. Abstract Algebra II.** (3 cr. ; A-F or Audit; Every Spring)

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Polynomial rings, divisibility in integral domains, field extensions, finite fields, special topic, and applications. prereq: 5371 with a grade of C- or better or instructor consent

**MATH 5810. Linear Programming.** (; 3 cr. ; A-F or Audit; Spring Odd Year)  
Motivation problems, modeling, theory of simplex method, duality and sensitivity analysis, large-scale problems, complexity, and Karmarkar algorithm. prereq: 3280 or 4326f with a grade of C- or better

**MATH 5830. Numerical Analysis: Approximation and Quadrature.** (; 4 cr. ; Student Option; Every Fall)  
Error analysis, interpolation and approximation, numerical integration, solution of nonlinear systems. prereq: 3280 or 4326 with a grade of C- or better, proficiency in FORTRAN or C or C ++

**MATH 5840. Numerical Analysis: Systems and Optimization.** (; 4 cr. ;

Student Option; Spring Even Year)  
Solution of systems of linear equations; elimination and factorization methods; iterative methods; error analysis; eigenvalue/eigenvector approximation; unconstrained optimization; nonlinear least squares. prereq: 3280 or 4326 with a grade of C- or better, proficiency in FORTRAN or C or C ++

**MATH 5850. Numerical Differential Equations.** (; 4 cr. ; A-F or Audit; Spring Odd Year)  
Computational differencing techniques as applied to initial- and boundary-value problems. Introduction to variational formulations of differential equations and general technique of weighed residuals. prereq: 3280 with a grade of C- or better, proficiency in FORTRAN or C or C ++

**MATH 5991. Independent Study.** (1-4 cr. [max 8 cr.] ; A-F or Audit; Every Fall, Spring & Summer)  
Directed individual reading and/or research in mathematics; must be arranged with instructor

and department head before registration. prereq: department consent; Maximum 6 credits to a grad program.

**MATH 8201. Real Analysis.** (; 3 cr. ; A-F or Audit; Periodic Spring)  
Rigorous development of abstract measure spaces, measurable functions, and corresponding theory of integration. Lebesgue measure and Lebesgue integral developed as a particular model. (offered alt yrs) prereq: 5201 with a grade of C- or better

**MATH 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer)  
(No description) prereq: Master's student, adviser and DGS consent

**MATH 8774. Plan B Final Project Research.** (1-4 cr. ; A-F or Audit; Every Fall & Spring)  
Independent research performed under Advisor's supervision. Starting the 1st semester after submission of their Graduate

Degree Plan Form, Plan B students must register for 2 cr of MATH 8774 every semester until they defend their project. pre-req: advisors consent

**MATH 8777. Thesis Credits: Master's.** (1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer)  
(No description) prereq: Maximum 18 credits per semester or summer; 10 credits total required (Plan A only)

**MATH 8980. Graduate Seminar.** (1 cr. ; A-F or Audit; Every Fall)  
Survey of applications of discrete, continuous, and stochastic modeling techniques. For first-year graduate students in applied and computational mathematics. prereq: instructor consent

**MATH 8990. Graduate Colloquium.** (0.5 cr. ; S-N only; Every Fall, Spring & Summer)  
Graduate colloquium attendance. Students must attend at least 16 graduate colloquia organized by the department of mathematics and statistics. For graduate students in Mathematical Sciences program only. pre-req: department consent

**MATH 8991. Comprehensive Exam.** (0.5 cr. ; S-N only; Every Fall, Spring & Summer)  
Mastery of knowledge in core courses in mathematical sciences. Students must achieve a satisfactory score in a comprehensive examination. For graduate students in Mathematical Sciences program only. pre-req: department consent

**MATH 8994. Directed Research.** (1-4 cr. [max 12 cr.] ; A-F or Audit; Every Fall, Spring & Summer)  
TBD prereq: instructor consent

**ME 5050. Fundamentals of Nuclear Engineering.** (3 cr. ; A-F or Audit; Every Fall)  
Introduction to the fundamentals of nuclear engineering including atomic and nuclear physics, fission, fusion, isotopes, radioactivity, nuclear reactions, radiation detection, criticality,

and reactor kinetics. Overview of types of reactors and some operational considerations. A discussion of radiation types and safety. pre-req: SCSE graduate student or instructor consent

**ME 5060. Machine Vision and Image Based Robot Control.** (3 cr. ; A-F or Audit; Every Fall)

This course will introduce the up-to-date techniques of autonomous image-based robot control. The covered topics include algorithms on image acquisition, camera calibration, object identification, and visual servoing. The methods and concepts introduced will be combined with engineering applications such as obstacle avoidance in traffic safety, image-guided robotic surgery, and human robot interaction in life support. Through this course, students will acquire both hardware and software development experiences on visual servoing, which could be directly applied to their future engineering career or advanced academic pursuit. pre-req: CS 1511, MATH 3280, ME 3140 or equivalent or instructor consent

**ME 5110. Analytic Techniques in Mechanical Engineering.** (3 cr. ; A-F or Audit; Every Fall)

Fundamental mezzanine course on analytic techniques as applied in Mechanical Engineering, and required for the Mechanical Engineering MS degree. Topics covered include tensor analysis of linear and nonlinear elasticity, nonlinear analysis and complex variable techniques in control systems, and special functions for solution of thermodynamics and fluid-dynamics partial differential equations in a variety of coordinate systems. Computational analytic tools and techniques will be incorporated as appropriate. pre-req: BSME major with B or better in MATH 3280 and 3298 or graduate student or instructor consent

**ME 5120. Advanced Dynamics and Control.** (3 cr. ; A-F or Audit; Every Spring)

This course covers modeling and control of linear and nonlinear mechanical and electro mechanical systems. Topics include lumped

parameter and Lagrangian nonlinear modeling of mechanical and electro-mechanical systems, time domain response of dynamic systems, Lyapunov stability, and controller design for linear and non-linear systems. pre-req: BSME major with B or better in ME 3140 and MATH 3280 or graduate student or instructor consent.

**ME 5210. Advanced Thermal Fluid Sciences.** (3 cr. ; A-F or Audit; Every Spring)  
This course covers heat transfer in fluid flowing around bodies and in tubes/ducts, energy, forced/natural convection, laminar/turbulent flow regimes, turbulent transport and modeling, high-speed flows, viscous dissipation, variable property effects, application to heat exchange devices, and convective mass transfer. pre req: BSME major with B or better in ME 4112 or graduate student or consent of instructor

**ME 5220. Advanced Mechanics of Materials.** (3 cr. ; A-F or Audit; Every Spring)  
This course will cover the concepts related to advanced mechanics of materials including stress, strain, material properties, energy methods including Catigliano's Theorem, elasticity problems, advanced topics including plasticity and creep. Throughout the term of the semester students will solve engineering problems relating to these topics and will be also be exposed to the numerical techniques used to solve these problems. pre-req: BSME major with B or better in MATH 3280 and MATH 3298 and ENGR 2016 or CE 2017; or graduate student or instructor consent

**ME 5305. Computational Fluid Dynamics.** (3 cr. ; A-F only; Spring Even Year)  
Finite-difference methods for steady and transient diffusion and convection-diffusion problems. Finite-volume technique for the solution of multi-dimensional fluid flow, and heat and mass transfer problems. Utilize CFD software to solve complex problems. prereq: 4112 (concurrent registration allowed) or ChE 3112, BSChE, or BSME or BSIE candidate or instructor consent

**ME 5315. Nondestructive Evaluation of Engineering Materials.** (; 3 cr. ; A-F only; Periodic Fall)

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Fundamentals of Ultrasonic and Acoustic Emission NDE are considered including wave propagation, experimental measurement systems, flaw detection and characterization, and material characterization. Labs are used to support the study of ultrasonic and acoustic emission NDE. Other NDE techniques including magnetics, penetrants, eddy currents, thermography, are surveyed. prereq: 3140

**ME 5325. Sustainable Energy System.** (3 cr. ; A-F only; Spring Odd Year)

A comparison of different energy systems will be made in terms of economic, environmental and political implications. Specific energy alternatives will include coal, oil, geothermal, bioenergy, solar, wind, fission, fusion, hydrogen, fuel cell. prereq: 3211, BSChE or BSEE or BSIE or BSME candidate

**ME 5335. Introduction to Finite Element Analysis.** (3 cr. ; A-F only; Fall Even Year)

An introduction to finite element analysis, including theoretical and applied components in mechanical and thermal systems. prereq: BSME or BSIE or MSEM candidate or instructor consent

**ME 5345. Smart Materials and Structures.** (; 3 cr. ; A-F or Audit; Spring Even Year)

Introduction to smart materials and structures, such as piezoelectric materials, shape memory alloys, magnetostrictive materials, adaptive structures, and active vibration control systems. The course will cover their material properties, modeling methods, and engineering applications in sensors, actuators, energy harvesting, and biomedical devices. prereq: 3140, 3222

**ME 5355. Gas Turbines.** (3 cr. ; A-F or Audit; Fall Even Year)

Gas turbine cycles, regenerations, recuperation, reheat, intercooling, combined cycle plants, and thermochemical regeneration. Axial and radial flow compressors and turbines;

combustor designs, energy analysis, emissions, and noise. Turbojet, fanjet, turboprop engine performance. Stationary power plants. prereq: 3111, 3211 and BSME or MEng or MSEM or instructor consent

**ME 5365. Introduction to Medical Device Development.** (3 cr. ; A-F or Audit; Spring Odd Year)

This course will cover the concepts related to the development of medical devices including biocompatibility of materials, prototyping medical devices, identifying unmet clinical needs, regulatory requirements, intellectual property protection, and reimbursement. Throughout the term of the semester students will apply these concepts to a project where they will develop a medical device concept to address an unmet clinical need. pre-req: ME 2105, BSME or BSIE upper division or MSEM or MSME candidate, or instructor consent

**ME 5991. Independent Study in Mechanical Engineering.** (1-4 cr. [max 6 cr.]

; Student Option; Periodic Fall, Spring & Summer) Directed study of special interest topics not available in standard curriculum. Must be arranged with instructor before registration. May include readings, research and/or special projects. prereq: MSEM candidate, department consent

### **ME 8310. Mechanical Engineering**

**Capstone Project.** (3 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Capstone project in which each student should utilize their acquired mechanical engineering skills and demonstrate their mastery of mechanical engineering concepts by completing a well-defined project that addresses a real-world problem. The project is to be documented with a formal paper and an oral presentation. prereq: MEng or MSME candidates and minimum of 12 credits successfully completed or department consent

**ME 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Master's student, adviser and DGS consent

**ME 8777. Thesis Credits: Master's.** (1-10 cr. ; No Grade Associated; Every Fall, Spring & Summer) Thesis Credits pre-req: ME grad student

**ME 8993. Graduate Seminar.** (1 cr. [max 2 cr.] ; S-N or Audit; Every Fall & Spring) Practice in preparation and oral presentation of reports on articles from the literature or on graduate research and topics related to professional ethics. pre-req: ME grad student

### **MED 5085. Medical Research Ethics, Responsible Conduct of Research.** (1 cr. ; S-N only; Every Fall)

Designed for postdoctoral fellows and graduate and undergraduate students to define and investigate ethical behavior in research. The potential pitfalls encountered when doing

medical research also will be emphasized. Topics include morality and ethics; rationale for training in responsible conduct of research; definition of research misconduct; fabrication and falsification; conflict of interest; financial misconduct; authorship; grant writing; peer review; mentorship; animal research issues; human research issues; technology transfer; gender/race issues; and whistleblowing prereq: instructor consent

### **MED 6023. Seminars in Native American Health.** ( ; 1-2 cr. [max 4 cr.] ; P-N or Audit; Every Fall)

Current issues impacting health of Indian people. Causes of morbidity and mortality, including social, cultural, and economic issues. Discussion focuses on solutions to problems in context of Indian communities. prereq: 2nd year med student

### **MED 6102. Introduction to Rural Family Medicine and Native American Health Care.** ( ; 4 cr. ; P-N only; Every Fall)

The Introduction to Rural Family Medicine and Native Health Care course for first year medical students illustrates the positive qualities of practicing rural family medicine in rural Minnesota and Native American communities. The course introduces students to cultural, historical and political components of Native American nations, tribes and people. This course will include lectures, panel discussion, small group discussions and simulation. Also included in this course are didactic lectures and hands-on learning of medical history taking and physical examination skills taught in a small group setting. prereq: Registered medical student

### **MED 6520. Foundations of Medicine.** ( ; 9 cr. [max 18 cr.] ; P-N only; Every Fall)

This is a dense course. The course begins with an overview of biochemistry and biochemical processes required for normal cell function. Followed by several aspects of cell biology. These include discussions of cellular structure and organelles, gene expression and its control, and the mechanisms of cell division and cell death. It concludes with a discussion of membrane transport and cellular signaling. The course continues with a discussion of

genetics and genomics, including the inheritance of genetic traits and the use of genetic information for the diagnosis and treatment of disease. Throughout the course, there are short segments on the principles of drug action including pharmacokinetic and pharmacodynamic considerations. A heavy emphasis is placed on antibacterial drugs, as these are essential for further drug discussion in each of the organ-based courses that follow Foundations. Towards the end of the course you will receive an introduction to embryology and the final segment covers the normal structure and function(s) of the basic tissues of the body and provides a necessary background for understanding how the various organ systems (to be studied in subsequent courses) are organized around these basic tissues. This material will be closely interfaced with fundamental principles of pathology, which focuses on cell injury and neoplasia. Normal histology that is covered includes: epithelium and glands, connective tissues, muscles, and neural tissue. prereq: Regis med student

### **MED 6530. Rural Medical Scholars Program I (RMSP I).** (5 cr. ; P-N only; Every Fall)

This course provides an opportunity to get out of the classroom and get into small communities to practice our skills and learn about what it's like to be a small town physician. Students spend time getting to know the community, the healthcare system and how the two work together. prereq: Medical School Student

### **MED 6531. Rural Medical Scholars Program II (RMSP II).** (4 cr. ; P-N only; Every Fall)

Rural Family Medicine, Native American and Minority students clinical, cultural, interprofessional and community experiential program. As a health care professional in training, the student will participate in acute and longitudinal care, electronic portfolio use, and Faculty Advisor interaction to develop an understanding of rural medicine and educational competencies. The preceptorship course will occur in conjunction with Rural Family Medicine. prereq: Medical Student

### **MED 6541. Hematology Immunology Oncology.** ( ; 7 cr. [max 10 cr.] ; P-N only; Every Summer)

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Introduction to principles of human immunology and hematology. Basic science principles, including pharmacology and pathology together with clinical aspects of innate and acquired immunity within context of hemato-lympho reticular system. prereq: Regis med student

### **MED 6566. Cardiovascular Respiratory, Renal, Acid-Base Medicine 1.** ( ; 6 cr. [max 7 cr.] ; P-N only; Every Fall)

Integrated comprehensive overview of cardiovascular system. Anatomical, biochemical, physiological, pathological, and pharmacologic aspects of heart, blood vessels, and blood, including histology, embryology, anatomy, gross and microscopic pathology, as well as clinical features, diagnosis, and pharmacological therapy. prereq: Regis med student

**MED 6573. Neurological Medicine.** (11 cr. [max 15 cr.] ; P-N only; Every Spring) Interdisciplinary study of human nervous system, including consideration of eye and ear. Basic sciences of anatomy, behavioral science, biochemistry, microbiology, pathology, pharmacology, and physiology correlated with clinical material. prereq: Registered med student or instructor consent

### **MED 6601. Art and Science at the End of Life.** (1 cr. ; P-N only; Every Summer)

This course will introduce students to concepts common in the care of end of life patients. While end of life is a focus point, many of the topics (cultural humility, spirituality, communication, etc.) are relevant to the practice of medicine in general. pre-req: medical student

### **MED 6724. Gastrointestinal Medicine.** (6 cr.

[max 9 cr.] ; P-N only; Every Spring) Interdisciplinary integrative course discusses fundamental concepts of anatomy, physiology, nutrition, pathology, clinical medicine, and microbiology as they relate to issues of gastrointestinal and hepatobiliary system. prereq: Registered med student

### **MED 6728. Cardiovascular Respiratory, Renal, Acid-Base Medicine 2.** (9 cr. [max 10 cr.] ; P-N only; Every Fall)

Maintenance and regulation of human internal environment by the respiratory system. Histology of upper airways and lungs; respiratory gas exchange; introduction to respiratory component of acid-base balance. Integrative lab covering cardiovascular respiratory adjustments to exercise. prereq: Registered med student

### **MED 6762. Hormonal and Reproductive Medicine.** (6 cr. [max 7 cr.] ; P-N only; Every

Spring)  
Structure and function of endocrine and reproductive systems. Essential background for understanding findings of clinical medicine related to endocrine regulation of reproduction and homeostasis. prereq: Registered med student

**MED 6773. Integrated Clinical Medicine.** (; 6 cr. ; O-N or Audit; Every Spring)  
Integration of basic, clinical, and behavioral science principles to understand the human body and its integrative function and psychosocial responses, especially in multisystem conditions. Emphasizing evidence based medicine principles, health issues are explored over the life cycle from pediatrics to geriatrics.

**MED 6788. Skin/Musculoskeletal System.** (7 cr. [max 10 cr.] ; P-N only; Every Fall)  
Interdisciplinary study of integument and musculoskeletal system. Basic sciences of anatomy, microbiology, pathology, pharmacology, and physiology correlated with clinical material. prereq: Registered med student

**MED 6996. Summer Internship in Pediatrics.** (0 cr. ; No Grade Associated; Every Summer)  
This course is to provide interested medical students exposure to clinical general pediatrics early in medical school. The course offers a two-week preceptorship with a general pediatrician during the summer hiatus between the first and second year of medical school. This course is only available to students who are a part of the EPAC Explore group. The student will be paired with a local general pediatrician in the Twin Cities. The student will spend a minimum of 4 half days per week and a maximum of 8 half days per week for two consecutive weeks with their preceptor. The student will do what the general pediatrician is doing - general clinic, pediatric urgent care visits, hospital rounds, nursery rounds etc. pre-req: Students interested in participating must complete an electronic application in late February/early March. Registration will be completed by the department after acceptance.

**MED 6997. Summer Internship in Medicine.** (3-12 cr. ; P-N or Audit; Every Summer)  
Medical students, typically between their first

and second-year of medical school, may elect to participate in either directed clinical experiences in small communities or research studies. prereq: Registered med, satisfactory completion of first year of medical school, instructor consent

**MU 5201. Advanced Music History.** (2 cr. ; A-F or Audit; Every Fall)  
Specialized study of selected composers and/ or genres. prereq: 3201, 3202 or instructor consent

**MU 5203. Advanced Choral Literature.** (2 cr. ; A-F or Audit; Periodic Fall & Spring)  
Study of representative choral literature from various periods of music history. prereq: 3702 or instructor consent

**MU 5204. Instrumental Ensemble Literature.** (2 cr. ; A-F or Audit; Periodic Fall & Spring)  
Study of major works for large wind and orchestral ensembles. prereq: Grad Student or instructor consent

**MU 5205. Instrumental Solo Literature.** (1 cr. [max 3 cr.] ; A-F or Audit; Periodic Fall & Spring)  
Survey of instrumental solo literature within the student's applied field of study. prereq: Grad student or instructor consent

**MU 5206. Vocal Solo Literature.** (1-2 cr. ; A-F or Audit; Periodic Fall & Spring)  
A historical survey of standard repertoire for solo voice in art song, opera, and oratorio; focus varies by semester. prereq: Grad student or instructor consent

**MU 5207. Instrumental Chamber Music Literature.** (1 cr. ; A-F or Audit; Periodic Fall & Spring)  
Study of chamber music literature with emphasis on student's major applied area. prereq: Grad student or instructor consent

**MU 5208. Vocal Chamber Literature.** (1 cr. ; A-F or Audit; Periodic Fall & Spring)  
A survey of standard repertoire for solo voice with chamber ensembles. prereq: Grad student or instructor consent

**MU 5210. The Professional Singer: Entrepreneurship for Opera Singers.** (1 cr. ; A-F or Audit; Periodic Spring)

The study and application of audition skills for the opera singer. pre-req: Music major with concurrent registration in MU 4311 or 8301 and instructor consent

**MU 5211. Piano Literature I.** (2 cr. ; A-F or Audit; Fall Even Year)

The objective of this Piano Literature course is to study selected keyboard repertoire from the Middle Ages through Classical Period. pre-req: Music majors with instructor consent

**MU 5212. Piano Literature II.** (2 cr. ; A-F or Audit; Spring Odd Year)

The objective of this Piano Literature course is to study selected keyboard repertoire from the Romantic Period through the Contemporary/ Present Period. pre-req: Music majors with instructor consent

**MU 5510. Opera Studio.** (1 cr. [max 6 cr.] ; A F or Audit; Every Fall & Spring)

Opera production techniques; performance of solo and ensemble opera literature. prereq: 3510 or equivalent, Grad student or instructor consent

**MU 5627. Art of Accompanying: Vocal Music.** (2 cr. ; A-F or Audit; Fall Even Year)  
Vocal accompanying art song, recitative and aria, choral music, and functional skills (e.g., score reading, keyboard harmony). Vocal coaching techniques, listening to standard vocal repertoire, and performance. prereq: Graduate Enrollment; credit will not be granted if already received for MU 3627

**MU 5628. Art of Accompanying: Instrumental Music.** (2 cr. ; A-F or Audit; Spring Odd Year)  
Instrumental accompanying (string, brass, and woodwinds) and functional skills (e.g., score reading, keyboard harmony). Rehearsal techniques, listening to standard instrumental repertoire, performance. prereq: Graduate enrollment; credit will not be given if already received for MU 3628

**MU 5991. Independent Study.** (1-3 cr. [max 9 cr.] ; A-F or Audit; Every Fall & Spring)  
Directed study in areas of student interest arranged with instructor before registration. prereq: Min 60 cr or Grad Student or instructor consent; can apply max 6 cr to a Grad program

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writing plan B project. prereq: Grad student or instructor consent

**MU 8300. Graduate Recital.** (1 cr. [max 2 cr.] ; A-F or Audit; Every Fall & Spring)  
Preparation and presentation of a solo musical performance. prereq: Grad student, instructor consent

**MU 8301. Graduate Applied Music: Major Instrument.** (2 cr. [max 10 cr.] ; A-F or Audit; Every Fall, Spring & Summer)  
Studio lesson on major instrument or voice; one-half hour per week per credit. prereq: Advanced proficiency, grad student, instructor consent

**MU 8302. Graduate Applied Music: Secondary Instrument.** (1 cr. [max 4 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Half-hour weekly studio lesson; instrument or voice. prereq: Intermediate proficiency, grad student, instructor consent; may be repeated

**MU 8333. FTE: Master's.** (; 1 cr. ; No Grade Associated; Periodic Fall & Spring)  
(no description) prereq: Master's student, adviser and DGS consent

**MU 8401. Graduate Music Pedagogy.** (1 cr. ; A-F or Audit; Every Spring)  
Principles and techniques of music pedagogy with emphasis on the student's applied field of study. prereq: Graduate Student or instructor consent

**MU 8600. Methods of Research in Music Education.** (3 cr. [max 9 cr.] ; A-F or Audit; Periodic Fall & Spring)  
Survey and analysis of current issues in

**MU 5995. Special Topics: (Various Titles to be Assigned).** (; 1-3 cr. [max 6 cr.] ; A-F or Audit; Periodic Summer)  
Selected studies in topics defined by type, period, or composer. prereq: instructor consent

**MU 8101. Graduate Music Theory.** (2 cr. ; A F or Audit; Every Spring)  
Advanced analytical studies of representative historical musical compositions. Students will utilize multiple analytical processes and compose model pieces. prereq: Graduate student or instructor consent

**MU 8222. Music Bibliography and Research.** (3 cr. ; A-F or Audit; Every Fall)  
Research methods in music; preparation for

music education research and/or practice.  
prereq: Grad student or instructor consent

**MU 8601. Foundations of Music Education.**

(3 cr. ; A-F or Audit; Every Spring)

Principles and foundations of philosophical aesthetics, psychology of music, music advocacy, history of music education, current issues and research in music learning. prereq: Grad student or instructor consent

**MU 8605. Curricular Trends in Music**

**Education.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Techniques, theories, and models of music and arts leadership; considerations for supervising music personnel, facilities, budgets, curricular programs, and policies. prereq: Grad student or instructor consent

**MU 8701. Graduate Applied Conducting.**

(1-2 cr. [max 12 cr.] ; A-F or Audit; Periodic Fall & Spring)

Studio lessons in conducting; one half-hour per week per credit. prereq: 3702, 3706 or equivalent; Graduate Student or instructor consent

**MU 8899. Directed Project in Music**

**Education.** (1-12 cr. ; A-F or Audit; Periodic Fall & Spring)

Directed project, Plan B. Research project on selected theoretical or practical issue/topic in Music Education. prereq: Grad, instructor consent

**MU 8900. Psychology of Music.** (3 cr. [max 9 cr.] ; A-F or Audit; Every Spring)

The nature of musical behaviors and how they are perceived. Understanding physical properties of musical sound, fundamental concepts concerning musical measurement and musical preference. prereq: Grad student, instructor consent

**MU 8991. Independent Study.** (1-2 cr. [max 6 cr.] ; A-F or Audit; Periodic Fall & Spring)

Directed study in areas of student interest arranged with instructor before registration; written report required. prereq: Grad student, instructor consent

**OJED 5310. American Indians and**

**Special Education.** (; 4 cr. ; A-F or Audit; Fall Even Year)

Exploration of disability awareness in

traditional and contemporary native culture, exploring historical and contemporary issues effecting American Indian students in special education. Overview of special education including standards, law theories, rules, and examination of the high incidence of American Indians in special education including FAS, autism, biological and environmental conditions. Portfolio requirements will be introduced. A field component will accompany this course. prereq: Naadamaadwin Tribal Special Education cohort (special education licensure)

**PHAR 5100. Pro-Seminar.** (1 cr. ; A-F only; Every Fall)

History, foundational frameworks, and key research domains for social and administrative pharmacy through examining landmark literature. Students think critically, reflect on important works, and create a cognitive map of the discipline and their own focus for study.

**PHAR 5201. Applied Medical Terminology.** (; 2 cr. ; Student Option; Every Fall, Spring & Summer)

This course will help students recognize medical abbreviations, relate terms to procedures and diagnostics, comprehend the meaning of medical terminology by using word elements, and apply medical terms in the context of patient care. Communication related to disease states, procedures, and diagnostics in health care can sometimes seem like another language. During this course, students will not only increase their medical vocabulary by more than 2500 words in a self paced manner, they will also learn to identify and articulately describe a wide variety of medical conditions and processes. This is a completely online, self-paced course but runs on an accelerated 10-week schedule each Fall, Spring, and Summer term. For more information, contact phar5201@umn.edu or 612-624-7976. Prereq: Basic knowledge of human anatomy/physiology

**PHAR 5204. Drugs and the U.S. Healthcare System.** (; 3 cr. ; Student Option; Every Fall & Spring)

Being an empowered patient is important when discussing ethics-driven issues within the U.S. health care system. This course will

expose students to current controversial issues surrounding medications and national health care and help students examine their own role as a participant in this system. Students will learn to draw comparisons between medication use systems around the world and analyze other controversies related to access, choice, and quality of health care. During this course, students will understand how their choices, ethics and behavior affect societal decisions surrounding the availability of medications in the US and what their rights are as a citizen participant during the health care debate. This is a completely online course with weekly due dates offered each Fall and Spring term. For more information, contact phar4200@umn.edu or 612-624-7976.

**PHAR 5205. Obesity: Issues, Interventions, Innovations.** (; 2 cr. ; Student Option; Every Spring)

This course will focus on the role of the pharmacist in treating obesity. Students will learn the pharmacology of past and current medications to treat obesity, as well as the pathophysiology of the disease to understand why more options aren't available. Students will explore drug information sources for dietary supplements for weight loss, discuss the care of an obese patient including non pharmacologic treatments for obesity, as well as recognizing the potential for bias and its effect on patient care. Finally, students will look at bariatric surgery and discuss some specific adjustments in care for bariatric patients. This is a completely online course with weekly due dates offered each Fall and Spring term. For more information, contact phar5205@umn.edu or 612-624-7976. Prereq: Second or third year pharmacy student, or student enrolled in a graduate science or health-related program. Biochemistry and physiology suggested.

**PHAR 5220. Regulatory Issues in Drug Research.** (1-2 cr. ; Student Option; Every Spring)

Regulatory issues encountered in conducting drug research trials. Performing different aspects of clinical trials. Lectures, readings, small group discussions, homework assignments. prereq: Pharm D. professional student and instructor consent

**PHAR 5230. Principles of Clinical Pharmacology Research.** (2 cr. ; A-F only; Every Fall)

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A-F or Audit; Every Spring)

Herbal products/supplements. Pharmacology, clinical indications, and drug interactions of most commonly used products in nontraditional complementary health care. Historical significance and evidenced-based role of these products in health care. Case studies of clinical applications. prereq: Organic chemistry, pathophysiology of disease states, 3rd or 4th yr pharmacy student

**PHAR 5300. Directed Study: Providing Care to Patients with Addiction.** (2 cr. ; Student Option; Every Fall & Spring)

In this course students will analyze stereotypes of addiction and examine the differences between addiction of controlled prescription agents versus other agents.

Students will learn origins of addiction and apply practical strategies in simulated scenarios.

**PHAR 5310. Topics in Pharmacy Ethics (Pandemics).** (; 2 cr. ; A-F only; Every Fall, Spring & Summer)

Using COVID-19 as a pandemic model, students in this elective course will explore the ethical considerations informing personal, public policy and biomedical research decisions during a pandemic. Students will apply ethical principles and selected schools of ethical thought to discuss and debate those decisions.

**PHAR 5610. Pharmacoepidemiology.** (3 cr. ; A-F only; Fall Odd Year)

Application of epidemiologic principles to study/

Topics related to drug therapy investigation are emphasized. Topics include experimental design of drug studies in human research subject volunteers (e.g. to learn appropriate dose, interval, drug-drug interactions, etc.). In the era of Personalized Medicine, this course will address topics related to individualization of therapy including effects of genetic polymorphisms, demographic variables, physiologic variables, and age on drug disposition treatment outcomes. prereq: 3rd Year Pharmacy Student or by instructor permission

**PHAR 5270. Therapeutics of Herbal and Other Natural Medicinals.** (2 cr. ;

use. Beneficial/adverse outcomes of drugs in human populations.

**PHAR 5620. Drug Metabolism and Disposition.** (3 cr. ; A-F or Audit; Every Spring)

Oxidative/conjugative enzymes systems involved in human drug metabolism/disposition. Various in vitro models used to evaluate drug metabolism or chemical entity, pros/cons of each. Factors involved in conducting in vivo studies.

**PHAR 5700. Applied Fundamentals of Pharmacotherapy.** (3 cr. ; A-F only; Every Fall, Spring & Summer)

Pharmacotherapy, the treatment of disease through the administration of medications, is a field particularly interesting to many health care workers. This course is designed to introduce students to some of the main drug classes available for the treatment of particular diseases. Students will also learn about basic pharmacology, recognize brand and generic drug names, and explore their common uses and therapeutic classes. A basic understanding of treatment options available for common disease states will also be developed during this course. Additionally, the course develops basic proficiency in the use of drug information resources. This is a completely online course with due dates throughout the semester, though students have the option to work ahead if they choose. This course is offered each Fall, Spring, and Summer term. For more information, contact phar3700@umn.edu or 612-624-7976. Prereq: Medical terminology recommended

**PHAR 6122. Pharmacotherapy II: Patient Centered Pathophysiologic Approach.** (5 cr. ; A-F only; Every Spring)

Pathophysiology/pharmacotherapy of common cardiovascular, endocrine, and gastrointestinal disorders. prereq: 6121, concurrent 5101, 5102, 6131, 6154, 6163, 6173

**PHAR 6123. Pharmacotherapy III: Patient Centered Pathophysiologic Approach.** (5 cr. ; A-F only; Every Fall)

Pathophysiology/pharmacotherapy of common neurologic, psychiatric, pulmonary, and geriatric disorders. prereq: 5101, 5102, 6122, 6153, 6163, concurrent registration in 6175

**PHAR 6124. Pharmacotherapy IV: Patient Centered Pathophysiologic Approach.** (5

cr. ; A-F only; Every Spring)  
Pathophysiology and pharmacotherapy of common infectious diseases, oncologic and toxicologic disorders. prereq: 6121, 6122, 6123, 6155, 6163

**PHAR 6131. Pharmacy and the Health Care System.** (3 cr. ; A-F only; Every Spring)

Delivery of pharmaceuticals and pharmacy services in the U.S. health care system, issues in hospital and community practice, characteristics of the pharmaceutical industry, economic and financial issues in delivering pharmaceutical services. prereq: Second year pharmacy student

**PHAR 6133. Pharmacy Practice Management.** (3 cr. ; A-F only; Every Spring)  
Principles of pharmacy management, including inventory control, purchasing, pricing, financial analysis, and personnel management. prereq: Third year pharmacy student

**PHAR 6135. Pharmacy Outcomes.** (2 cr. ; A-F only; Every Spring)  
How to integrate knowledge of basic sciences, pharmacotherapy, pharmacy practice management, pharmaceutical care, written communication, literature evaluation, drug information retrieval, law/ethics, and pharmacoconomics to manage patients with multiple medical conditions. prereq: 6123, 6175

**PHAR 6137. Ethics in Pharmacy Practice.** (1 cr. ; A-F only; Every Spring)  
Theories of ethics, ethical analysis of practical ethical issues experienced by pharmacists. Relationship of ethical reasoning to public policy and law. Readings from peer-reviewed publications and popular media. Case studies. prereq: Pharmacy student 3rd yr

**PHAR 6150. CoP Honors: Medicinal Chemistry Seminar.** (1 cr. [max 2 cr.] ; A-F only; Every Fall & Spring)  
Current topics in medicinal chemistry. prereq: instructor consent

**PHAR 6155. Medicinal Agents II.** (2 cr. ; A-F only; Every Spring)  
Chemical/biological properties and therapeutic uses of drugs affecting central nervous, endocrine, and intermediary metabolism systems. prereq: 6154, concurrent registration in 5102 and 6174

**PHAR 6156. Medicinal Agents III.** (4 cr. ; A-F only; Every Fall)  
Therapeutic properties and uses of antiviral, anti-infective and antineoplastic agents.

prereq: 6141, 6151, 6153

**PHAR 6157. Human Nutrition and Drug Therapy.** (3 cr. ; A-F only; Every Spring)  
Basic concepts of human nutrition and clinical application. prereq: 6152

**PHAR 6158. Recombinant DNA-Derived Drugs.** (1 cr. ; A-F only; Every Spring)  
Biotechnology as it related to basic/clinical pharmaceutical sciences. Emphasizes recombinant DNA techniques and preparation/ use of biotechnology-derived agents in diagnosing/treating disease. prereq: 6151

**PHAR 6160. CoP Honors: Experimental and Clinical Pharmacology Seminar.** (1 cr. ; A-F only; Every Fall & Spring)  
Selected topics in experimental and clinical pharmacology. prereq: instructor consent

**PHAR 6164. Biopharmaceutics.** (3 cr. ; A-F only; Every Fall)  
Applied theory of dosage form design for optimal drug activity and bioavailability for all routes of drug administration. prereq: 6161, 6162, 6163

**PHAR 6173. Pharmaceutical Care Skills III.** (2 cr. ; A-F only; Every Fall)  
Integrating basic/clinical science curriculum in a lab setting.

**PHAR 6174. Pharmaceutical Care Skills IV.** (2 cr. ; A-F only; Every Spring)  
Basic/clinical science curriculum in lab setting. Longitudinal care in lab setting. prereq: 6122

**PHAR 6175. Pharmaceutical Care Skills V.** (2 cr. ; A-F only; Every Fall)  
Integrating basic and clinical science curriculum in a lab setting. prereq: 6111, 6112, 6171, 6172, 6173, 6174 or instructor consent

**PHAR 6181. Pharm.D. Paper & Seminar.** (1 cr. ; A-F only; Every Fall)  
How to write a research paper. Students present research project plan. Professional behavior, patient confidentiality, universal precautions. prereq: Third year pharmacy student

**PHAR 6182. Pharm.D. IV Seminar.** (1 cr. ; S-N only; Every Spring)  
Students present thesis topics to peers and faculty evaluators. prereq: 4th yr pharmacy student, 6181

**PHAR 6183. Pharm.D. IV Paper.** (2 cr. ; S-N only; Every Fall)

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Final paper describing a hypothesis-driven research project, patient-care oriented project, management project, drug-usage evaluation, or extensive literature review. prereq: 4th yr pharmacy student, 6181

**PHAR 6200. Drugs and the U.S. Healthcare System.** (3 cr. ; Student Option; Every Fall & Spring)

Being an empowered patient is important when discussing ethics-driven issues within the U.S. healthcare system. This course will expose students to current controversial issues

surrounding medications and national healthcare, and help students examine their own role as a participant in this system. Students will learn to draw comparisons between medication use systems around the world and analyze other controversies related to access, choice and quality of healthcare. During this course, students will understand how their choices, ethics and behavior affect societal decisions surrounding the availability of medications in the US and what their rights are as a citizen-participant during the healthcare debate. This is a completely online course with weekly due dates. Course information is sent to

the U of M email addresses of registered students shortly before, and/or on, the first day of classes each Fall and Spring term. For more information, contact [phar4200@umn.edu](mailto:phar4200@umn.edu) or 612-624-7976. prereq: Pharmacy student

**PHAR 6204. College of Pharmacy Community Outreach.** (1-2 cr. [max 3 cr.] ; A F only; Every Fall, Spring & Summer) Apply knowledge gained in classroom and teaching laboratories to community-based patient care activities. prereq: Current student pharmacist in College of Pharmacy.

**PHAR 6208. Community-based**

**Immunization Delivery.** (1 cr. ; S-N or Audit; Every Fall)  
Students will learn about, plan, and implement influenza immunization clinics. prereq: 6175, CPR certification, bloodborne pathogen training, enrolled Pharmacy student

**PHAR 6211. Non-Prescription Drug Therapy: Focus on Patient Self-Care.** (; 2 cr. ; A-F or Audit; Every Spring)  
Expands on over-the-counter medications presented in 6112. Diagnostic and durable medical equipment available in community pharmacies as well as the use of alternative medications is discussed. prereq: 6112

**PHAR 6212. Dermatology.** (1 cr. ; A-F or Audit; Every Fall)  
Pathophysiology and pharmacotherapy of dermatologic disorders. prereq: 3rd yr pharmacy student

**PHAR 6215. Applied Pharmacokinetics.** (2 cr. ; A-F or Audit; Every Spring)  
Applying clinical pharmacokinetics and assay methodologies to patient care. Assessing drug therapy outcomes. prereq: 6163

**PHAR 6217. Advanced Pharmaceutical Care Clinic.** (; 1-2 cr. ; Student Option; Every Spring)  
Expanded, direct patient care opportunities. Students conduct comprehensive pharmaceutical care assessments in presence of practitioners. Weekly student case presentations/discussions. prereq: 2nd or 3rd yr pharmacy student

**PHAR 6219. Building a Pharmaceutical Practice.** (2 cr. ; A-F only; Every Spring) Initiating a pharmaceutical care practice.  
Building a personal practice plan. prereq: 2nd or 3rd year Pharmacy student

**PHAR 6220. Pediatric Drug Therapy.** (2 cr. ; A-F only; Every Spring)  
Pathophysiology/therapeutics of disease states. Common issues encountered in providing pharmaceutical care to pediatric patients. prereq: 3rd or 4th yr pharmacy student

**PHAR 6222. Advanced Pharmaceutical Compounding.** (2 cr. ; A-F only; Every Spring)  
Expands compounding skills beyond those gained in pharmaceutical care lab. prereq: 2nd or 3rd yr pharmacy student

**PHAR 6223. Pharmacokinetics Research Seminar.** (; 1 cr. ; A-F only; Every Fall & Spring)  
Students critically evaluate literature in

pharmacokinetics, pharmacodynamics, and drug metabolism. prereq: 6163 with a grade of "B" or better.

**PHAR 6224. Pharmacogenomics: Genetic Basis for Variability in Drug Response.** (; 2 cr. ; A-F only; Every Spring)  
Theory/practice of pharmacogenomics. Principles of human genetics/genomics. Applications to scientific education, problems in drug therapy optimization, and patient care. prereq: 3rd year or later healthcare or related education program or equivalent experience, or instructor consent.

**PHAR 6225. Diabetes Experience.** (; 1 cr. ; A-F only; Every Spring)  
Diabetes mellitus. Student presentations, hands-on learning. prereq: 2nd or 3rd yr Pharm student

**PHAR 6226. Interprofessional Diabetes Experience.** (2 cr. ; A-F only; Every Spring)  
Diabetes mellitus through active, hands-on learning in interprofessional environment. Participate in week-long experience of living with diabetes. Online learning activities. prereq: 2nd year or later pharmacy student

**PHAR 6227. Leading Adaptive Change.** (2 cr. ; S-N only; Every Fall)  
Hands-on experience leading a change initiative. Students create a vision for change, plan an approach, implement their plan, and evaluate outcomes. Project focuses on area of pharmacy practice or education.

**PHAR 6230. Ambulatory PC Clinic.** (; 2 cr. ; Student Option; Every Spring)  
How to conduct pharmaceutical care assessments, for patients with actual drug related needs, in a controlled clinic setting. prereq: Enrolled pharmacy student

**PHAR 6231. Community Pharmacy Management.** (2 cr. ; A-F only; Every Spring)  
Management techniques needed in community pharmacy practice, with emphasis on marketing and service. prereq: 2nd or 3rd yr Pharmacy student

**PHAR 6232. Health System Pharmacy Management.** (; 2 cr. ; A-F only; Every Spring)  
Management techniques needed in various institutional pharmacy settings. Integrating distributive and clinical components of institutional practice prereq: 2nd or 3rd year pharmacy student

**PHAR 6233. Drug Use Review and Management.** (; 2 cr. ; A-F only; Every Fall)  
Principles of drug use review in various health care settings. Optimizing quality, minimizing cost. prereq: 2nd or 3rd year pharmacy

student

**PHAR 6235. Pharmaceutical Industry: Business and Policy.** (2 cr. ; A-F or Audit; Every Spring)  
Developing, manufacturing, distributing, economically evaluating, purchasing, managing, and ordering pharmaceuticals in health sector. Unique market characteristics, complex regulatory processes, rapid technological change, high expense growth, public policy issues.

**PHAR 6236. Clinical and Pharmacy Management in Modern U.S. Health Care and Regulatory Landscape.** (2 cr. ; A-F only; Every Fall)  
This interactive course provides diverse introductory exposure to key non-traditional pharmacy topics within the broader, complex, and evolving U.S. healthcare and managed care landscape. Class entails expertise and critical evaluation of clinical and pharmacy management topics such as utilization & care management, formulary, clinical planning, HEOR, healthcare policy and strategy, clinical account management, specialty pharmacy, Medicare, benefits consulting, pharmaceutical industry, business issues in managed care, and clinical pharmacy leadership. Relevant regulatory topics such as drug development are included as complementary topics, time permitting.

**PHAR 6237. Leading Change in Pharmacy I.** (; 2 cr. ; S-N only; Every Fall & Spring)  
Mini-curriculum. Focuses on leadership development and its relation to advancing the profession of pharmacy. prereq: 2nd or 3rd yr. Pharmacy student

**PHAR 6238. Leading Change in Pharm II.** (; 2 cr. ; S-N only; Every Spring)  
Mini-curriculum. Focuses on leadership development and its relation to advancing the profession of pharmacy.

**PHAR 6250. CoP Honors: Social and Administrative Pharmacy Seminar.** (; 1 cr. [max 2 cr.] ; A-F only; Every Fall & Spring)  
Current topics in hospital pharmacy prereq: instructor consent

**PHAR 6260. CoP Honors: Pharmaceutics Seminar.** (; 1 cr. ; A-F or Audit; Every Fall & Spring)  
Contemporary topics in pharmaceutics research. prereq: instructor consent

**PHAR 6272. Shaping an Antiracist Future for Healthcare.** (2 cr. ; Student Option No Audit; Every Fall, Spring & Summer)

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Directed research in pharmacy practice, pharmaceutics, medicinal chemistry, or experimental and clinical pharmacology. prereq: instructor consent

**PHAR 6294. Directed Study I.** (1-5 cr. ; Student Option; Every Fall, Spring & Summer)  
Directed studies in pharmacy practice, pharmaceutics, medicinal chemistry, and experimental or clinical pharmacology.

**PHAR 6301. Veterinary Pharmacotherapy.** (;

The goal of this course is to provide a safe space for study and raising self-awareness of racism and antiracism in the US, sharing and discussion of personal development, how racism plays out in healthcare, and how to combat it through evidence-based allyship.

**PHAR 6293. Directed Research I.** (1-5 cr. [max 10 cr.] ; Student Option; Every Fall, Spring & Summer)

1 cr. [max 2 cr.] ; A-F only; Every Spring) For students to gain knowledge concerning pharmacotherapy of common medical conditions of small animals. prereq: 3rd year pharmacy student

**PHAR 6310. Topics in Pharmacy Ethics (Pandemics).** (; 2 cr. ; A-F only; Every Fall, Spring & Summer)  
Using COVID-19 as a pandemic model, students in this elective course will explore the ethical considerations informing personal,



public policy and biomedical research decisions during a pandemic. Students will apply ethical principles and selected schools of ethical thought to discuss and debate those decisions.

**PHAR 6393. Directed Research II.** (1-5 cr. [max 10 cr.] ; Student Option; Every Fall, Spring & Summer)

Directed research in pharmacy practice, pharmaceuticals, medicinal chemistry, or experimental and clinical pharmacology. prereq: instructor consent

**PHAR 6394. Directed Study II.** (1-5 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Directed studies in pharmacy practice, pharmaceuticals, medicinal chemistry, and experimental or clinical pharmacology.

**PHAR 6493. Directed Research III.** (1-5 cr. [max 10 cr.] ; Student Option; Every Fall, Spring & Summer)

Directed research in pharmacy practice, pharmaceuticals, medicinal chemistry, or experimental and clinical pharmacology. prereq: instructor consent

**PHAR 6494. Directed Study III.** (1-5 cr. ; S-N or Audit; Every Fall, Spring & Summer)

Directed studies in pharmacy, pharmaceuticals, medicinal chemistry, and experimental or clinical pharmacology.

**PHAR 6700. Becoming a Pharmacist.** (2 cr. ; S-N only; Every Fall)

This course provides an introduction to the knowledge, skills and attitudes necessary for success in the professional pharmacy curriculum and in the practice of pharmacy, and will serve as a foundation for future learning throughout your career as a pharmacist. In this class, you will prepare for becoming a student for life. You will be introduced to the tools necessary to thrive in the university student environment, as well as to the essential PharmD curriculum components, referred to as domain competencies, to grow as a professional in a global environment focusing on patient centered care.

**PHAR 6701. CoP Community Outreach.** (0 cr. ; No Grade Associated; Every Fall, Spring & Summer)

Teaching laboratories to community/clinic based interprofessional patient care model. Prereq: Current Student Pharmacist in the College of Pharmacy

**PHAR 6702. Integrated Biochemical Sciences.** (4.5 cr. ; A-F only; Every Fall) This course is designed to provide students with a strong foundation in the structure and function of medicinals which is a prerequisite for advanced studies in pharmacy. The basic goals are to familiarize the students to the

structural and physical properties of proteins, nucleic acids, lipids and carbohydrates, as well as ligands/drugs that bind to these macromolecules in an effort to understand the functional role each plays in the biochemistry of medicinals and the normal and abnormal functioning of a cell. A particular emphasis is placed on the basic concepts that are central to structure-function relationships of therapeutics. Macromolecular classes are presented progressively from basic monomeric structural composition and structural diversity to macromolecular assemblies and associated intrinsic function to macromolecular involvement in cellular architecture and cellular processes to molecular pathology with specific examples. prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 6704. Foundations of Social and Administrative Pharmacy.** (2.5 cr. ; A-F only; Every Fall)

Foundations of Social and Administrative Pharmacy (SAPH) provides the foundation for how one should think about rational use of drugs in a system of care. Content and skills learned in this course will be applied in subsequent courses continuing through the 4th year of the curriculum and lifelong into practice. Additionally, this course includes a module focused on Drug Literature Evaluation(DLE). prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 6706. Foundations of Pharmaceutical Care.** (1.5 cr. ; A-F only; Every Fall)

Foundations of Pharmaceutical Care lays the groundwork for how a pharmacist should think about the rational use of drugs in caring for patients. Content and skills learned in this course will be applied in and provide a framework for all subsequent courses continuing through the 4th year of the curriculum and lifelong into practice. prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 6708. Drug Delivery I.** (2.5 cr. ; A-F only; Every Fall)

In this course, a systematic approach establishes the fundamental physicochemical principles applicable to dosage forms. The foundational scientific principles (continued in DDII) are illuminated with key examples of solution drug dosage forms. These concepts are relevant to current as well as future dosage forms as drugs must be dissolved in a solution before they can be absorbed into the systemic circulation and eventually the site of action. prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 6710. Pharmaceutical Care Skills Lab**

I. (2 cr. ; S-N only; Every Fall)

This course is designed for first year pharmacy students to provide an introduction to the profession and begin building the skills necessary to become a competent, caring pharmaceutical care practitioner. The course consists of two components: a laboratory section and a lecture. prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 6715. Career and Professional Foundations I.** (1 cr. ; A-F only; Every Spring)

During the first year of the Professional Development and Assessment Sequence, the emphasis will be on knowledge acquisition and student success in both the curriculum and profession. The class will include work in career and professional development. prereq: Successful completion of Becoming a Pharmacist

**PHAR 6716. Applied Pharmaceutical Care.** (3.2 cr. ; A-F only; Every Spring)

Evidence-based patient-centered pharmaceutical care involves assessing patients' drug-related needs, identifying, resolving, and preventing drug therapy problems, developing a care plan for follow up, and communicating with a patient and the health care team. These concepts will be applied to patient and population scenarios featuring common medical conditions and medications students are likely to encounter during their introductory pharmacy practice experiences (IPPEs). prereq: Successful completion of Becoming a Pharmacist

**PHAR 6718. Drug Delivery II.** (2.4 cr. ; A-F only; Every Spring)

Building on Drug Delivery I, this course covers other dosage forms (mostly solid and dispersed dosage forms) as well as to differentiate between them. New areas covered include chemical kinetics, chemical stability, buffer systems, polymers & proteins, and rheology. The course will introduce students to the physicochemical principles that are relevant to design, preparation, storage, use, efficacy, and evaluation of pharmaceutical dosage forms. prereq: Successful completion of Drug Delivery I

**PHAR 6720. Pharmaceutical Care Skills Lab II.** (2 cr. ; S-N only; Every Spring)

This course is part of the pharmaceutical care learning center curriculum spanning six semesters. These courses provide an introduction to the profession and begin building the skills necessary to become a competent and caring pharmaceutical care practitioner. prereq: Successful completion of Pharmaceutical Care Skills Lab I

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**PHAR 6722. Principles of Medicinal Chemistry.** (2.1 cr. ; A-F only; Every Spring)

This is an introductory course that will familiarize students with the discipline of medicinal chemistry, the principles of drug design and drug metabolism. prereq: Successful completion of Integrated Biochemical Sciences

**PHAR 6724. Introduction to the Immune System and Infectious Disease.** (3.1 cr. ; A-F only; Every Spring)

This course focuses on the immunological, epidemiological, and pathogenic basis of viral, bacterial, protozoal, fungal and helminthic disease; the biological composition of vaccines and the immunologic response to live attenuated pathogens and microbial extracts;

the chemical, cellular, and biological principles of the immune system; the biological and molecular response to allergens and hypersensitivity; and an introduction to cellular and molecular aspects of inflammation. prereq: Successful completion of Integrated Biochemical Sciences

**PHAR 6726. Principles of Pharmacology.** (2.3 cr. ; A-F only; Every Spring)

This is an introductory course that builds on information in basic science courses offered in the first semester of the PharmD program. It provides foundational content necessary for comprehension and application of all subsequent pharmacotherapy modules that require application of pharmacological concepts and knowledge. prereq: Successful completion of Foundations of SAPH

**PHAR 6728. Pharmaceutical Calculations.** (0.7 cr. ; A-F only; Every Fall)

Accurately performing pharmaceutical calculations is a critical component of patient care in every pharmacy practice environment. Calculations contribute just as much to good patient outcomes as the newest methods and guidelines for diagnosis, treatment, and prevention. The challenge of pharmacy calculations lies not in the cutting edge of science or their mathematical complexity, but in the need for consistent accuracy to prevent patient harm and possible fatality. To obtain this level of accuracy, an understanding of methods and deliberate, undivided attention to detail is required. Students must understand and master the basic concepts of pharmaceutical calculations with organization, consistency and accuracy in order to provide optimal care to their future patients every day. Students should be committed to becoming a competent generalist practitioner who assumes responsibility, and is willing to be held accountable for their patients medication outcomes. prereq: enrolled in the Pharm.D. program, successful completion of Phar 6700

**PHAR 6730. Career and Professional Foundations II.** (0.5 cr. ; A-F only; Every Fall)

For the second year of the Career and Professional Foundations Sequence, the emphasis will be on reinforcing, supporting, developing and assessing competencies and skills that are exercised in multiple courses and emphasized in the Colleged competency domains e.g. team effectiveness. This class will also include work in career and professional development. prereq: Successful completion of PD concurrent registration is required (or allowed) in A I

**PHAR 6732. Medicinal Chemistry and Pharmacology of Cardiovascular Agents.** (2.3 cr. ; A-F only; Every Fall)

This course builds upon the foundational concepts learned in Principles of Pharmacology and Principles of Medicinal Chemistry and applies them to drug classes primarily used for the treatment of cardiovascular diseases. prereq: Principles of Pharmacology and Principles of Medicinal Chemistry

**PHAR 6734. Cellular Metabolism and Nutrition.** (2.8 cr. ; A-F only; Every Fall) This course is designed to provide students with an understanding of the basic principles of

intermediary metabolism and how such processes are used by the body for growth, production of energy and disposition of metabolites. The course also addresses the basic nutrients used by the body and their roles as OTC products in community pharmacies. prereq: Integrated Biochemical Sciences

**PHAR 6736. Cardiovascular Pharmacotherapy.** (1.9 cr. ; A-F only; Every Fall)

Cardiovascular disease represents the number one cause of morbidity and mortality for adults in the U.S. The key topics covered in this course are critical to preparing a generalist practitioner to have input on optimizing the care of patients with common conditions such as hypertension, dyslipidemia, ischemic heart disease (angina, acute myocardial infarction) supraventricular arrhythmias (atrial fibrillation) and chronic heart failure. prereq: All PharmD year one coursework, Physiology Competency Exam

**PHAR 6738. Pharmacokinetics.** (3.7 cr. ; A-F only; Every Fall)

This course is designed to give generalist practitioners the fundamental skills to solve pharmacokinetically-based problems in patient care, particularly in regards to dosage regimen design and adjustment. Pharmacokinetics builds on the concepts learned in Drug Delivery I and II, and follows the path of a drug molecule from its incorporation into a dosage form to its release and disposition in a biological system. prereq: Drug Delivery I concurrent registration is required (or allowed) in II

**PHAR 6740. Pharmaceutical Care Skills Lab III.** (2 cr. ; S-N only; Every Fall)

This course is designed for second year pharmacy students to continue to build the skills necessary to become a competent, caring pharmaceutical care practitioner. The course consists of two components: a laboratory section and a discussion. prereq: Pharmaceutical Care Skills Lab I concurrent registration is required (or allowed) in II, Applied Pharmaceutical Care

**PHAR 6742. Evidence based problem analysis I.** (1 cr. ; S-N only; Every Spring) In this course, students will obtain and practice the skills necessary to research, prepare and present a scholarly paper and seminar. The course builds on the Biostatistics and Drug Literature Evaluation material from Becoming a Pharmacist, Foundations of Social and Administrative Pharmacy, and Foundations of Pharmaceutical Care. The course relies heavily on group work. prereq: Becoming a Pharmacist, Foundations of Social and Administrative Pharmacy, Foundations of Pharmaceutical Care

**PHAR 6745. Career and Professional Foundations III.** (0.5 cr. ; A-F only; Every Spring)

For the second year of the Professional Development and Assessment Sequence, the emphasis will be on knowledge comprehension. This class will include work in career and professional development.

**PHAR 6748. Biopharmaceutics.** (2.6 cr. ; A-F only; Every Spring)

Biopharmaceutics is the final course in a four-course sequence that comprises the curriculum in pharmaceutics. Biopharmaceutics integrates core knowledge obtained in the previous three courses (Drug Delivery I & II and Pharmacokinetics), and also relies on general knowledge in anatomy, physiology, mathematics, general chemistry, and pharmacology. prereq: Courses and/or content: Calculus, thermodynamics, viscosity, sedimentation, diffusion, chemical kinetics, novice to developing level understanding of dosage forms, developing understanding of pharmacokinetics/ pharmacodynamics, physiology, general chemistry, physics, biochemistry, enzyme kinetics, and metabolic pathways. It is strongly recommended that students review course materials in Drug Delivery I concurrent registration is required (or allowed) in II and Pharmacokinetics as well as anatomy, physiology, calculus, and physics with consideration of the application of the concepts to the delivery of drugs to patients.

**PHAR 6750. Pharmaceutical Care Skills Lab 4.** (2 cr. ; S-N only; Every Spring)

This course is designed for second year pharmacy students to continue to build the skills necessary to become a competent, caring pharmaceutical care practitioner. prereq: Students must have successfully completed Pharm Care Skills 1, 2, and 3, and Applied Pharmaceutical Care. Students must be concomitantly registered in all required PD2 courses in order to have the content required to complete integrated activities, e.g., students must be enrolled in Diabetes in order to successfully complete the patient care sequence utilizing diabetes content in this course. Exceptions may be made on a case by case basis. Topic areas from prerequisites and corequisites: documentation and care plans, subject matter (GI, pain, cardiovascular, diabetes), medication history taking skills, aseptic technique, philosophy of pharmaceutical care, literature evaluation skills, motivational interviewing skills, pharmacy calculations, drug delivery.

**PHAR 6752. Integrated Endocrinology.** (2.1 cr. ; A-F only; Every Spring)

This course integrates all pertinent endocrinology topics (excluding diabetes) into

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one course. Specifically, the pathophysiology, medicinal chemistry, pharmacology and the therapeutic application of this knowledge will be covered in an integrated approach via specific modules. All major endocrine pathways will be taught including: hypothalamic/pituitary,

steroids, female sex hormones, hormonal contraception, menopause/hormone therapy, bone health, male gonadal hormones, drugs in pregnancy and lactation, sexual dysfunction and thyroid hormone. prereq: Students will need to have successfully completed: - Cellular Metabolism/Nutrition, - Cardiovascular Pharmacotherapy - Pharmaceutical Care Skills

Labs 1-3. Students should be concurrently enrolled in Kidney, Fluids, and Electrolytes, and Diabetes and Metabolic Syndrome. Students should be able to describe the function of the overall endocrine systems and the multiple roles of hormones in the body.

**PHAR 6754. Diabetes and Metabolic**

**Syndromes.** (2.1 cr. ; A-F only; Every Spring) In this course, students will learn the principles of the pathophysiology of diabetes, pharmacology of the antidiabetic agents, evaluate key research on diabetes, interpret and apply clinical guidelines for diabetes, assess socioeconomic aspects of diabetes, and apply this information to patient cases. Special populations with diabetes will also be discussed including pediatric, gestational, and geriatric diabetes. Students will also learn the pathophysiology of metabolic syndrome, pharmacology of obesity treatments, nonpharmacological and pharmacological ways to treat metabolic syndrome, including the implications of bariatric surgery on use of pharmacologic agents in general, and apply this information to patient cases. prereq: Students will need to have successfully completed: Molecular Metabolism/Nutrition, Cardiovascular Pharmacotherapy concurrent registration is required (or allowed) in Pharmaceutical Care Skills Lab 1-3. Students should be able to describe the physiology of insulin action, incretin hormones, amylin, and the fasting and fed states. Students should be able to describe how insulin is designed and manufactured. Students should be able to describe the following biochemistry topics: carbohydrate metabolism and lipid metabolism, and protein. Students should be able to assess a patient and determine most appropriate pharmacotherapy treatment options for a patient's hypertension and dyslipidemia treatments, including ability to describe, interpret and apply evidence-based guidelines. Students should be able to describe how nutrition impacts energy production, utilization and storage, and obesity. Students need to be able to describe the caloric content of carbohydrates, proteins and lipids and be able to apply that knowledge to reading food labels and evaluating a patient's nutritional status.

**PHAR 6756. Kidney, Fluid, and Electrolytes.** (2.1 cr. ; A-F only; Every Spring)

In this course, students will learn key concepts and develop specific skills in the management of common fluid and electrolyte and single acid/base disorders and in prevention and management of chronic kidney disease and

associated conditions. prereq: Students must have completed the following courses successfully: - Applied Pharmaceutical Care, - Foundations of Social and Administrative Pharmacy, - Medicinal Chemistry and Pharmacology of Cardiovascular Agents, - Pharmacokinetics, - Cardiovascular Pharmacotherapy, - Cellular Metabolism and Nutrition See the course syllabus for more detailed prerequisites.

**PHAR 6758. Pulmonary Pharmacotherapy.**

(1.1 cr. ; A-F only; Every Spring)  
This course will provide students with the requisite pathophysiology and

pharmacotherapeutic knowledge to care for patients with common pulmonary diseases. prereq: Students must have completed the following courses successfully: - Applied Pharmaceutical Care - Foundations of Social and Administrative Pharmacy - Medicinal Chemistry and Pharmacology of Cardiovascular Agents - Pharmacokinetics, - Cardiovascular Pharmacotherapy, - Cellular Metabolism and Nutrition See the course syllabus for more detailed prerequisites.

**PHAR 6760. Career and Professional Foundations IV.** (0.5 cr. ; A-F only; Every Fall)

For the third year of the Career and Professional Foundations sequence, the emphasis will be on deeper exploration into career options, as well as the tools needed for contemporary pharmacy practice. Students will have the opportunity to engage with their peers as well as practicing pharmacists as they learn about the expectations of contemporary professional practice. prereq: Phar 6715, 6730, 6745

**PHAR 6762. Medicinal Chemistry and Neuropharmacology.** (2.8 cr. ; A-F only; Every Fall)

Neuropharmacology and Medicinal Chemistry of Neurological Treatments builds upon the foundational concepts learned in Principles of Pharmacology and Principles of Medicinal Chemistry, and applies them to drug classes primarily used for the treatment of central nervous system (CNS) and peripheral nervous system (PNS) dysfunction. prereq: Phar 6722, 6726, and 6732

**PHAR 6766. Biotechnology-Derived Drugs.** (1 cr. ; A-F only; Every Fall)

Biotechnology-derived drugs are where the future is, and pharmacy students need to understand how they are made, how they act and what special considerations are involved. This course will provide the foundational knowledge necessary to dispense current biotechnology-derived drugs and provide the basis for self-education needed to understand the biotechnology-derived drugs of the future. prereq: Phar 6702, 6722, 6726, 6724, 6734, and 6752

**PHAR 6768. Infectious Diseases.** (3 cr. ; A-F only; Every Fall)

Course will focus on the pharmacology, pharmacokinetics, and pharmacodynamics of antibiotics and the pharmacotherapy of infectious diseases. prereq: Phar 6702, 6706, 6718, 6724, 6736, 6738, 6748, 6756, 6758

**PHAR 6770. Pharmaceutical Care Skills Lab V.** (2 cr. ; S-N only; Every Fall)

This course is designed for third year pharmacy students to continue to build the skills necessary to become a competent, caring pharmaceutical care practitioner. The course consists of two components: a

laboratory section and a discussion. prereq: Pharmaceutical Care Skills Labs I, II, III, and IV, and Applied Pharmaceutical Care

**PHAR 6772. Topics in Pharmacotherapy.** (1.6 cr. ; A-F only; Every Fall)

This course is designed to provide students with the pharmacologic, pharmacotherapeutic, and pharmaceutics knowledge they need to understand therapies for dermatologic, gastrointestinal, and genitourinary conditions, and arthritis and gout. It is designed to prepare future generalist pharmacists to be knowledgeable about common conditions of aforementioned topics and appropriate pharmacotherapy options for treatment. It will focus primarily on pharmacotherapy, but will have an overview of pathophysiology of these conditions. Students will be expected to apply knowledge to design and monitor a patient-centered pharmaceutical care plan and to appropriately educate patients regarding proper use of medications covered in the course. This course prepares students to be able to identify clinically relevant information in the modern healthcare setting, learn it at a depth beyond memorization, and apply and interpret its application to relevant patient case vignettes. prereq: All required PharmD year two coursework

**PHAR 6774. Pharmacotherapy of Neurologic and Psychiatric Disorders.** (3.1 cr. ; A-F only; Every Fall)

This course is designed to prepare future generalist pharmacists to be knowledgeable about common psychiatric and neurologic disorders and about the appropriate use of medications used to treat them. The course will primarily focus on the pharmacotherapies used to treat psychiatric and neurologic disorders. This course will additionally provide an overview of the presentation and pathophysiology of specific psychiatric and neurologic disorders, an overview of the differences between the practices of psychiatry and neurology and a discussion of stigmas associated with mental illness. An overview of non-pharmacologic therapies will be introduced to the extent relevant to the generalist pharmacists. At the conclusion of the course students will be expected to apply knowledge learned in the course in order to design and monitor a pharmacotherapeutic plan for specific patients and to appropriately counsel patients regarding proper use of the various psychiatric and neurologic medications covered in the course. prereq: All required PharmD year two coursework

**PHAR 6778. Pharmacy Law.** (; 0.7 cr. ; A-F only; Every Spring)

The course covers both federal and state laws that impact and regulate the practice of pharmacy including federal regulation of medications, regulation of controlled

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The goal of this course is to facilitate integration knowledge of basic sciences, pharmacotherapy, pharmacy practice management, pharmaceutical care, written communication, literature evaluation, drug

substances, and the Minnesota Pharmacy Practice Act. The course will be offered entirely online.

**PHAR 6780. Pharmacy Outcomes.** (2.5 cr. ;

information retrieval, law and ethics, and pharmacoconomics to manage patients with multiple medical conditions. This course is where students are required to perform and demonstrate knowledge during curricular assessments. prereq: Phar 6700, 6702,

6704, 6706, 6708, 6710, 7310, 6716, 6718, 6720, 6722, 6724, 6726, 7325, 6732, 6734, 6736, 6738, 6740, 6742, 7330, 6748, 6750, 6752, 6754, 6756, 6758, 7340, 7345, 6770, 6774, 6768, 6762

**PHAR 6782. Evidence Based Practice.** (1.8 cr. ; A-F only; Every Fall)

The Evidence Based Practice has been designed to facilitate acquisition and application of evidence based practice knowledge and skills. Evidence based practice involves the use of the best available evidence, clinical expertise and patients' values to make complex pharmacy related decisions. prereq: Phar 6700, 6704, 6706, 6742

**PHAR 6784. Integrated Oncology.** (2.8 cr. ; A-F only; Every Spring)

This course focuses on the etiology and molecular biology of tumorigenesis, medicinal agents, and pharmacology of anticancer agents, treatment of the most common cancers, supportive care of the patient with cancer, and social and ethical considerations of the treatment of the patient with cancer including end of life directives. prereq: PD3 in good academic standing, students will find it helpful to review the following topic areas: Principles of Biochemistry (Lipids [Structure/Function], Proteins [Folding/Conformation]), Cellular Physiology Molecular Biology, Genetics (Cell Biology [signal transduction, DNA replication, transcription, protein translation, cell cycle, apoptosis], Immunology, Tumorigenesis, Angiogenesis, Genetics principles, Anatomy/Physiology [GI tract, pulmonary, hormone and feedback regulation])

**PHAR 6786. Acute Patient Care Pharmacotherapy.** (3.4 cr. ; A-F only; Every Spring)

The purpose of this course is to prepare students to approach patients with multiple medical problems and the dynamic changes that patients can experience in the acute care settings. Students will then learn about the pharmacotherapy approach related to managing those disease states/conditions. Students will be expected to develop therapeutic plans for patient case scenarios at the onset of a hospital admission as well as additional problem that could present over the course of a hospitalization or result in readmission. Additional scenario problems will be incorporated into the cases as the course progresses and the cases and problems will become more complex. By the end of the course, students will have had an opportunity to address multiple medical problems and make pharmacotherapy decisions and will be evaluated based on those decisions. Knowledge gained in this course will prepare students for the APPE acute care/institutional rotation. prereq: successful completion of all 1st year, 2nd year, and fall 3rd year coursework

**PHAR 6797. Advanced Pharmacy Practice Learning Experience 1.** (2 cr. ; S-N only; Every Fall, Spring & Summer)

This course is the first in a series of 3 courses (summer, fall, and spring) designed to align with and augment learning occurring on Advanced Pharmacy Practice Experiences (APPEs). In the first course (summer semester), students will complete the top 200 drug modules and drug administration CORE Readiness modules to solidify learning from year 1-3 of the curriculum. In addition to these requirements, students will complete additional activities specific to their current rotation placement. For example, students completing their ambulatory care rotation will participate in topic discussions specific to ambulatory care practice with faculty. Additionally, various optional learning activities will be made available to students to complement their rotations based on students' personal interests, or based on direction from their preceptor.

**PHAR 6798. Advanced Pharmacy Practice Learning Experience (APPLE) 2.** (2 cr. ; S N only; Every Fall)

This course is the second in a series of 3 courses (summer, fall, and spring) designed to align with and augment learning occurring on Advanced Pharmacy Practice Experiences (APPEs). In the first course (summer semester), students will complete the top 200 drug modules and drug administration CORE Readiness modules to solidify learning from year 1-3 of the curriculum. In this second course (fall semester) students will focus on preparing for residency/job searching and health inequities. In addition to these requirements, students will complete additional activities specific to their current rotation placement. For example, students completing their ambulatory care rotation will participate in a journal club specific to ambulatory care practice. Additionally, various optional learning activities will be made available to students to complement their rotations based on students' personal interests, or based on direction from their preceptor.

**PHAR 6799. Being a Pharmacist.** (0.1 cr. ; S N only; Every Spring)

The Pharm.D. curriculum at the University of Minnesota is anchored by the basic, clinical, and social sciences relevant to the practice of pharmacy. This course serves as a culmination of academic and intellectual expression of the basic, clinical, and social pharmaceutical sciences and connects them to pharmacy practice. Future growth in knowledge and skill of our graduates/practitioners will predominantly occur through collegial exchange and conference-based learning environments. Being A Pharmacist will model how our students will continue to grow in knowledge and skill as they enter practice. In this course, students will be

encouraged to think critically, reflect, and apply their skills. Prerequisite: Successful completion of all courses in the PharmD rotation, with the exception of the final APPE rotation.

**PHAR 6900. Curricular Studies for Internship and Pharmacy Employment.** (1 cr. [max 4 cr.]; S-N only; Every Fall, Spring & Summer)

This course is designed for students pursuing an internship or pharmacy-related employment to receive course credit (typically for visa requirements). The course does NOT count toward elective credit requirements. If applicable, students must remain visa compliant and are solely responsible for doing so. The vast majority of the course is the hours a student spends at their internship/employment site. A written assignment is required at the end of the course. Students will meet once during the semester, arranged with instructors.

**PHAR 6901. Pharmaceutical Care Experience.** (1 cr. ; S-N only; Every Spring)

The Pharmaceutical Care Experience builds on Foundations of Pharmaceutical Care and provides an early opportunity to practice pharmaceutical care in a primary care clinic setting. This elective will allow students to assess each patient's unique medication experience and drug-related needs through patient interviews. Students will use this information to develop a patient-centered care plan under the guidance of a practitioner mentor. The pharmaceutical care process will be applied and assessed in all future coursework, including, but not limited to, pharmacotherapy patient case work-ups, applied learning in the Pharmaceutical Care Learning Center, and during experiential education experiences

**PHAR 6902. Foundations for Integrative Mental Health and Psychiatric Practice.** (2 cr. ; A-F only; Every Fall)

This course is design to allow students to examine concepts, theories, and paradigms foundational to psychiatric/mental health practice and interprofessional integrative mental health care. Students develop clinical interviewing methods that elicit a client's health narrative and facilitate the therapeutic relationship. Students also practice techniques that promote beginning skills important in reflective clinical practice. The course is primarily online, with 3 required 3-hr patient care simulations. There will be content posted on the course website for student learning. Activities and assessments include quizzes, patient scenario cases, reflective papers (upon re-watching the video of their interactions with the interprofessional teams and standardized patients during the simulation sessions), and individual and interprofessional group. Pharmacy students need to be PD3 students committed to earning the Interprofessional

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electives, and mental health APPE)

**PHAR 6903. Assessment and Management of Psychiatric Disorders.** (2 cr. ; A-F only; Every Spring)

Integrative Mental Health Focus Area designation. We ask pharmacy students to commit to the entire series (fall and spring

This course is design to allow students to apply advanced concepts from integrative mental health theory and research, social sciences, neuropsychology, and neurophysiology in the

differentiation and explanation of psychiatric symptoms and disorders across the age continuum.

**PHAR 6904. Health Coaching for Pharmacists: Creating a Culture of Change for Patients.** (1 cr. ; S-N only; Every Spring)  
Health Coaching for Pharmacists will examine current foundations for health and wellbeing, including definitions and standards. Students will learn health coaching models, theories and associated components. We will develop students' self-awareness through mindfulness exploration and self-assessments. Students will learn skills and techniques for coaching patients such as motivational interviewing, non-violent communication, active listening, appreciative inquiry, emotional intelligence and coaching presence. Students will apply learned skills through peer practice during in-person sessions.

**PHAR 6905. Applied Psych Pharmacotherapy.** (2 cr. ; A-F only; Every Spring)  
This course provides a semester-long application of the PD3 fall semester psych pharmacotherapy content through complex scenarios and exploration of advances psychiatric pharmacy topics. Students developed case presentations will be worked up using a standardized format, and shared with a designated visiting expert prior to class session. Class session each week will begin with a discussion of the case and work-up that is primarily student-led, with a visiting psych/behavioral health clinician providing expert feedback and guidance for the second half of the class session. The course will be structured to make visiting clinician involvement as simple and non-disruptive as possible, including participating from office at work with online video conference option Cisco Meeting Server (formerly Acano). Pharmacy students need to be PD3 students who have passed the Core Psychiatric and Neurology Pharmacotherapy with a grade of B or better. Student must be in good academic standing within the pharmacy program.

**PHAR 6906. Introduction to Pharmacy Research.** (1 cr. ; A-F only; Every Spring)  
Overview of principles to research in particular research topic areas. Forum for scientists involved in research in particular topic areas to discuss research, environment, careers with students. prereq: consent of course director

**PHAR 6907. Interprofessional Collaborative Practice in HIV Care.** (1 cr. ; S-N only; Every Spring)  
Interprofessional Collaborative Practice has the potential to positively affect the lives of persons living with HIV/AIDS. This short semester course is designed to provide learners with foundational knowledge of HIV prevention and care and to develop the ability to work as a member of an interprofessional collaborative health care team. Learners will explore options for involvement in HIV care as part of their health care career and will be

inspired to lifelong learning related to HIV care and interprofessional collaborative practice. The methods of instruction include lectures with small group discussion incorporated throughout. The course exercises are designed to provide hands on experience with some of the tools and concepts covered in the course.

**PHAR 6908. Drugs of Abuse.** (2 cr. ; S-N only; Spring Odd Year)  
Basic medicinal chemistry of substances of abuse, associated paraphernalia. prereq: Organic Chemistry I and Phar 6702

**PHAR 6909. Applied Cultural Competence in Patient Care and Pharmacy Practice.** (1 cr. ; A-F only; Every Spring)  
This course builds on content learned in PharmD program - to provide students with fundamental knowledge, skills and attitudes required of culturally competent, caring general pharmacist practitioners. Content is integrated with didactic courses and prepares students for IPPE and APPE experiences, as well as for their future careers. Steady changes in the demographics of the U.S. and the state of Minnesota highlight the demand for cultural awareness and sensitivity in the clinical environment as the percentage of racial, ethnic and cultural minorities in America is projected to continue to outpace the number of minority health care professionals. Racial and ethnic disparities in health and health care access have been recognized in the United States for over 30 years. Despite an improved life expectancy for all races and ethnicities, inequities in morbidity and mortality rates and utilization of preventative and necessary health care services persist for various segments of the population. As the United States' population becomes increasingly diverse, pharmacists are becoming progressively more responsible for the health care management of people from various races, ethnicities, languages and cultures. Providing culturally and linguistically competent health care to these patients has the potential to reduce ever important disparities in health and health care services and to improve the nation's overall health outcomes.

**PHAR 6913. The Science and Spirit of Wellbeing.** (; 1 cr. ; A-F only; Every Spring)  
Care, in general, and healthcare in particular, requires a certain degree of wellbeing on the part of the provider. This elective survey course introduces students to evidence based wellbeing. The course explores individual wellbeing as well as implications for practice and the health and wellbeing of others. prereq: instr consent

**PHAR 6937. Foundations of Leadership.** (2 cr. ; A-F only; Every Fall & Spring)  
The Foundations of Leadership course is designed as a "mini - curriculum" focused on leadership development and its relation to advancing the profession of pharmacy. prereq: PDII or PDIII Pharmacy Student

**PHAR 6938. Developing Adaptive Leadership.** (1 cr. ; A-F only; Every Spring)  
Directed Study: Developing Adaptive Leadership prereq: Pharm.D. student; successful completion of Phar 6937

**PHAR 6939. Leading Change Experience I.** (2 cr. ; S-N only; Every Fall)  
In collaboration with a faculty advisor, students implement a change that requires adaptive leadership. Work will focus on building a "short term win" and a team that can continue efforts into the future. Students will also gain experience in collecting and managing data to assist the change process (e.g., needs assessment and/or outcomes assessment). In addition, working with their faculty advisor, students will create and implement an individualized plan for their own personal leadership development. Students will also gain experience in supporting the leadership development of others. To support individualized development, a leadership networking partner (pharmacist) is assigned and periodic networking events and/or meetings are held. prereq: Phar 6937 and 6938

**PHAR 6940. Leading Change Experience II.** (2 cr. ; S-N only; Every Spring)  
Continues leading change and development work initiated in Leading Change Experience I. During this term, students continue with their networking partners, present their leading change work, facilitate transition of the work to new leaders, conduct a critical appraisal of their leadership development and support second year students as they initiate their projects. Students will also evolve their roles into shifting from personal development to the development of others. Assisting in a mentoring role in several capacities 1) transitioning new leaders into the leading change experience and 2) providing guidance, ideas and encouragement to those students interested in change initiatives. prereq: Phar 6937 and 6938

**PHAR 6941. Leadership Best Sellers for Pharmacists.** (; 2 cr. ; A-F only; Every Fall & Spring)  
Part of the leadership track in pharmacy.

**PHAR 6942. Leadership Capstone.** (; 2 cr. ; S-N only; Every Fall, Spring & Summer)  
Supports completion of Leadership Emphasis Designation. Documentation/self-reflection of leadership learning experiences pursued inside/outside of classroom. Prerequisites: This course is for students who are in the fourth year of the Leadership Emphasis Area. Successful completion of Phar 6937, 6938, 6939 and 6940. Completion or concurrent enrollment in 6941 (Leadership Best Sellers).

**PHAR 6961. Women's Health.** (2 cr. ; A-F or Audit; Every Spring)  
During this course, students will have the opportunity to actively learn and discuss women's health issues taught in the core curriculum to a greater extent. The core

Courses listed in this catalog are current as of 2020-09-08. For up-to-date information, visit [www.catalogs.umn.edu](http://www.catalogs.umn.edu). 43

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curriculum focuses on the pharmacotherapy

around women's health, we will focus on the patient's perspective, pathophysiology, and

other quality care considerations specific to women including cultural, religious,

psychosocial, and socioeconomic factors effecting health. Health topics will range from social issues to menstrual health, breast cancer to eating disorders, with a specific focus on preparing students for professional practice and the pharmacist's role. prereq: courses: Endocrinology pharmacotherapy sequence in the PD2 year; prereq topics: Contraceptive agents, emergency contraception, hormonal contraception

**PHAR 6962. Ethics in Pharmacy Practice.** (2 cr. ; A-F only; Every Spring)

Ethical principles, selected schools of ethical thought. Students discuss/debate ethical dilemmas in pharmacy practice and health care. prereq: 3rd year Pharmacy student

**PHAR 6964. Clinical Toxicology.** (1 cr. ; A-F only; Spring Odd Year)

This course will cover the clinical signs/symptoms, general management and treatment of poisonings and toxicologic emergencies that are not covered in the main curriculum. It will also cover decontamination and laboratory principles associated with poisonings and toxicologic emergencies. This class will be comprised of lecture format presentations. Students will be given 1 hour to complete the final exam and midterm. Prerequisites: All students will have successfully completed the first year professional pharmacy program, as well as successfully completed fall semester of the second year. All students will have also successfully completed or be in the process of completing anatomy, physiology, pathophysiology, and pharmacology. The student is responsible for this material to the extent necessary as a framework for toxicologic therapeutics. Thus, students are encouraged to review basic anatomy and physiology and specifically encouraged to review the section of the pharmacology textbook relevant to the classes of drugs covered.

**PHAR 6966. Food Medicine: Contemporary Issues.** (1 cr. ; Student Option No Audit; Every Fall & Spring)

Food contributes to the prevention, and conversely, the development of disease processes. In order to better understand the interrelatedness of food and health, this course offers a critical perspective on how the ubiquity of food; race, class, gender; and indigeneity; colonization and corporatization affect peoples food experiences; and subsequently, individual and population health. Students will examine modern food systems and describe implications for social determinants of health, health promotion, chronic disease management and IP collaborative practice. We will address questions such as: How do food systems impact our health? What makes food a political and environmental issue? Are we what we eat? Why do we categorize things that are not food as food? What is food sovereignty?

**PHAR 6968. Critical Care.** (1 cr. ; A-F only; Spring Even Year)

Critical Care is an elective that consists of 2 main components, a faculty/clinician presentation on an important topic to contemporary critical care practice followed

by a student evaluation and presentation on a selected primary literature topic that applies and integrates the presentation with current practice challenges. Key topics that are covered include discussion of the Surviving Sepsis Guidelines with discussion on the role of corticosteroids, identification and management of the anxious or delirious ICU patient and application of the updated PAD guidelines, systems of The second 50-minutes a student (or pair of students) present the faculty-selected study using PowerPoint slides and encourage group discussion of the paper's merits and application to current critical care practice or future research. Challenges of critical care research are incorporated into the weekly discussions. prereq: Successful completion of P1, P2, and Fall of P3 professional pharmacy program. Interest in critical care pharmacy practice and/or clinical research.

**PHAR 6971. Geriatric Pharmacotherapy.** (2 cr. ; A-F only; Every Spring)

Pharmacokinetic/pharmacodynamic changes and their implications in elders. Effects of drug-drug/drug-disease interactions. Drug adherence barriers to provide optimum pharmacotherapy to elderly persons. prereq: 3rd or 4th year Pharmacy student

**PHAR 7001. Early Pharmacy Practice**

**Experience I.** (1 cr. ; A-F only; Every Fall) First in a series of four courses. Focuses on patient's perspective in managing and living with chronic conditions and chronic medication use. Includes community-based instruction, mentor program prereq: Criminal background check, BLS CPR cert for infants/chld/adults, [proof of negative Mantoux test or explanation of positive test], proof of chicken pox immunity

**PHAR 7002. Early Pharmacy Practice**

**Experience II.** (1 cr. ; A-F only; Every Spring) Second in a series of four courses. Focuses on patient's perspective in managing and living with chronic conditions and chronic medication use. Includes community-based instruction, mentor program. prereq: 7001 or instructor consent, criminal background check, BLS CPR cert, proof of negative Mantoux test or explanation of positive test, proof of chicken pox immunity

**PHAR 7003. Early Pharmacy Practice**

**Experience III.** (0.5 cr. ; A-F only; Every Fall) Third in a series of four courses. Focusing on patient's perspective in managing and living with chronic conditions and chronic medication use. Includes community-based instruction. Emphasizes mentoring. prereq: 7002 or instructor consent, criminal background check, BLS CPR cert for infants/chld/adults, [proof of negative Mantoux test or explanation of positive test], proof of chicken pox immunity

**PHAR 7004. Early Pharmacy Practice**

**Experience IV.** (0.5 cr. ; A-F only; Every Spring) Fourth in a series of four courses. Focuses on patient's perspective in managing and living with chronic conditions and chronic medication use. Includes community-based instruction. Emphasizes mentoring. Upcoming patient care

opportunities. prereq: 7003 or instructor consent, criminal background check, BLS CPR certification, proof of negative Mantoux test or explanation of positive test, proof of chicken pox immunity

**PHAR 7005. Introductory Community Practice Pharmacy Experience.** (; 2.5 cr. ; S N only; Every Spring)

Experience in patient care at community practice setting. Three weeks, 40 hrs/week. prereq: 6111, 6171, 7001, 1st-yr pharm student

**PHAR 7006. Introductory Institutional Pharmacy Practice Experience.** (; 2.5 cr. ; S N only; Every Spring)

Experience in patient care in hospital setting. Three-week, 40 hours/week. prereq: College of Pharmacy student completed PHAR 6121, 6122, 6131, 6132, 6173, 6174, 7003 and 7004 with a passing grade and is registered with the Minnesota Board of Pharmacy as an intern.

**PHAR 7010. APPE Continuing Professional Development Portfolio.** (; 1.5 cr. [max 4.5 cr.] ; S-N only; Every Spring)

The International Pharmaceutical Federation has defined Continuing Professional Development (CPD), as the responsibility of individual pharmacists for systematic maintenance, development and broadening of knowledge, skills and attitudes, to ensure continuing competence as a professional, throughout their careers. Pharmacists must self-assess their performance and associated learning needs, followed by planning of learning, acting on those plans, and evaluating progress. Documentation of this process allows for peer review and support, along with regulatory review. prereq: 3rd year Pharmacy student

**PHAR 7128. Acute Patient Care Practice Experience II.** (4 cr. ; A-F only; Every Fall, Spring & Summer)

Experience in an inpatient setting. Students are responsible for all drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7213. Elective Practice Experience**

**III.** (4 cr. ; A-F only; Every Fall, Spring & Summer) Experience in inpatient or outpatient pharmacy practices where direct patient contact and care occurs for 5 weeks, -or- experience in a non-patient care setting, sites vary widely from governmental agencies to pharmacy associations to specialized practices for 5 weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7214. Elective Practice Experience IV.** (4 cr. ; A-F only; Every Fall & Spring)

Five weeks of experience in inpatient or outpatient pharmacy practices where

direct patient contact and care occurs, -or experience in a non-patient care setting. Sites vary widely from governmental agencies to pharmacy associations to specialized practices. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7310. Introduction to Community Health and Interprofessional Engagement.**

(1 cr. ; S-N only; Every Fall)

This course builds on content learned in Becoming a Pharmacist - to provide students with fundamental knowledge, skills and attitudes required of competent, caring general pharmacist practitioners. Content is integrated with concurrent first year didactic courses and prepares students for Pre-APPE. prereq: Successful completion of Becoming a Pharmacist (BaP)

**PHAR 7325. Introductory Community Practice Pharmacy Experience.**

(3 cr. ; S-N only; Every Fall & Summer)

The purpose of the Community IPPE is to introduce you to the fundamentals of pharmacy practice and developing professional attitude and behavior in the community pharmacy setting. The course will build upon knowledge gained in the first year didactic curriculum, specifically Foundations of SAPH and Foundations of Pharmaceutical Care. The format of the IPPE course includes: in person, online and an experiential components. The experiential component is a combination of observation, application of current knowledge, and feedback and assessment between you, the preceptor, and others. prereq: College of Pharmacy students must complete PHAR 6700 (Becoming a Pharmacist), 6706 (Foundations in Pharmaceutical Care), 6716 (Applied Pharmaceutical Care), 6728 (Pharmaceutical Calculations), 6710 (Pharmaceutical Care Skills Lab 1), 6720 (Pharmaceutical Care Skills lab 2), 6704 (foundations of SAPH), 6730 (first year seminar), 6718 (drug delivery), 6722 (med chem), 6726 (pharmacology) with a passing grade. You must be registered with the Minnesota Board of Pharmacy as an intern prior to the onsite experiential component of this course.

**PHAR 7330. Community Teacher**

**Experience I.** (0.4 cr. ; S-N only; Every Fall)

EPhECT is a service learning experience which pairs second year students with a volunteer Community Teacher (CT). Students develop a working/professional relationship with their CT and learn from CT's health and life experiences. Students will work with their CT to choose and complete activities unique to each CT's health profile. CTs benefit by gaining better understanding of their health by discussing and evaluating their health profile with professional students. CTs will also better understand the pharmacist's role in healthcare. prereq: Students must have completed or be currently enrolled in the following courses: Becoming a Pharmacist Foundations of Pharmaceutical Care Applied Pharmaceutical Care Pharmaceutical Skills Lab I and II

**PHAR 7340. Community Teacher**

**Experience II.** (0.4 cr. ; S-N only; Every Spring)

EPhECT is a service learning experience which pairs second year students with a volunteer Community Teacher (CT). Through this course students develop a working/professional relationship with their CT and learn from their CT health and life experiences. Students will work with their CT to choose and complete activities unique to each CT health profile. prereq: Students must have completed or be currently enrolled in the following courses: Becoming a Pharmacist, Foundations of Pharmaceutical Care, Applied Pharmaceutical Care, Pharmaceutical Skills Lab I, II, and III, EPhECT I, and Foundations of SAPH

**PHAR 7345. Introductory Institutional Practice Pharmacy Experience.**

(3 cr. ; S-N only; Every Fall & Summer)

The purpose of the Institutional IPPE is to introduce students to the fundamentals of pharmacy practice in the institutional pharmacy setting. The course will build upon knowledge gained in the first two years of the didactic curriculum. The student will spend 120 hours at the institutional site with their preceptor (who is approved by the MN BOP) and the College. An Additional 36 hours is allocated between assignments and online course materials. prereq: In addition to the requirements to have completed the community IPPE course, students must have successfully completed Phar 6730 (Professional Development and Assessment II), Phar 6736 (Cardiovascular Pharmacotherapy), Phar 6738 (Pharmacokinetics), Phar 6740 (Pharmaceutical Care Skills III), Phar 6742 (Colloquium I: Scholarly Presentation Skills), and Spring PD2 courses. Students must also be registered interns in the state of Minnesota.

**PHAR 7401. Acute Patient Care Practice**

**Experience.** (12 cr. ; S-N only; Every Fall, Spring & Summer)

Experience in an inpatient setting. Students are responsible for all drug-related needs of individual patients. Full-time for twelve weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7411. Ambulatory Patient Care**

**Practice Experience I.** (5 cr. ; S-N only; Every Fall, Spring & Summer)

Experience in an ambulatory setting. Students responsible for drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. IV, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7412. Ambulatory Care Elective 2.**

(5 cr. ; S-N only; Every Fall, Spring & Summer) Experience in an ambulatory setting. Students responsible for drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. IV, MN Board of Pharmacy intern,

criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7413. Community Pharmacy Practice**

**Experience.** (5 cr. ; S-N only; Every Fall, Spring & Summer)

Students assigned to participating community pharmacies and involved in community practice activities full-time for five weeks. prereq: Pharm.D. IV, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7431. Elective Experience 1.**

(5 cr. ; S N only; Every Fall, Spring & Summer) Patient care experience in any setting. Students responsible for drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7432. Elective Experience 2.**

(5 cr. ; S N only; Every Fall, Spring & Summer) Patient care experience in any setting. Students responsible for drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7433. Elective Experience 3.**

(5 cr. ; S N only; Every Fall, Spring & Summer) Patient care experience in any setting. Students responsible for drug-related needs of individual patients. Full-time for five weeks. prereq: Pharm.D. I-III, MN Board of Pharmacy intern, criminal background check, BLS CPR certification, proof of negative Mantoux test [or explanation of positive test], proof of chicken pox immunity

**PHAR 7501. Advanced Pharmacy**

**Practice Experience 1.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7502. Advanced Pharmacy**

**Practice Experience 2.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification;

negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7503. Advanced Pharmacy Practice Experience 3.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7504. Advanced Pharmacy Practice Experience 4.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7505. Advanced Pharmacy Practice Experience 5.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7506. Advanced Pharmacy Practice Experience 6.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7507. Advanced Pharmacy Practice Experience 7.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7508. Advanced Pharmacy Practice Experience 8.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7509. Advanced Pharmacy Practice Experience 9.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHAR 7510. Advanced Pharmacy Practice Experience 10.** (4 cr. ; S-N only; Every Fall, Spring & Summer)

This course is an experiential rotation in any setting (acute care, institutional practice, community practice, ambulatory care, and electives). Students are responsible for drug related needs of individuals (patients, etc.). Full-time for four weeks. Prereq: PharmD I III; MN Board of Pharmacy intern; criminal background check; BLS CPR certification; negative Mantoux test (or explanation of positive test); chicken pox immunity

**PHIL 5991. Independent Study.** (1-3 cr. [max 10 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Work in problems of special interest to student arranged with instructor before registration. Written work required. May be taken in conjunction with another philosophy course. Prereq: instructor consent

**PHIL 5997. Intern Teaching Assistantship.** (2 cr. [max 4 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Practical experience in assisting teaching of philosophy. Application deadline one week before beginning of registration for the following semester. prereq: instructor consent

**PETE 5991. Independent Study.** (1-4 cr. [max 8 cr.] ; A-F or Audit; Every Fall, Spring & Summer)

Directed research and study in selected area of physical education or exercise science. prereq: grad student, instructor consent

**PHYS 5033. Introduction to Particle Physics.** (3 cr. ; A-F or Audit; Periodic Fall)

A survey of particle physics, including physics beyond the Standard Model. Topics include symmetries and conservation laws, quark

models, quantum electrodynamics and chromodynamics, Feynman diagrams, and neutrino oscillations. prereq: 2021, 2022, MATH 3280, 3298

**PHYS 5041. Optics.** (; 3 cr. ; A-F or Audit; Spring Even Year)

Fundamentals of physical optics. prereq: 2022

**PHYS 5052. Computational Methods in Physics.** (; 3 cr. ; A-F or Audit; Fall Odd Year)

Applications of numerical methods to problems in classical and quantum physics, emphasizing ordinary and partial differential equations. Computer modeling of physical systems and experimentation with simulations of physical systems. prereq: 2021, 1 sem programming, Math 3280

**PHYS 5053. Data Analysis Methods in Physics.** (3 cr. ; A-F or Audit; Fall Even Year)

Problems of data analysis in the context of dynamical models. Emphasis will be placed on large datasets that arise in astrophysics, particle dynamics, physical oceanography and meteorology. (2 hr lect & 2 hr lab) prereq: 2012 or 2015 or 2018 and 2016, 1 sem programming, lab or field experience beyond 2012/2015 and 2016

**PHYS 5061. Experimental Methods.** (3 cr. ; A-F or Audit; Spring Odd Year)

Instruction and practice in methods of experimental physics; microcomputer-based data acquisition; vacuum techniques. prereq: 2033 and 3061

**PHYS 5063. Theoretical Methods.** (3 cr. ; A-F or Audit; Spring Odd Year)

Selection of theoretical methods used in physics including variational calculus. Lie groups and algebra path integrals, perturbation theory, renormalization group, differential geometry. pre-req: grad student or instructor consent

**PHYS 5071. Quantum Computation.** (3 cr. ; A-F or Audit; Periodic Spring)

Quantum mechanics in Heisenberg formalism, Quantum information theory, Shor's factoring algorithm, Grover's search algorithm, quantum communication and quantum cryptography. prereq: Math 3280 or PHYS 2021 or graduate student

**PHYS 5090. Physics Seminar.** (; 1 cr. [max 2 cr.] ; A-F or Audit; Every Spring)

Preparation and presentation of oral reports on approved physics topics, research projects, and journal articles. prereq: Sr or grad student

**PHYS 5501. Advanced Classical Mechanics.** (; 3 cr. ; A-F or Audit; Fall Odd Year)

Hamiltonian and Lagrangian formulations for discrete systems, canonical transformations, nonlinear dynamics, and chaos theory. prereq: 4001

**PHYS 5511. Electrodynamics.** (; 3 cr. ; A-F or Audit; Spring Odd Year)

Maxwell's equations, relativity and electrodynamics, radiation and scattering of electromagnetic waves, relativistic particles in electromagnetic fields, and radiation reaction. prereq: 4011



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semester or summer; 10 cr total required (Plan A only)

**PHYS 5521. Quantum Mechanics I.** (3 cr. ; A-F or Audit; Fall Even Year)

Schrodinger equation, operator formulation, angular momentum, symmetries. prereq: 4021

**PHYS 5522. Quantum Mechanics II.** (3 cr. ; A-F or Audit; Spring Odd Year)

Identical particles, perturbation theory, scattering, interaction with electromagnetic field. prereq: 5521

**PHYS 5531. Introduction to Solid State Physics.** (3 cr. ; A-F or Audit; Spring Even Year)

Solid structure, thermal, and electronic properties of solids and solid surfaces. prereq: 4021, 4031

**PHYS 5541. Fluid Dynamics.** (3 cr. ; A-F or Audit; Spring Odd Year)

Analytic and numeric treatment of dynamics of fluids. Rotating, stratified fluids, with applications in limnology, oceanography, and meteorology. prereq: 2022 or 2001, Math 3280

**PHYS 5551. General Relativity.** (4 cr. ; A-F or Audit; Fall Even Year)

Differential geometry, tensors, metrics, curvature, Einstein's equation, Newtonian limit, Killing vectors, cosmology, perfect fluids, Schwarzschild and Kerr solutions, observational tests, black holes. prereq: 4001

**PHYS 5561. Astrophysics I Stellar Astrophysics.** (3 cr. ; A-F or Audit; Fall Even Year)

The application of physical laws to the understanding of astrophysical objects: celestial mechanics, energy transport, stellar structure and evolution, the interstellar medium, and stellar remnants. prereq: AST 2050 and PHYS 2021

**PHYS 5562. Astrophysics II: Galaxies and the Universe.** (3 cr. ; A-F or Audit; Spring Odd Year)

The application of physical laws and processes to the understanding of physics objects: galactic structure and dynamics, large scale structure and cosmology. pre-req: AST 2050 and PHYS 2021

**PHYS 5591. Independent Study.** (1-3 cr. [max 6 cr.]; S-N or Audit; Every Fall & Spring) Special studies, useful in individual graduate programs, not available in regular course offerings. prereq: Consent of director of graduate studies, instructor consent

**PHYS 5594. Physics Research.** (1-3 cr. [max 6 cr.]; S-N or Audit; Every Fall, Spring & Summer) Physics Research prereq: instructor consent

**PHYS 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Every Fall, Spring & Summer)

(No description) prereq: Master's student, adviser and DGS consent

**PHYS 8777. Thesis Credits: Master's.** (1-18 cr. [max 50 cr.]; No Grade Associated; Every Fall & Spring) (No description) prereq: Max 18 cr per

**PSY 5021. Advanced Developmental Psychology.** (3 cr. ; A-F or Audit; Every Fall)

Course format involved reading and discussion of reviews and journal articles about theories, research methodology, and topics central to the scientific study of human development from conception through adulthood. The role of theory as a guide for research and practice, and classical as well as contemporary theories will be examined. Normative changes and individual differences will be examined. Theoretical frameworks in the domains of social, cognitive, language, and temperament/personality development will be examined. prereq: PSY graduate student or instructor consent

**PSY 5052. Advanced Statistics I.** (3 cr. ; A-F or Audit; Every Fall)

Advanced statistics used for experimental and correlational research in psychology; analyze data from simple and complex research designs analysis of variance and linear regression techniques; hypothesis testing; nonparametric statistics; assumptions of tests and diagnosis of assumption violations; interpretations of results; use of common statistical software (e.g., SPSS or R). prereq: Math placement level 4 or MACT 23 or higher or graduate student in psychology or instructor consent required.

**PSY 5111. Advanced Personality Science and Research.** (3 cr. ; A-F or Audit; Spring Odd Year)

Modern personality theory and the empirical research that supports it; emphasis on major issues that confront personality psychologists in the conceptualization and assessment of personality; relationship between personality and consequential outcomes (such as mental illness, physical health, interpersonal relationship quality, job performance, etc.); mixed designs for conducting research on interactions between traits and experimentally manipulated conditions. pre-req: Psychology graduate student or instructor consent

**PSY 5120. Career and Lifestyle Development.** (2 cr. ; A-F or Audit; Every Fall) Overview of career development and decision theories related to life planning and career choices. Methods and techniques involved in the career counseling process. prereq: Psychology graduate student or instructor consent.

**PSY 5121. Psychopathology Over the Lifespan.** (3 cr. ; A-F or Audit; Every Fall) Psychopathology from integrative biopsychosocial and developmental psychopathology perspectives; adult and child psychopathologies including symptomatology, prevalence, etiological evidence, typical course and prognosis, associated features, cultural and social considerations, comorbidity and differential diagnosis. prereq: psychology graduate student or instructor consent

**PSY 5130. Evolutionary Psychology.** (3 cr. ; A-F or Audit; Fall Odd Year)

Evolution and the theory of natural selection as it applies to behavioral processes, e.g., survival, mating strategies, parenting and family, cooperation and conflict. prereq: psychology graduate student or instructor consent

**PSY 5131. Mind-Body Connection.** (3 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Examination of interface between biological and psychological development associated with risks for substance abuse, depression, and conduct disorders; potential commonality of mechanisms. Topics may include communication between brain and endocrine systems, evolution of the brain, homosexuality, psychoneuroimmunology, and psychopharmacology.

**PSY 5155. Forensic Psychology.** (3 cr. ; A-F or Audit; Periodic Spring)

Examines the application of psychology to the judicial system in such diverse areas as criminal diversion and rehabilitation; expert testimony; jury selection; police training; divorce mediation; and custody evaluations. prereq: 1003 or instructor consent

**PSY 5401. Advanced Social Psychology.** (3 cr. ; A-F or Audit; Every Fall & Spring)

Examination of core content areas and topics within experimental social psychology with a focus on application within both clinical and industrial/organizational psychology. Topics include attitude formation and attitude change, attribution theory, the self, conformity, prejudice, aggression, and prosocial behavior. prereq: psychology grad student or instructor consent; credit will not be granted if already received for 3201

**PSY 5500. Behavioral Approaches to Worker Wellbeing.** (3 cr. ; A-F or Audit; Periodic Fall & Spring)

Introduces factors contributing to total worker wellbeing and focuses on the work environments influence on health behavior. Emphasizes integrated approach to health protection and health promotion. Students will learn to design/redesign the work environment and to implement individual and organizational level interventions to overcome barriers and support successful health behavior change. Total worker wellbeing addresses issues such as stress, work/life balance, job satisfaction, safety, higher risk workers, optimal wellbeing, changing workforce demographics, management and leadership commitment, and injury prevention. Students will learn about the benefits integrated programs can have for both employees and employers, environmental assessment tools, empirically based intervention designs, workplace policy, supportive research, and real world examples. Students will engage in self-reflection of personal wellbeing and will design an empirical intervention-based research study to promote health behavior or reduce health risks. pre-req: Psy grad student or instructor consent

**PSY 5621. Cognition and Emotion.** (3 cr. ; A

F or Audit; Every Fall)  
Students in this course will read and

discuss scholarly reviews and journal  
articles on

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theories, research methodology, and topics central to the scientific study of human cognition, emotion, and their applications. There will be discussions on the models of cognitive (perception, memory, language, thinking, and reasoning) and emotional processes and their interrelatedness. Consideration will be given to how these contemporary models are developed and evaluated through empirical studies. Finally, how these theoretical models can be applied to educational, clinical, legal, and workplace settings will be examined. prereq: psychology graduate student or instructor consent

**PSY 5631. Biological Bases of Behavior.** (3 cr. ; A-F or Audit; Every Fall)  
Understanding how communication within the body (neuronal, endocrinological, immunological) affects behavior and psychological processes and how these systems interact to influence these processes. Examining how perturbations within these systems lead to mental illness and/or problematic behaviors. How psychoactive drugs affect these systems, with respect to clinical treatment and abuse. The neurological mechanisms of reward and drug dependence (withdrawal, cravings) will be investigated. prereq: psychology grad student or instructor consent

**PSY 5701. Advanced Personnel Psychology.** (3 cr. ; A-F or Audit; Every Fall & Spring)  
Students will apply theories and research finding to address issues of personnel recruitment, selection, and classification in the workplace. prereq: psychology graduate student or instructor consent; credit will not be granted if already received for 3701

**PSY 5702. Advanced Organizational Psychology.** (3 cr. ; A-F or Audit; Every Fall & Spring)  
This course covers core contents in organizational psychology, with a focus on understanding of research findings to enhance organizational functioning and employee well being. Topics include employee motivation, job attitudes, work stress, teams, leadership, and organizational justice and culture. prereq: psychology graduate student or instructor consent; credit will not be granted if already received for 3707

**PSY 8021. Research Methods and Evaluation.** (3 cr. ; A-F or Audit; Every Spring)  
Examination of quasi-experimental and experimental designs within psychological science. The course will provide comprehensive coverage of the assessment of reliability and validity of measures, methods, and research designs to facilitate the development of a research proposal. A wide variety of quantitative and qualitative research designs, measurement techniques, and methods will be described and evaluated in terms of internal, external, construct, and statistical conclusion validity. prereq: Grade

of C or higher in PSY 5052, in an equivalent graduate-level statistics course, or in an undergraduate research methods course in a social science discipline.

**PSY 8052. Advanced Statistics II.** (3 cr. ; A-F or Audit; Every Spring)  
Advanced statistics used for experimental and correlational research in psychology; analyze data using advanced univariate, basic multivariate, and meta-analytic techniques; assumptions of test; diagnosis of assumption violations; interpretation of results; use of common statistical software (e.g., SPSS or R). prereq: 5052 with a grade of B or better

**PSY 8097. Clinical-Counseling Practicum.** (3 cr. ; A-F or Audit; Every Spring)  
Supervised counseling practice experience within the University setting. Emphasis is on developing individual and group counseling skills. prereq: Clinical counseling track psychology graduate student

**PSY 8099. Research Project in Psychology.** (3 cr. [max 6 cr.] ; S-N or Audit; Every Fall & Spring)  
This course provides a capstone experience for students to integrate all they have learned in order to produce scholarly work. Under the guidance of a faculty advisor, students will plan, design, conduct, and present an original project. prereq: psychology grad student

**PSY 8103. Introduction to Graduate Studies.** (0 cr. ; S-N or Audit; Every Fall)  
This course will orient new students to key facets of graduate studies in the Master's in Psychological Science Program. Program expectations, requirements, and timelines will be clarified to enable students to make progress in formulating goals in their chosen tracks. This course will provide students with a basis for academic collaboration and professional development by facilitating student interactions with peers and the faculty in psychology. prereq: graduate psychology student

**PSY 8197. Clinical Counseling Internship.** (3 cr. [max 6 cr.] ; S-N or Audit; Every Fall & Spring)  
Supervised clinical work in a professional psychological services setting. Psychological assessment and clinical intervention are emphasized. prereq: 8097 and instructor consent

**PSY 8221. Individual Adult and Group Therapy/Counseling.** (3 cr. ; A-F or Audit; Every Spring)  
This course provides an overview of a variety of individual and group therapy models and techniques utilized with adults. Evidence based techniques and empirically supported treatments will be emphasized along with their application to specific psychological diagnoses. prereq: Clinical counseling track psychology graduate student or instructor consent

**PSY 8223. Child, Adolescent, and Family Therapy.** (3 cr. ; A-F or Audit; Every

Fall & Spring)

Individual child and adolescent psychological intervention models and techniques as well as a variety of family therapy models and techniques will be reviewed, emphasizing those with demonstrated empirical effectiveness. Students will be introduced to the provision of effective youth and family counseling approaches in preparation for practicum experience. prereq: Clinical counseling track psychology graduate student

**PSY 8224. Clinical Treatment Planning.** (3 cr. ; A-F or Audit; Every Fall & Spring)  
This course provides an overview of methods and strategies of evidence-based clinical treatment planning. Identification and evaluation of measurable process and outcome goals are emphasized. Treatment planning will target specific psychological diagnoses for adults and children, and various modalities, as well as crisis intervention/counseling. prereq: Clinical counseling track psychology graduate student or instructor consent

**PSY 8231. Assessment I: Foundations and Cognitive Assessment.** (3 cr. ; A-F or Audit; Every Fall)  
This course provides an overview of basic psychometric issues, test administration, and cognitive assessment. It covers fundamental issues in evidence-based assessment and the development of competent administration and interpretation skills of common cognitive assessments. prereq: Clinical counseling track psychology grad student or instructor consent

**PSY 8232. Assessment II.** (3 cr. ; A-F or Audit; Every Spring)  
Building on content from Assessment I, this course applies concepts of psychological testing and measurement to the assessment of specific clinical syndromes and personality through objective personality tests, behavioral observations, symptom checklists, rating forms and structured diagnostic interviewing. Students will learn to appropriately use and interpret results from such measures in the course of clinical/counseling practice. Issue of clinical judgment and controversies concerning common assessment approaches will be covered. prereq: 8231 and instructor consent

**PSY 8301. Multicultural Foundations in Clinical/Counseling Psychology.** (3 cr. ; A-F or Audit; Every Fall & Summer)  
This course explores the complexities of culture in practice. The focus is on becoming culturally responsive counselors and therapists. Within evidence-based practice, this course provides guidelines for integrating cultural considerations into the theory and practice of assessment, diagnosis, and therapeutic interventions. prereq: Clinical counseling track psychology graduate student or instructor consent

**PSY 8302. Ethical and Legal Issues in Therapy and Counseling.** (3 cr. ; A-F or Audit; Every Spring)  
This course covers approaches to ethical

decision making of relevance to work as a psychologist. Codes of ethical conduct, as well as legal issues related to research and practice are foci. Students will learn about important

historical cases illustrating ethical and legal issues in the field. prereq: Clinical counseling track psychology graduate student or instructor consent

**PSY 8333. FTE: Master's.** (1 cr. ; No Grade Associated; Periodic Fall & Spring)

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(no description) prereq: master's student, adviser and DGS consent

### **PSY 8701. Performance Evaluation and Management.** (3 cr. ; A-F or Audit; Every Fall & Spring)

This course centers on the methods of evaluating performance and on actions taken with employees based upon such appraisals. Theoretical understanding and familiarity with research on interpersonal judgment and perception, criterion theory and development, rating scale construction and use, sources of information, and effective communication will help students in this course develop skills in designing performance appraisal and feedback systems which meet organizational needs while enhancing employee motivation. prereq: psychology graduate student or instructor consent

### **PSY 8705. Organizational Systems & Development.** (3 cr. ; A-F or Audit; Every Fall & Spring)

This course is designed to cover topics central to organizational systems and development, including classical and contemporary theories of organizations, organizational structure, organizational design, technology, and cross cultural differences and issues. Students will learn how to integrate theory, research findings, and applied techniques to help organizations adapt within the ever-changing local and global environment. prereq: psychology graduate student or instructor consent

### **PSY 8706. Personnel Training & Development.** (3 cr. ; A-F or Audit; Every Fall & Spring)

This course is designed to cover topics central to personnel training and development. This course requires the integration of theories, tools, concepts, and techniques learned in the classroom with an application in a "real" organization. Students will learn how to analyze performance deficiencies in order to determine whether training is required and, if so, how to design and implement effective training to help fix performance problems. Basic phenomena of learning, various training and development approaches commonly used in business and industry, and design issues necessary for planning evaluation and improvement strategies will be covered. prereq: psychology graduate student or instructor consent

### **PSY 8991. Graduate Applied Projects in Psychology.** (; 1-2 cr. ; Student Option; Every Fall & Spring)

Under faculty supervision, students will work on applied psychology projects. prereq: Psychology graduate student, instructor consent

### **SAFE 6002. Regulatory Standards and**

### **Hazard Control.** (3 cr. [max 4 cr.] ; A-F or Audit; Every Fall)

Overview of OSHA and other health and safety standards, codes and regulations with an emphasis on the recognition and control of workplace hazards as defined by the standards, codes and regulations. prereq: MEHS student or department approval and instructor consent

### **SAFE 6011. System Safety and Loss Control Techniques.** (3 cr. [max 4 cr.] ; A-F or Audit; Every Fall)

Analytical techniques of data collection, data analysis, and risk assessment in designing and implementing proactive system safety processes. Comprehensive approach to cost reduction and containment processes and programs, which minimize financial and accidental losses. Lab arranged. prereq: MEHS student or department approval and instructor consent

### **SAFE 6012. Risk Management and Workers' Compensation.** (3 cr. [max 4 cr.] ; A-F or Audit; Every Spring)

Comprehensive overview of risk management strategies and insurance system; essential elements of workers' compensation cost reduction and containment programs in industry. Workers' compensation and occupational safety in preventing corporate financial losses. Lab arranged. prereq: MEHS student or department approval and instructor consent

### **SAFE 6051. Construction Safety.** (3 cr. ; A-F or Audit; Every Spring)

Code of Federal Regulations 1926 and other standards and regulations that affect construction industry. Emphasis on recognition, analysis, and corrective action. Principles of construction safety management, project implementation, and subcontractor management. Lab arranged. prereq: 6002 or department approval and instructor consent

### **SAFE 6101. Principles of Industrial Hygiene.** (3 cr. ; A-F or Audit; Every Fall)

Effects of chemical, physical, and biological agents on the body and typical methods of control; lab use of monitoring and corrective devices. Lab arranged. prereq: MEHS student or department approval and instructor consent

### **SAFE 6102. Advanced Industrial Hygiene and Health Physics.** (3 cr. ; A-F or Audit; Every Spring)

Recognition, evaluation, and control techniques necessary for prevention of occupationally related diseases. Introduction to health hazards of radiated energy such as ionizing nuclear radiation and x-rays; nonionizing radiation hazards from microwaves, lasers, and infrared and ultraviolet light. Lab arranged. prereq: 6101 or department approval and instructor consent

### **SAFE 6201. Fire Prevention and Emergency Preparedness.** (3 cr. ; A-F or Audit; Spring Odd Year)

Hazard analysis and risk assessment as related to prevention and control of undesired fires; analytical study of flammable materials and extinguishing systems found in industrial settings; organization and development of emergency preparedness programs. prereq: MEHS student or department approval and instructor consent

### **SAFE 6211. Transportation Safety.** (3 cr. ; A-F or Audit; Spring Even Year)

Study of health and safety programs used in rail, road, air, and marine transportation, emphasizing fleet safety programs. prereq: MEHS student or department approval and instructor consent

### **SAFE 6212. Noise Control Engineering.** (3 cr. ; A-F or Audit; Fall Even Year)

A multi-disciplinary approach to a comprehensive introduction to the principles of noise and noise conservation (hygiene, safety, acoustics, audiology, occupational medicine, engineering, behavioral and legal). Emphasis will be on noise control engineering protocols. Lab arranged. prereq: MEHS student or department approval and instructor consent

### **SAFE 6213. Principles of Ventilation and Indoor Air Quality.** (3 cr. ; A-F or Audit; Fall Odd Year)

Comprehensive introduction on design, maintenance, and evaluation of exhaust ventilation systems. Methodology for conducting indoor air quality investigations. Lab arranged. prereq: MEHS student or department approval and instructor consent

### **SAFE 6291. Independent Study in Industrial Safety.** (1-3 cr. ; S-N or Audit; Every Fall & Spring)

Special projects, field studies, or research in industrial hygiene or safety topics prereq: 6002, instructor consent

### **SAFE 6295. Special Topics: (Various Titles to be Assigned).** (; 1-3 cr. ; A-F or Audit; Periodic Fall & Spring)

Selected topics in industrial safety or hygiene. Similar topics may not be repeated for credit. prereq: MEHS student or department approval and instructor consent

### **SAFE 6301. Occupational Biomechanics and Work Physiology.** (3 cr. ; A-F or Audit; Fall Even Year)

Overview to study physical interaction of workers with their tools, machines, and materials so as to enhance workers' performance while minimizing risk of future musculoskeletal disorders. Lab arranged. prereq: 6302 or department approval and instructor consent

### **SAFE 6302. Occupational Ergonomics and Injury Management.** (; 3 cr. ; A-F or Audit; Every Spring)

Overview of occupational ergonomics and related disciplines such as work physiology, biomechanics, human anatomy, engineering design, medical management. Hands-on

approach, including ergonomic job analysis, risk factor quantification, and documentation for demanding tasks. Lab arranged. prereq: MEHS student or department approval and instructor consent

**SAFE 6401. Environmental Safety and Legal Implications.** (3 cr. ; A-F or Audit; Fall Odd Year)

Federal, state, and local laws and judicial interpretations that have applications to

environmental health and safety programs. Corporate responsibility regarding environment, employee, and product. prereq: MEHS student or department approval and instructor consent

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**SAFE 6821. Organization and Administration of Safety Programs.** (3 cr. ; A-F or Audit; Every Fall)

Current administrative practices. Involvement in design and development of safety programs suitable for an industrial facility. prereq: 6012 or department approval and instructor consent

**SAFE 6997. Internship in Environmental Health and Safety.** (3 cr. ; S-N or Audit; Every Fall, Spring & Summer)

Cooperative internship in an industrial, governmental, or other organization that has an established safety program or is in the process of implementing one. Requires a significant Plan B-type project for the firm. prereq: MEHS student, department approval

**SW 5032. Child Welfare and the Law.** (; 2 cr. ; A-F only; Every Fall, Spring & Summer)

Intensive advanced course in the federal, state, and tribal laws and court processes regulating child welfare practice. Includes laws and procedures and the role of the social worker in legal proceedings. prereq: master of social work student or instructor consent

**SW 5091. Independent Study.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)

Directed reading, research, or other experiences leading to presentation of a report. prereq: instructor consent

**SW 5095. Special Topics: (Various Titles to be Assigned).** (; 1-4 cr. [max 48 cr.] ; Student Option; Periodic Fall, Spring & Summer)

Proseminar on contemporary topics of concern to students and faculty. Topics announced in Class Schedule.

**SW 5096. Special Project.** (1-4 cr. [max 8 cr.] ; S-N or Audit; Every Fall, Spring & Summer)

Approval of faculty sponsor and field coordinator required to do a project in generalist or advanced generalist social work practice. Project may closely coordinate with another course or may be an independent area of interest. prereq: instructor consent

**SW 5101. Human Behavior in the Social Environment.** (; 3 cr. ; A-F only; Every Fall)

Overview of social psychological and social systems concepts. Applications of concepts to social work and human service issues. Focus on individuals, human development, families, groups, organizations, communities, and society/culture. prereq: MSW student or instructor consent

**SW 5111. Grant Writing in the Human Services.** (; 1-2 cr. ; A-F only; Periodic Spring & Summer)

Step-by-step development of grant planning and grant writing. Sources of grants: private

foundations and public agencies. Needs assessment methodologies, budgeting, and program evaluation. prereq: Jr or sr or Grad or instructor consent

**SW 5120. Cross-Cultural Exploration Through Learning Circles.** (1 cr. [max 2 cr.] ; S-N only; Every Fall & Spring)

In a small group (learning circle) students will learn about diverse groups, cross cultural interactions and explore the concepts of individual and organizational cultural competence through the use of interactive and experimental methods, and applying new knowledge to practice in social work prereq: Admission into MSW, 8100 or instructor consent

**SW 5144. Grief, Loss and Coping in Social Work Practice.** (; 2 cr. ; A-F or Audit; Periodic Fall, Spring & Summer)

Students will gain conceptual understanding, advanced assessment and intervention skills, and competencies relative to grief, loss and coping and the clinical impact on client systems. Theory and perspectives are provided from various disciplines, and a spectrum of multicultural influences, with an emphasis on person-in-environment. Materials from lay people, social work and other professional disciplines are presented and critical reviewed to guide application of best social work practices and/or evidence-based assessment, interventions and evaluation. Interdisciplinary collaboration and application skills is emphasized. Self-reflection on personal experiences is part of this course to reinforce professional skills, boundaries and ethical conduct. prereq: Social Work graduate student

**SW 5201. Social Welfare Policy.** (; 3 cr. ; A-F only; Every Fall)

Historical development of field of social welfare in the United States and emergence of social work profession. Social policy analysis techniques and ways to influence social policy and vulnerable/minority issues. prereq: MSW student or instructor consent

**SW 5215. Trauma Informed Social Work Practice with Children and Adolescents.** (; 2 cr. ; A-F or Audit; Periodic Spring & Summer)

Course addresses the impact of psychological trauma on children and adolescents, particularly those in the child welfare system. An overview of screening, assessment and intervention strategies to address the mental health needs of children affected by trauma is provided, as well as guidelines informed practice. prereq: Social Work graduate student

**SW 5222. Intervention in Family Violence.** (; 2 cr. ; A-F only; Periodic Fall & Summer)

Current theory, research, and practice in field of family violence. Multidisciplinary assessment and intervention skills for working with families with diverse backgrounds. prereq: Social Work grad student or instructor consent

**SW 5271. Women and Social Policy.** (; 2 cr. ; A-F only; Periodic Fall & Spring)

Policies affecting the well-being of women; strategies for better meeting women's needs. Focuses on policies that affect women's roles and statuses within the domestic unit and within larger economic and political spheres. prereq: Jr or sr or Grad or instructor consent

**SW 5280. Substance Use Trends and Interventions in Social Work.** (; 2 cr. ; Student Option; Every Fall, Spring & Summer)

A multi-level systems perspective in examining the effects of alcohol problems on individuals, families and other populations. Topics will include: epidemiology, etiology, screening, assessment, diagnosis, treatment options, specialized populations, and various social work practice areas. Credit will not be granted if already received for SW 4280

**SW 5333. New Zealand Engaging and Empowering Maori Youth in Community Change.** (GLOBAL PER; 3 cr. ; A-F or Audit; Periodic Summer)

Through a short-term study abroad program in New Zealand, this course will provide students with an international perspective on community-engaged strategies to address social justice issues, youth development, and human rights through culturally responsive practice with indigenous and diverse communities. through site visits and seminars with local experts in several cities and communities in New Zealand, students will learn approaches used by organizations engaged in collaborative work with indigenous youth to empower and promote social change through community development, macro practice, and advocacy. pre-req: graduate student, GPA of 2.5 or higher, instructor consent;

**SW 5500. Healthcare, Social Work, and Interdisciplinary Care.** (; 2 cr. ; A-F or Audit; Fall Odd Year)

This course focuses on skill building and knowledge of social work roles in assessment, interventions, values, skills and competencies relative to interdisciplinary social work in healthcare settings. Student learning outcomes include the comprehension of professional collaboration and competencies as well as theoretical foundations, research, policies, and ethics. The course emphasizes providing interdisciplinary collaboration in various settings such as chronic illness; oncology/palliative care; community and public health; gerontology; pediatrics; emergency services; grief and loss; and, the importance of responding to cultural context. Additional content includes navigating medical infrastructures, such as HIPAA, health insurance, disability resources, Medicare/Medicaid, family support, mental health needs,

advocacy, and information/referral. pre-req: MSW student or instructor consent

**SW 5990. Pre-Field Work.** ( ; 0 cr. ; No Grade Associated; Every Fall & Summer)

This 0 credit courses is designed to cover the expense of criminal background checks required of all MSW students before they can

enroll in their initial field placement with our program (Field I for Standard Students and Field II for Advanced Students).

**SW 8031. Advanced Practice in Child Welfare.** ( ; 3 cr. ; A-F only; Every Spring)  
Advanced skill development in assessment, intervention, and evaluation in relationship to

direct child welfare social work practice. pre-req: 5032, 8441

**SW 8051. School Social Work.** ( ; 1-2 cr. ; A-F only; Periodic Fall & Spring)

Overview of social work practice in educational settings, roles and functions of social workers within a complex ecological system, and skills

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families, and groups and to diverse populations. Development of counseling skills. pre-req: SW grad student or instructor consent

**SW 8112. Organization and Community Practice I.** ( ; 3 cr. ; A-F only; Every Spring)  
Using a problem-solving model and the ecological and strengths perspectives, students develop assessment and interventions skills for effective practice with organizations and community. Topics include using supervision, facilitating meetings, advocacy, cultural competence, and promoting organizational and community change. pre-req: 8111

**SW 8235. American Indians and Social Policy.** ( ; 3 cr. ; A-F or Audit; Every Fall, Spring & Summer)  
Informs human service providers of policies affecting American Indians, including relationships of tribal governments with the United States and Minnesota governments, the interface between Indian and non-Indian service delivery systems, and Indian culture and politics. pre-req: 5201 or advanced standing MSW program or instructor consent; credit will not be granted if already received for 5235.

**SW 8331. Organization and Community Practice II.** ( ; 3 cr. ; A-F only; Every Fall)  
Prepares students for advanced practice in organizations and communities. It provides a framework for assessing and intervening in organizations and communities using an asset-based and problem-solving approach. Specific strategies and tactics for strengthening organizations and communities are addressed. pre-req: 5101, 8112 or Advanced Standing in MSW program

**SW 8332. Advanced Practice in Administration and Community Development.** ( ; 3 cr. ; A-F only; Every Spring)

This course focuses on application of advanced knowledge and skills essential for understanding macro practice. Analysis of organizations and communities is required. Emphasis will be on analysis of complex social problems and the development of organizational and community solutions. pre-req: 8331

**SW 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Every Fall & Spring)  
(No description) pre-req: Master's student, adviser and DGS consent

**SW 8441. Individual, Family and Group Practice II.** ( ; 3 cr. ; A-F only; Every Fall)  
Examines a range of social work practice theories and their application to practice with individuals, families, and groups. Advanced skills in assessment and intervention in addressing complex problems with a focus on micro practice. Application to diverse populations and settings. pre-req: 5101, 8112 or

advanced standing MSW student

**SW 8443. Advanced Practice in Mental Health.** ( ; 3 cr. ; A-F only; Every Spring)  
Advanced skill development in direct practice social work assessment, intervention, and evaluation in relationship to mental health issues. pre-req: 8441 concurrent registration is required

**SW 8771. Health in American Indian Communities.** ( ; 2 cr. ; A-F only; Every Spring)

Introduction to historical and contemporary concepts of American Indian health. Policy issues, cultural and sensitivity knowledge, and practice methods with American Indian clients and communities at micro, mezzo, and macro levels of intervention. pre-req: 8235

**SW 8801. Field Placement I.** ( ; 3-6 cr. ; S-N only; Every Fall, Spring & Summer)  
Practicum experience with emphasis on developing knowledge and skill base for "beginning generalist" practice in a community agency. Concurrent seminar assists students in integrating classroom theories and intervention methodologies with field experiences. Application to diverse populations. pre-req: 8111, 8112; SW Grad student, instructor consent

**SW 8802. Field Placement II.** ( ; 3-8 cr. ; S-N only; Every Fall, Spring & Summer)  
Developing knowledge and skill base for "advanced generalist" practice in a community agency. Concurrent seminar focuses on integrating classroom theories and intervention methodologies with experiences with client systems at micro, mezzo, and macro levels of practice. Attention to vulnerable/minority issues. pre-req: concurrent registration in 8031 or 8332 or 8443 or 8544, SW Grad Student and instructor consent

**SW 8881. Dynamics of American Indian Families.** ( ; 2 cr. ; A-F only; Every Fall & Spring)  
Introduction to traditional and contemporary concepts relating to American Indian families. Public policy, social problems, cultural strengths, conflicts, and culturally competent social work practice. pre-req: 8235 or concurrent with SW 8235 or instructor consent

**SW 8991. Practice in the American Indian Community.** (2-4 cr. ; S-N only; Periodic Spring & Summer)  
Gives MSW students supervised direct practice experience in the American Indian community. Application of cultural knowledge and culturally competent practice skills. pre-req: Soc work grad student, 8771 or 8881, instructor consent

and knowledge needed by social workers in a school setting. pre-req: Soc work grad student or instructor consent

**SW 8070. Evidence-Based Practice in Clinical Social Work.** ( ; 3 cr. ; Student Option; Every Spring & Summer)

Students will be presented with complex case situations and asked to draw on knowledge and skills to best address these situations from initial assessment through intervention and termination. Students will gain knowledge of specific modalities in evidence-based interventions and best practice research, with a focus on cultural context and appropriate practice behaviors for skilled practice. pre-req: 8441

**SW 8100. Social Work with Diverse Populations.** ( ; 3 cr. ; A-F only; Every Fall & Spring)

Examines societal issues generated by systemic discrimination and explores methods for reducing discrimination. Particular focus on advanced social work practice with diverse populations. pre-req: MSW students or instructor consent

**SW 8101. Introduction to Research.** ( ; 2 cr. ; A-F only; Every Spring)

Introduction to social science research and its applications to social work and social welfare. pre-req: SW Grad student or instructor consent

**SW 8102. Advanced Research.** ( ; 3 cr. ; A-F only; Every Fall & Summer)

Application of social science knowledge and skills to evaluate practice and to conduct community-based research and program evaluation projects. Develop a research proposal. pre-req: 8101 or admission to advanced standing MSW program

**SW 8105. MSW Portfolio and Final Oral Seminar.** (0 cr. ; S-N or Audit; Every Spring & Summer)

Seminar provides support for completing MSW portfolio and final oral exam. pre-req: 8102

**SW 8106. Child Welfare Practice with African American Families.** (2 cr. ; A-F or Audit; Every Fall & Spring)

Students will learn about African American family strengths, values and norms; and about the social history and current status of the overrepresentation of African Americans in the child welfare system. They will also explore best practice in providing child welfare services to African American families. pre-req: 8100 or instructor consent

**SW 8111. Individual, Family and Group Practice I.** ( ; 3 cr. ; A-F only; Every Fall)

Overview of generalist social work practice, ethics, ecological perspective, and problem solving model. Application to individuals,

**SOC 8593. Directed Study.** (1-4 cr. [max 8 cr.] ; Student Option; Every Fall, Spring & Summer)  
Individualized graduate study under supervision of a faculty member in the Sociology Program. pre-req: grad student, instructor consent

**SOC 8593. Directed Study.** (1-4 cr. [max

8 cr.] ; Student Option; Every Fall, Spring & Summer)

Individualized graduate study under supervision of a faculty member in the Sociology Program. pre-req: grad student, instructor consent

#### **SPED 5204. Assessment in the General**

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assessment strategies, large-scale and high stakes testing, rubrics, checklists and other evaluative tools and techniques. This course has a 30-hour practicum. prereq: sped post-bac

**SPED 5250. Foundations of Autism Spectrum Disorders.** (; 3 cr. [max 4 cr.] ; A-F or Audit; Periodic Fall)  
Includes history, definitions, assessment, characteristics, legal aspects, varying perspectives, and etiology of the Autism Spectrum Disorders.

**SPED 5260. Language and Social Skills for Children and Youth with Autism Spectrum Disorders.** (; 4 cr. ; A-F or Audit; Periodic Spring & Summer)  
Specialized instruction in the foundation of language development, social stories, augmented and alternative communication systems, theory of mind, social skill development and play. prereq: 4250 or 5250 and 4270 or 5270

**SPED 5270. Methods for Teaching Children and Youth with Autism Spectrum Disorders.** (; 4 cr. ; A-F or Audit; Periodic Spring & Summer)  
In-depth assessment, environmental factors, curricular options, instructional strategies, behavioral programming, material for teaching, sensory integration strategies, IEP/IIIP development and implementation, and technology on the continuum of placements for children and youth with ASD. prereq: 4250 or 5250 or instructor consent

**SPED 5280. Assessment of Students with Autism Spectrum Disorders.** (2 cr. ; A-F or Audit; Fall Even Year)  
This course will focus on assessment procedures used by practitioners in the field of special education - specifically in Autism. Students will learn a variety of standardized and informal assessment procedures, referral, evaluation, planning, and programming. Students will also learn to interpret and integrate evaluation results in the planning and programming process in working with students with Autism. prereq: 4250, instructor consent

**SPED 5361. Characteristics of Developmental Disabilities.** (; 4 cr. ; A-F or Audit; Periodic Summer)  
Overview of children with moderate to severe developmental disabilities. Special emphasis will be placed on characteristics, etiology, implications of medical conditions, and the legal aspects of educating students with developmental disabilities. Assessment, instructional, and collaborative strategies will be introduced. prereq: Departmental consent

**SPED 5381. Classroom and Behavior Management.** (; 4 cr. ; A-F or Audit; Every Fall & Spring)

Classroom management and behavior change for P-12 students; identification and assessment of problem behaviors; proactive and reactive strategies for managing disruptive behavior; application of applied behavior analysis to modifying behaviors; legal and ethical issues in behavior change. Concurrent with 4381; requires an additional paper, research project or field based practicum (option for post baccalaureate students at the 5000 level). prereq: 4433, postbac grad

**SPED 5433. Foundations in Special Education.** (; 4 cr. ; Student Option; Every Fall, Spring & Summer)

This is a foundational course in special education focusing on history, philosophy, theories, and issues of special education. Topics include: overview of special education rules and processes, and survey of exceptionalities, including disability perspectives. Because this course is taught concurrently with 4433, it will require one or more of the following: paper or project. prereq: Postbac grad student

**SPED 5435. Parent and Professional Communication and Collaboration.** (; 4 cr. ; Student Option; Periodic Fall)

Group process, problem solving, decision making, collaboration, and teamwork applied to the special education process. Techniques for working with parents, professionals, paraprofessionals, and community agencies when planning and implementing Individualized Educational Plans. Because this course is taught concurrently with 4435, it will require one or more of the following: paper or project. prereq: 4433 or 5433, postbac grad or instructor consent

**SPED 5452. Academic Interventions for Students with Disabilities.** (; 3 cr. [max 4 cr.] ; A-F or Audit; Every Spring)

Understanding various models for teaching students with reading, writing, or math difficulties; development of intervention plan based on assessment and observation. Practicum. prereq: 4433 or 5433, postbac grad or instructor consent

**SPED 5455. Transitional Planning for Adolescents With Disabilities.** (; 3 cr. [max 4 cr.] ; A-F or Audit; Periodic Spring & Summer)

Assessment procedures, planning and instructional methods to help students with disabilities make the transition from school to postsecondary training, education, and employment. Practicum. prereq: 5433 or 4433, postbac grad or instructor consent

**and Special Education Classroom.** (; 4 cr. ; A-F or Audit; Every Fall & Spring)  
Exploration of topics in responsive and responsible assessment of student learning. Candidates will be introduced to use of assessment strategies and making decisions about exceptionality, eligibility, and educational programming. Topics include types of

**SPED 5585. Individual Education Plans: Development and Implementation.** (; 3 cr. ; A-F or Audit; Every Fall & Summer)

Historical perspective of the Individual Education Plan (IEP), its professional significance in education and the impact of the IEP on students and teachers in special education. Explores procedural guidelines, develop an IEP based on best practice and develop lesson and unit plans.

**SPED 5600. Student Teaching.** (1-12 cr. ; S N or Audit; Every Fall, Spring & Summer)

Observational, evaluative, and instructional experience with students with disabilities in K-12 settings. Seminar included. prereq: instructor consent

**SPED 5870. Professional Methods for Working with Fetal Alcohol Spectrum.** (; 4 cr. ; A-F or Audit; Every Fall)

Exploration of the continuum of placements of living, education, and vocational settings for individuals with FASD. Advocacy issues, in-depth assessment, environmental factors, curricular options, IEP/IIIP development and implementation and programming of the lifespan of individuals with FASD. prereq: 5850 or instructor consent; credit will not be granted if already received for 4870

**SPED 5991. Independent Study.** (1-6 cr. ; A F or Audit; Every Fall, Spring & Summer)  
Directed independent study, readings, or projects of interest to student. prereq: Department approval

**STAT 5411. Analysis of Variance.** (3 cr. ; Student Option; Every Fall)  
Analysis of variance techniques as applied to scientific experiments and studies. Randomized block designs, factorial designs, nesting. Checking model assumptions. Using statistical computer software. prereq: 3411 or 3611; a grade of C- or better is required in all prerequisite courses

**STAT 5511. Regression Analysis.** (3 cr. ; A-F or Audit; Every Fall & Spring)  
Simple, polynomial, and multiple regression. Matrix formulation of estimation, testing, and prediction in linear regression model. Analysis of residuals, model selection, transformations, and use of computer software. prereq: 3611, Math 3280 or Math 4326, a grade of C- or better in is required in all prerequisite courses

**STAT 5515. Multivariate Statistics.** (; 3 cr. ; Student Option; Fall Odd Year)

Multivariate normal distribution, MANOVA, canonical correlation, discriminate analysis, principal components. Use of computer software. prereq: 5411 or 5511, Math 3280 or Math 4326, a grade of C- or better in is required in all prerequisite courses

**STAT 5521. Applied Time Series Analysis.** (3 cr. ; A-F or Audit; Every Spring)  
Characteristics of time series; time series regression and exploratory data analysis; introduction of ARIMA models, including model building, estimation and forecasting; spectral

analysis and filtering. Use of statistical software R. prereq: Math 3280, Stat 3612 or 5511 or instructor consent

**STAT 5531. Probability Models.** (4 cr. ; A-F or Audit; Every Fall & Spring)  
Development of probability models and their applications to science and engineering. Classical models such as binomial, Poisson, and exponential distributions. Random variables, joint distributions, expectation, covariance, independence, conditional probability. Markov processes and their

applications. Selected topics in stochastic processes. prereq: 3611, Math 1297 or Math 1597, a grade of C- or better in is required in all prerequisite courses

**STAT 5571. Probability.** (4 cr. ; A-F or Audit; Every Fall & Spring)  
Axioms of probability. Discrete and continuous random variables and their probability distributions. Joint and conditional distributions. Mathematical expectation, moments,

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correlation, and conditional expectation. Normal and related distributions. Limit theorems. prereq: 3611, Math 3298, a grade of C- or better in is required in all prerequisite courses

**STAT 5572. Statistical Inference.** (; 4 cr. ; A F or Audit; Every Spring)  
Mathematical statistics; Bayes' and maximum likelihood estimators, unbiased estimators; confidence intervals; hypothesis testing, including likelihood ratio tests, most powerful tests, and goodness-of-fit tests. prereq: STAT 3612 and 5571 with a grade of C- or better

**STAT 8444. FTE: Doctoral.** (; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Doctoral student, adviser and DGS consent

**STAT 8611. Linear Models.** (; 3 cr. ; A-F or Audit; Fall Even Year)  
Developing statistical theory of general linear model. Distribution theory, testing, and estimation. Analysis of variance and regression. (offered alt yrs) prereq: 5572 with a grade of C- or better

**STAT 8711. Statistics Seminar.** (; 3 cr. ; S-N or Audit; Every Spring)  
Applications of probabilistic and statistical modeling methods, such as linear and nonlinear regression, generalized linear models, Markov chains, and Poisson processes. Case-study analyses of models from areas such as natural sciences, medicine, engineering, and industry. prereq: 5572 with a grade of C- or better

**STAT 8774. Plan B Final Project Research.** (1-4 cr. ; A-F only; Every Fall & Spring)  
Independent research performed under Advisors supervision. pre-req: Mathematical Sciences M.S. student, advisors consent

**STAT 8888. Thesis Credits: Doctoral.** (; 1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall, Spring & Summer)  
(No description) prereq: max 18 cr per semester or summer; 24 cr required

**TH 5991. Independent Study in Theatre.** (1-3 cr. [max 6 cr.] ; A-F or Audit; Every Fall, Spring & Summer)  
Directed, advanced readings and projects arranged between student and faculty mentor. prereq: Sr, department approval; undergrads max 6 cr in 3991 and 5991 combined

**TH 5997. Internship in Professional Theatre.** (1-12 cr. ; S-N or Audit; Every Fall, Spring & Summer)  
Internship with a cooperating professional, commercial, or repertory theatre. prereq: department approval; 1 cr for each 45 hrs work

**TRES 5100. Foundations of Indigenous Environmental Systems and Worldviews (Bioregionalism).** (; 3 cr. ; A-F or Audit; Every Fall)

This introductory course explores environmental resources, practices, and stewardship from tribal perspectives. A variety of instructional experiences including sharing circles, guest lectures and field study introduce students to related Indigenous knowledge, management systems and stewardship practices. The current needs of tribal communities are examined through studying the idea of Native scholars, traditional teachers and environmental activists. pre-req: admission to MTRES program or instructor consent

**TRES 5101. Tribal Natural Resource Program Management 1.** (; 3 cr. [max 6 cr.] ; A-F or Audit; Every Fall)

This course is the first in a series of two that will examine topics and issues that a natural resource manager will face in the day-to-day operation of a comprehensive tribal natural resource and environmental management program in Indian County. These courses will provide an overview of a tribal natural resources director's basic functions and responsibilities, the types of programs and projects that tribal natural resources department might implement, the agencies and other sources that provide funding and the knowledge and skills that a director will need to operate an overall successful program. These courses will be taught from a practical, on-the-ground perspective to facilitate an understanding of the realities and typical circumstances that a tribal natural resource program director encounters. pre req: admission to MTRES program or instructor consent

**TRES 5102. Tribal Natural Resource Program Management 2.** (; 3 cr. ; A-F or Audit; Every Spring)

This second course in tribal natural resource management will delve into greater detail on man of the topics covered in the first course

and focus on case studies and evaluation of day operation of a comprehensive tribal natural resource and environmental management program in Indian Country. This course will address aspects of intergovernmental relations with other tribes and with federal, state, local and other agencies. pre-req: TRES 5101

**TRES 5201. Integrated Ecosystems Stewardship 1.** (; 3 cr. ; A-F or Audit; Every Spring)

This course is the first in a series of two that will provide the student with the understanding of the biological, chemical, and physical processes necessary to support Native American ways of life in balance with pressures of economic development. The course emphasizes practices that will provide sustainable subsistence foods and medicines for tribal member harvest and to support cultural activities. An integrated natural resource management approach will be used to discuss the reasons why clean air, water, and land are required to support a health human population. Specific topics in this course may include geological setting, surface water and groundwater interaction, physical environment of lakes and streams, aquatic food webs, biodiversity, fisheries management, wild rice management, assessment of water quality trends, carrying capacity, environmental regulations and standards. Concepts of mineral stewardship on tribal lands will also be explored. This includes principles of the occurrence, extraction, and processing. pre req: Admission to MTRES program or instructor consent

**TRES 5202. Integrated Ecosystems Stewardship 2.** (; 3 cr. ; A-F or Audit; Every Fall)

This course is the second in a series of two that will provide the student with the understanding of the biological, chemical, and physical processes necessary to support Native American ways of life in balance with pressures of economic development. Specific topics in this course may include wildlife management, range management, land use planning, terrestrial food webs, sustainable agriculture/forestry practices, assessment of air quality, biodiversity, and land use planning. Concept so energy stewardship on tribal lands will be explored. Carbon-based energy resources, with emphasis on coal and petroleum/gas; fundamentals of nuclear energy; technology of extraction, production, refinement, consumption, and byproduct

treatment/disposal; importance of carbon based energy in global industrialization; limits of population growth imposed by energy requirements? principles and associated technologies of renewable energy and energy conversion, with focus on solar, geothermal, tidal, and biofuel energy resources. pre-req: TRES 5201

**TRES 5301. Tribal Natural Resource Economics.** ( ; 3 cr. ; A-F or Audit; Every Fall) Through consideration of multiple perspectives regarding value and exchange, this course pursues micro- and macroeconomic analyses of natural resources under tribal stewardship.

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Special topics in Water Resources Science

**WRS 5101. Water Policy.** (3 cr. ; A-F or Audit; Every Fall)

Socio-cultural, legal, and economic factors that affect water resources management. Historical trends in water policy, resulting water laws in the United States. Federal state and local institutional structures for water management. prereq: Grad student or instructor consent; credit will not be granted if already received for CE 5201

**WRS 8060. Directed Studies in Water Resources Science.** (1-3 cr. [max 6 cr.] ; A-F or Audit; Periodic Fall, Spring & Summer) Directed studies in water resources science. prereq: instructor consent

**WRS 8095. Plan B Project.** (3 cr. ; S-N or Audit; Every Fall & Spring) Satisfies Plan B project requirement. May appear on master's program, but does not count toward credit minimum in major. Project topic arranged between student and adviser. Written report required. prereq: instructor consent

**WRS 8100. Interdisciplinary Seminar in Water Resources.** ( ; 0.5-3 cr. ; S-N only; Every Fall) Interdisciplinary seminar in water resources science. prereq: Graduate student

**WRS 8333. FTE: Master's.** ( ; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Master's student, adviser and DGS consent

**WRS 8444. FTE: Doctoral.** ( ; 1 cr. ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Doctoral student, adviser and DGS consent

**WRS 8581. Research and Professional Ethics in Water Resources and Environmental Science.** ( ; 0.5 cr. ; S-N only; Every Spring) Ethics of water resources science and environmental engineering research/practice. Societal responsibility, plagiarism, record keeping, authorship, confidentiality, conflicts of interest, professional relationships, fraud, reporting misconduct. prereq: Graduate student

**WRS 8666. Doctoral Pre-Thesis Credits.** ( ; 1-6 cr. [max 12 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 6 cr per semester or summer; doctoral student who has not

Key topics can include modes of valuation, resource markets, sustainability, pollution control, benefit-cost analysis, air and water quality, waste management, and conservation. pre-req: admission to MTRES program or instructor consent

**TRES 5400. Directed Project Seminar.** ( ; 1 cr. ; A-F or Audit; Every Fall)

This course provides students an opportunity to plan for their directed project and receive feedback on written and oral communication skills. Students plan and submit the directed project for approval as part of this course. pre-req: TRES 5102, admission to MTRES

passed prelim oral; no required consent for the first two registrations up to 12 cr; departmental consent for the third and fourth registrations up to an additional 12 cr, or 24 cr total (for doctoral students admitted summer 2007 and beyond; doctoral students admitted prior to summer 2007 may register up to 4 times totaling 60 cr)

**WRS 8777. Thesis Credits: Master's.** ( ; 1-18 cr. [max 50 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 18 cr per semester or summer; 10 cr total required (Plan A only)

**WRS 8888. Thesis Credits: Doctoral.** (1-24 cr. [max 100 cr.] ; No Grade Associated; Every Fall, Spring & Summer) (No description) prereq: Max 18 cr per semester or summer; 24 cr required

**WS 5595. Special Topics: (Various Titles to Be Assigned).** ( ; 3 cr. [max 6 cr.] ; A-F or Audit; Periodic Fall & Spring) Advanced topics that fall outside current curriculum. Topic announced before course is offered. prereq: 90 cr or grad student or instructor consent

**WS 5897. Teaching Internship in Women's Studies.** (1-2 cr. [max 4 cr.] ; S-N or Audit; Periodic Fall & Spring) Practical experience assisting in teaching in Department of Women's Studies. Before interning for a course, students must obtain a grade of at least B+ in the course. prereq: 1000, 2101, 90cr, WS major, instructor consent

**WS 5991. Independent Study.** (1-3 cr. [max 6 cr.] ; A-F only; Every Fall, Spring & Summer) Readings, research, and/or projects on topics concerning women and women's issues. prereq: 90 cr or graduate student; instructor consent

**WRIT 5100. Introduction to Grant Writing and Project Planning.** ( ; 3 cr. ; A-F or Audit; Periodic Fall & Spring) Introduction to basic grant writing principles, including common types of grants, project planning, locating and researching funders, and preparing effective narratives and budgets. Course utilizes lectures, discussion, group

program or instructor consent

**TRES 5994. Tribal Natural Resource Stewardship Directed Project.** ( ; 3 cr. ; S-N only; Periodic Fall, Spring & Summer) Tribal Natural Resource Stewardship Directed Project pre-req: MTRES student

**WRS 5050. Special Topics in Water Resources Science.** ( ; 1-3 cr. ; A-F or Audit; Periodic Fall & Spring)

work, and guest speakers. prereq: Credit will not be granted if already received for Comp 5100, Coll Grad or Grad student

**WRIT 5197. Internship in Writing.** (1-3 cr. ; S-N only; Every Fall, Spring & Summer) Practical writing experience with a media organization, publisher, business, or government agency. prereq: instructor consent, Coll Grad or Grad student

**WRIT 5220. Document Design and Graphics.** ( ; 3 cr. ; A-F or Audit; Every Spring) Principles and practice of using computer programs to design, create, and print documents that effectively integrate verbal and graphic texts. prereq: Credit will not be granted if already received for Comp 5220, max 3 cr may be applied to Grad prog

**WRIT 5230. Web Design and Digital Culture.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) Practice in the aesthetic, cultural, and rhetorical uses of Web-design techniques, including discussion and writing about the theoretical and historical contexts of digital culture. prereq: Credit will not be granted if already received for Comp 5230, Grad student

**WRIT 5250. New Media Writing.** (3 cr. ; A-F or Audit; Periodic Fall & Spring) Combines the theory and production of new media writing--digital, verbal practices in converged media--through the application of readings and discussion to five projects that progress from written, print-based genres to new-media presentation. prereq: Credit will not be granted if already received for WRIT 4250, Grad student

**WRIT 5260. Visual Rhetoric and Culture.** ( ; 3 cr. ; A-F only; Every Fall) In addition to teaching the mechanics of graphic production, this class draws widely on the disciplines of digital design, statistics, narrative literature, engineering, and technical writing to enable students to conceive, produce, and write about visual texts critically and effectively.

**WRIT 5300. Research Methods for the Study of Writing.** ( ; 3 cr. ; A-F or Audit; Periodic Fall & Spring) Provides students with instruction and practice in critiquing research, generating research questions, designing research projects, and reporting research results in the study of writing. prereq: Coll Grad or Grad student



**WRIT 5591. Independent Study.** (1-3 cr. [max 6 cr.] ; Student Option; Every Fall, Spring & Summer)

Students choose projects with their instructor. prereq: College grad or grad student, credit will not be granted if already received for Comp 5991, max 3 cr may be applied to Grad prog, instructor consent

**WRIT 8094. Plan B Research (DRS).** (1 cr. [max 3 cr.] ; S-N only; Every Fall, Spring & Summer)

Directed research to complete Plan B Project as required by the English MA program. prereq: instructor consent

**WRIT 8902. Teaching College Writing.** (3 cr. ; A-F only; Every Fall)

Analyze theoretical works and study pedagogical principals and practices related to teaching academic writing in college, including methods, materials, and objectives. Includes a major research project as well as oral presentations and/or teaching demonstrations. prereq: Credit will not be granted if already received for COMP 8902, required for tchg assts in Writ and Engl Depts, instructor consent

**WRIT 8910. Practicum in Teaching Writing.** (1-4 cr. ; A-F or Audit; Every Fall & Spring)

Teaching, tutoring, and assisting in composition courses; experience in preparation of materials,

microteaching, and grading student work. prereq: Credit will not be granted if already received for Engl 8910 or Comp 8910, instructor consent

**WRIT 8994. Directed Research in Writing Studies.** (1-3 cr. ; A-F or Audit; Every Fall, Spring & Summer)

Controlled research in methods, materials, and theories (both linguistic and rhetorical) used in composition classes, sometimes involving experiments with composition students in secondary schools and colleges. prereq: Credit will not be granted if already received for Comp 8994; 8902; instructor consent