University of Minnesota Duluth
2022-2024 Graduate Courses

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For current information, refer to:

- Program search: z.umn.edu/publicprogramsearch
- Course search: z.umn.edu/publiccoursecatalog
- University policies: policy.umn.edu

University of Minnesota Duluth
1049 University Drive
Duluth, MN
55812
This lab complements AMS 5101. The lab is intended to expose students to various materials science laboratory test equipment and instruments at UMD and in the industry while working on a semester-long real-world project with an industry partner. The project and lab for AMS 5102 will focus on materials covered in the AMS 5101 course. The lab requires both internal (i.e., interdepartmental) and external (i.e., industry) collaboration.

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 8099. Graduate Seminar. (1 cr.; S-N or Audit; Every Fall & Spring)
The course will be a required course for graduate students in the AMS MS program. Students will participate in seminars organized by the DGS on contemporary technical topics of research and practice of applied materials science. Invited speakers will address technical topics and also topics related to ethics, leadership, and cultural global issues in applied materials science. The course requires students to complete assignments related to the outcomes of the course and give a presentation on in their research or project topic. pre-req: graduate status in the AMS program

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

Applied Material Science (AMS)

AMS 5101. Materials Analysis & Design I. (4 cr.; A-F or Audit; Every Fall)
This course introduces materials science and engineering and covers the following: polymers, ceramics, composites, coatings, and life cycle analysis. The course is designed to be hands-on and applied in nature. One intentional objective of the course is to connect students with the industry so they may better understand how to apply their knowledge to real-world applications. To assist in this objective, several guest lecturers will present during the course, and several materials-related industry tours and meetings are scheduled. The course is designed in such a way that students will learn in groups by working in teams, attending presentations, reading and peer reviewing reports, and working on projects, like what would be anticipated in an industry work setting. pre-req: CHE 3231 or ME 2105 or Grad student or instructor consent

AMS 5102. Materials Analysis & Design Lab I. (2 cr.; A-F or Audit; Every Fall)

Biology (BIOL)

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 5240. Ecological Genetics. (3 cr.; A-F or Audit; Periodic Fall & Spring)
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., pre-req: 1012, 2201, Stat 1411 or IBS grad student

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) pre-req: 2101 or 3100 or 3502 or 4501 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 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: IBS or WRS grad student or instructor consent

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) pre-req: 2801 or WRS or IBS Grad student

BIOL 5865. Conservation Biology. (2 cr.; A-F or Audit; Periodic Spring)
Introduction to science of species, habitat, and ecosystem conservation and management. pre-req: 2801 or IBS Grad student
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. prereq: CHEM 1153 or 1173 and minimum 60 credits or instructor consent


CHE 5555. Project Credits: MEng - Chemical Engineering. (3 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 graduate studies. prereq: MEng candidate, instructor consent

CHE 5613. Air Pollution Control - Advanced Topics. (3 cr. ; A-F or Audit; Every Spring) Air Pollution Control: Analysis of air pollution constituents, origins, and fates on the local, regional, and global scales. Discussion of the US, EU, and WHO regulatory apparatus concerning air quality. Design of air pollution control equipment. prereq: CHEM 1155, PHYS 2015, MATH 3280

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 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

Che 5101. Process Optimization: Lean Six Sigma. (3 cr. ; A-F or Audit; Every Fall) Emphasis on the prediction of transport rates required; credit will not be granted if already received for MIS 3241, MIS 2201 or MIS 2201, LSGE candidate or Business Analytics minor, credit will not be granted if already received for MIS 3231

BA 5301. 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. prereq: MISM 2201 or MIS 2201, LSGE candidate or Business Analytics minor, credit will not be granted if already received for MISM 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 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. prereq: MISM 2201, ECON 2030, LSGE candidate or Business Analytics minor. Credit will not be granted if already received for MIS 3241, MIS 4241, CIRA 3760 or CIRA 4761 or CIRA 5761

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 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 5714. Applications of Spectroscopy. (4 cr. ; A-F or Audit; Every Fall) Application of spectroscopic techniques to structure elucidation, including NMR, FTIR, MS, UV-Vs, X-ray, EPR spectroscopy.

Chemical Engineering (CHE)

CHE 5011. Process Optimization: Lean Six Sigma. (3 cr. ; A-F or Audit; Every Fall) Emphasis on the prediction of transport rates 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. prereq: 3112 or Grad student or instructor consent
Civil Engineering (CE)

CE 5115. Structural Dynamics. (3 cr.; A-F or Audit; Periodic Fall & Spring) Response of structures to one to five degrees of freedom and multiple degree of freedom systems to vibrations, earthquakes, blast and impact. prereq: 3115 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 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 5136. Structural Systems. (3 cr.; A-F or Audit; Every Fall & Spring) Building codes, design loads, computerized structural analysis and design, gravity and lateral system analysis and design, structural system descriptions and selection considerations, and structural contract documents. pre-req: CE 4115 and 4126 or CE 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; 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 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 renewable energy 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 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 ‘AASHTOWare 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 be 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. prereq: CE 3027

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
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Turing machines, Church-Turing Thesis, recursive and recursively enumerable languages. Lambda calculus. Undecidable problems, Rice's Theorem, undecidability of first-order logic and Godel 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 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 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 5432. Sensors and Internet of Things. (4 cr.; A-F or Audit; Every Fall) This course will introduce a broad range of sensors such as wearable biosensors that measure physiological changes, psychological changes, brain electrical activity, muscle impedance, and other sensors such as kinematic sensors, virtual reality, motion capture, luminosity and a range of robots, varying in size, features and autonomous capabilities, while emphasizing the basic principles of sensing for temperature, motion, sound, light, position, displacement, etc. IoT is ubiquitous systems that are built using embedded processors, sensors, other electronics and communication mechanisms. You will be introduced to IoT's through lectures, hands-on research papers. You will interface (embedded programming) various sensors with an AI based System-on-a-Chip (SoC) to learn to design a complete IoT system. In addition, you will learn to identify and mitigate any ethical issues related to this topic. Students will also learn the latest advances in the field of sensors and IoTs. preq: grad student, CS 2511, CS 2521, (CS 2531 or MATH 3355) or instructor consent, a grade of C- or better is required in all prerequisite courses, no credit if CS 4432 taken

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 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) Pre-req: 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, adviser's consent

CS 8893. 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

Consumer Insights & Analytics (CIA)

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, etc.)
Courses listed in this catalog are current as of 2022-08-22. For up-to-date information, visit www.catalogs.umn.edu.
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: ECON 1022, 1023, 3022 or 3023, 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

Education (EDUC)

EDUC 5230. Indigenous Peoples and the Environment. (3 cr.; A-F or Audit; Periodic Fall, Spring & Summer)
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 5990. Research Project. (1-6 cr. [max 36 cr.]; S-N only; Every Fall, Spring & Summer)
Faculty-supervised research project required for MEd prereq; instructor consent

EDUC 7001. Foundations of Education and Research. (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, and 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 7006. Ethics and Professionalism in Education. (3 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 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. pre-req: MEd candidate; credit will not be granted if already received for EHS 7009

EDUC 8666. Doctoral Pre-Thesis Credits. (1-6 cr. [max 12 cr.]; No Grade Associated; Every Fall, Spring & Summer)
(No description) pre-req: 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 prior to summer 2007). doctoral students admitted prior to summer 2007 may register up to 4 times totaling 60 cr)

Education, Secondary (EDSE)

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. pre-req: 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. Field experience is required for course completion. pre-req: Grad student or new faculty at a community college; instructor consent

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. Field experience is required for course completion. pre-req: 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. Field experience is required for course completion. pre-req: graduate student, faculty at community college or instructor consent

Electrical Engineering (EE)

EE 4999. Senior Design Project II. (3 cr.; A-F or Audit; Every Fall & Spring)
Students present senior design project results in formal written and oral reports after making refinements. Complete documentation of results in professional manner required. Results must be presented in an oral report with other senior project team members. ECE 4899 and ECE 4999 must be completed within one year for credit. pre-req: 4899 and BSEP candidate, instructor consent, no Grad credit; credit will not be granted if already received for 4951

EE 5161. Linear State-Space Control Systems. (3 cr.; A-F or Audit; Every Fall & Spring)
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; credit will not be granted if already received for 4161

EE 5311. Design of VLSI Circuits. (4 cr.; A-F or Audit; Every Fall)
This course covers custom design process of very large scale integrated circuits in CMOS technology. pre-req: EE 2212 or instructor consent

EE 5351. Introduction to Robotics and Mobile Robot Control Architectures. (3 cr.; A-F or Audit; Every Fall)
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 roots, collision avoidance, and control architectures. pre-req: 3151, credit will not be granted if already received for 4351

EE 5477. Antennas and Transmission Lines. (3 cr.; A-F or Audit; Every Fall & Spring)
Theory and performance of antennas and transmission lines. Topics: Allocation of RF spectrum, radiation theory, EM wave propagation, ground effects, interference,
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. prereq: 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. prereq: 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; prereq: 3235; credit will not be granted if already received for 4522

EE 5621. Microelectronics Technology. (3 cr.; A-F only; Every 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; 3235, credit will not be granted if already received for 4621 or 5611 with SUPREME IV simulator; fabrication technologies involved in other devices; optical devices, MEMS and semiconductor nanostructures.

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, bilinear transform & window functions, FFT, introduction to image processing. prereq: 2111; credit will not be granted if already received for 4741

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. prereq: graduate student

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 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)

Engineering Management (EMGT)

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)

English (ENGL)

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: graduate student or instructor consent

ENGL 5312. Chaucer. (4 cr.; A-F or Audit; Every Fall & Spring)
Introduction to Middle English. Reading and analysis of Chaucer's works, primarily Canterbury Tales and Troilus and Criseyde. prereq: graduate student or instructor consent

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: graduate student or instructor consent

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 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: grad student or instructor consent

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

Environment and Sustainability (ES)

ES 4999. Honors Project. (1-3 cr. [max 4 cr.]; A-F only; Periodic Fall, Spring & Summer)
Advanced individual project in any area of environment and sustainability demonstrating sound theoretical and research foundations and resulting in a written report or other expression of scholarly production. pre-req: instructor consent

Environmental Education (ENED)

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
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 5315. Operations and Management. (4 cr.; A-F or Audit; Every Fall)
Methods and practice of administrative processes of personnel, fiscal, and facility management. Involves annual operations and long-range management with sustainability of agency natural resources. Field study and presentation of a long-range management plan are included requirements. prereq: Certificate or Master of Environmental Education student

ENED 5500. 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 5590. Research Project. (1-6 cr.; S-N only; Every Fall, Spring & Summer)
Faculty-supervised research project required for MEEEd 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 research, curriculum, and/or issues. prereq: instructor consent, credit will not be granted if already received for Rec 4998

Family Medicine (FMED)

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 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 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

Finance (FIN)

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

Geographic Information Science (GIS)
GIS 4999. Honors Project in Geographic Information Science. (1-4 cr.; A-F only; Periodic Fall, Spring & Summer) Advanced individual project in any area of Geographic Information Science demonstrating sound theoretical and research foundations and resulting in a written report or other expression of scholarly production. pre-req: instructor consent; no grad credit

GIS 5553. 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 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. pre-req: GIS 3563 or 4565; credit will not be granted if already received for GEOG 5572.

GIS 5591. Independent Study. (1-3 cr.; max 6 cr.) A-F only; Every Fall, Spring & Summer) Independent study for graduate students interested in doing additional work in selected fields in GIS. pre-req: graduate student and instructor consent

Health (HLTH)

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. pre-req: instructor consent

Health Care Management (HCM)

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 care services administration and offers a current and historical overview of legal regulation of the health care industry. pre-req: 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: HCM 4520, FIN 3601, 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: HCM 4520, 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: HCM 4520, MBA student or department consent

History (HIST)

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

Industrial Engineering (IE)

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 5355. Data-Driven Engineering: Using Data Analytics for Engineering Design and Decision Making. (3 cr.; A-F or Audit; Fall Even Year) Data driven engineering refers to techniques and tools for making inferences and decisions based on data from manufacturing systems. These techniques are used by manufacturing industries to inform design, operations and supply chains. Students will understand descriptive, predictive and prescriptive parts of data analytics as applied to engineering examples. pre-req: STAT 3411, BSEE or BSME or double major

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. May include readings, research and/or special projects. pre-req: MSEM candidate, department consent

Integrated Biosciences (IBS)

IBS 8011. Integrated Biological Systems I. (3 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 evolution, 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; Periodic Fall & Spring) In-depth study of advanced topics in evolutionary biology, such as coevolution, evolution of disease organisms, ecosystem consequences of evolution, evolutionary stable strategies, and game theory. pre-req: IBS Grad 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
Inter-Institutional Cross-Reg (IICR)

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.

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 Saint Scholastica and the University of Wisconsin Superior and any other institution with whom such an agreement exists.

Linguistics (LING)

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. prereq; department approval

Management Studies (MGTS)

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: MGTS 3401, 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: MGTS 3401, 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: MGTS 3801, MBA student or instructor consent

MGTS 5841. Training and Development. (3 cr.; A-F or Audit; Every Spring)
Elements of training and development program planning and delivery: learning theories and approaches, needs assessment, training objectives, design, training methods, transfer-of-training strategies, and evaluation. Assess, design, and evaluate human resource development systems. Develop training skills and techniques. pre-req: 4+1 student or MBA student, department 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 of cultural differences in work environments.

Courses listed in this catalog are current as of 2022-08-22. For up-to-date information, visit www.catalogs.umn.edu.
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 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 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 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 transactions, and the roles of tribal accountants and auditors. prereq: MTAG 5120, MTAG student 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 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 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

Master of Business Admin (MBA)

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 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. prereq: 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; MTGS 3301 or BUS 2300 or equivalent; MBA student or college consent

MBA 8412. 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 of accounting information. Also examines the strengths and limitations of an organization's accounting system. prereq: 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 8511. 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, consumption, 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 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). (1-13 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

Master of Professional Studies (MPS)

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 professional studies. This course provides graduate 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: graduate student and instructor consent

MPS 8591. Directed Study. (1-8 cr.; A-F only; Every Fall, Spring & Summer) Individualized study with assigned instructor. prereq: graduate student and instructor consent

Mathematics (MATH)

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 Picard existence theorem for differential equations. prereq: 4201 with a grade of C- or better

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 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 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 cryptography, and recent advancements in the field. Only one of either MATH 4274 or MATH 5374 may be allowed for undergraduate mathematics electives. prereq: grad student or instructor consent

MATH 5356. 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 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 8 credits to a grad program

MATH 8333. FTE: Master's. (1 cr.; A-F or Audit; Every Fall, Spring & Summer) Independent study 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 8333 every semester until they defend their project. pre-req: advisor's 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

Mechanical Engineering (ME)

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 pursuance. pre-req: CS 1511, MATH 3280, ME 3140 or equivalent or instructor consent

ME 5101. Design and Manufacturing of Composite Materials. (3 cr.; A-F or Audit; Every Fall) This course provides students an overview of design, manufacturing and experimental characterization of fiber reinforced polymer (FRP) composite materials. Topics covered
include: current and future applications of composite materials, fibers, matrices, interfaces, micromechanics, classical lamination plate theory, failure and strength analysis of composite materials, manufacturing methods, characterization and repair of composite materials. pre-req: ME 2105 or grad student 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 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 5315. Nondestructive Evaluation of Engineering Materials.** (3 cr.; A-F only; Periodic Fall) 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 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 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: MEeng or MSME candidates and minimum of 12 credits successfully completed or department consent

**ME 8333. FTE: Master's.** (1-4 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

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**Medicine (MED)**

**MED 6023. Seminars in Native American Health.** (1 cr.; max 2 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.** (5 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 6201. The Medical School Duluth Campus Directed Study.** (1-6 cr. [max 36 cr.; P-N only; Periodic Fall, Spring & Summer) Directed study or directed research courses are opportunities for students to work individually with a faculty member to earn credit for individually designed content. The Medical School Directed Study course is available only for medical students during their foundational curriculum (years 1 and 2). To register for a directed study course the student and faculty member must complete and sign this contract prior to submitting it to the Medical School Registrar for processing. Students are only allowed to take two directed study courses throughout their foundation curriculum years. Each course can be taken for between one to six credits. One credit equals fifty to sixty hours of effort over the course of the semester. prereq: Year 1 or Year 2 Duluth Campus medical student, arrangement with a faculty mentor and approval from the Office of Curriculum, Assessment, and Evaluation.

**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 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 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 hematology, embryology, anatomy, gross and microscopic pathology, as well as clinical features, diagnosis, and pharmacological therapy. prereq: Regis med student
MED 6603. Justice, Law and Medicine. (2 cr.; P-N only; Every Fall)
Justice, Law and Medicine (JLM) provides students with tools to increase structural competency, a growing field in medical education. It introduces students to structural dimensions of health and health care, with a particular focus on health inequities and health justice. Most simply, JLM explores structural determinants of health, or the institutional, political, and socioeconomic forces that exert control over the resources a person can or cannot access that impact her health. Specifically, it considers institutional hierarchies, funding structures, laws and policies?and, within them, structural level biases and blind spots?and asks how these phenomena uniquely impact the health of Indigenous and/or rural community members in the Northland; clinical encounters, physician experiences and interprofessional opportunities; and the professional commitments of Medical School faculty. In so doing, JLM importantly highlights structural interventions that address health inequities, and it engages students in nascent platforms, practices, and agendas that illuminate structural-level disparities and the relationship between race, class, and symptom expression. Taken together, this content facilitates a deeper understanding of clinical and community contexts, and it equips students to respond in necessarily nuanced and multidimensional ways. pre-req: Medical School 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. pre-req: Registered med student

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. pre-req: Registered med student

Music (MU)

MU 5201. Advanced Music History. (2 cr.; A-F or Audit; Every Fall)
Advanced study, critique, and analysis of selected areas in music literature. pre-req: MU 3201, 3202 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. pre-req: 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. pre-req: Grad student or instructor consent

MU 5206. Vocal Solo Literature. (1-2 cr. [max 5 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. pre-req: Grad student or instructor consent

MU 5210. Studio Opera. (1 cr. [max 6 cr.]; A-F or Audit; Every Fall & Spring)
Opera production techniques; performance of solo and ensemble opera literature. pre-req: 3510 or equivalent, Grad student or instructor consent

MU 5211. 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. pre-req: Min 60 cr or Grad Student or instructor consent; can apply max 6 cr to a Grad program

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. pre-req: Graduate 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. pre-req: 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. pre-req: 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. pre-req: Intermediate proficiency, grad student, instructor consent; may be repeated

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. pre-req: 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. pre-req: Graduate 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. pre-req: 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. pre-req: Grad, 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. pre-req: Grad student, instructor consent

Pharmacy (PHAR)

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)
Interested in learning the difference between an antigen and an antibiotic? During this course, you will not only increase your medical vocabulary by more than 2500 words at your own pace, you will also learn to identify and articulate describe a wide variety of medical conditions and processes. Communication related to disease states, procedures, and diagnostics in health care can sometimes seem like another language. This course will help you recognize medical abbreviations, relate terms to procedures and diagnostics, and comprehend the meaning of medical terminology by using word elements. If you are interested in the health care field or would like to understand more about your own medical care, this course is a great place to start. Prereq: Basic knowledge of 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 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) 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.; 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 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/use. Beneficial/adverse outcomes of drugs in human populations.

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 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 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 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 6222. Advanced Pharmaceutical Compounding. (2 cr.; A-F only; Every Spring) Expands compounding skills beyond those gained in pharmaceutical care lab. prereq: 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: Second or third year PharmD 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 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 pharmaceutical management topics such as utilization & care management, formulary, clinical planning, HEOR, healthcare policy and strategy, clinical account management, pharmacy benefit 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 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. [max 2 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) 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) Directed research in pharmacy practice, pharmaceutics, medicinal chemistry, or experimental and clinical pharmacology. prereq: instructor consent

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 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 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 medicinal chemicals 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. prerequisites: 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). prerequisites: 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. prerequisites: 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. prerequisites: 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. prerequisites: Successful completion of Becoming a Pharmacist (BaP)

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. prerequisites: 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. prerequisites: 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. prerequisites: 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. prerequisites: 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. prerequisites: Pharmaceutical Care Skills Lab I concurrent registration is required (or allowed) in II, Applied Pharmaceutical Care

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. prerequisites: 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. prerequisites: 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. prerequisites: 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, pharmacoekinetiics, and pharmacodynamics of antibiotics and the pharmacotherapy of infectious diseases. prerequisites: PHAR 6702, 6706, 6718, 6724, 6726, 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. prerequisites: 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 pharmacetics 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
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 neuroologic 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 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 to the best available evidence, clinical expertise and patients’ values to make complex pharmacy related decisions. prereq: Phar 6700, 6704, 6706, 6742

PHAR 6798. Advanced Pharmacy Practice Learning Experience (APPLE) 2. (1 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). This course focuses on preparing students for the beginning of their career as a pharmacist. Students will design a study plan for licensure, review law content, and reflect on their journey in pharmacy education. 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 preceptors. Prerequisite: Successful completion of APPLE 1 and APPLE 2

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 internship requirements). The course does NOT count toward elective course 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 6902. Foundations for Integrative Mental Health and Psychiatric Practice. (2 cr.; A-F only; Every Fall)
This course is designed 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 Integrative Mental Health Focus Area designation. We ask pharmacy students to commit to the entire series (fall and spring electives, and mental health APPE)

PHAR 6906. Introduction to Pharmacy Research. (1 cr.; A-F only; Every Fall)
This course will provide an overview of principles to research in particular research topic areas. It will also provide a forum for scientists involved in research in particular topic areas to discuss their research, environment, and careers with students.

PHAR 6911. CI Cooper, RPh: Equity, Diversity, Inclusion & Antiracism GoodReads. (2 cr.; A-F only; Every Fall & Spring)
This course is designed to support students in finding ways to actively participate in equity, diversity, inclusion (EDI), and antiracism work in healthcare and life through reading and critical thinking. Students examine concepts, theories, and paradigms foundational to EDI and antiracism and apply what they have learned to real-life situations. One title is assigned to students in their enrolling semester followed by three subsequent books of their choice. Each student will create their own study plan (explained below) and progress through the course at a contracted pace. Students have up to one year to complete the course. Learning is primarily self-directed to meet unique interests and career goals. This course is remote online with one arranged Zoom session in the first semester. Students are invited to enroll in the fall or spring semester; there is no summer registration.

PHAR 6937. Foundations of Leadership. (2 cr.; A-F only; Every Fall)
The Foundations of Leadership course is designed as a “mini - curriculum” focused on leadership development and its relation to advancing the professions of pharmacy. prereq: Second year PharmD student

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 6941. Leadership Best Sellers for Pharmacists. (2 cr.; A-F only; Every Fall & Spring)
Part of the leadership track in pharmacy.

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 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...
The purpose of the Community IPPE is to introduce students to the fundamentals
of pharmacy practice in the community pharmacy setting. The course will build upon knowledge
and skills gained in the first year didactic curriculum, particularly Pharmaceutical Care
Skills Lab, Foundations of Pharmaceutical Care, and Applied Pharmaceutical Care. While
there is significant overlap across semesters, there will be greater concentration on different
topics by semester driven by the activities in workbooks. The fall semester will focus more
on patient education and pharmacy workflow. The spring semester will focus more on
patient care and pharmacy operations.

PHAR 7353. Introductory Pharmacy Practice Experience 3 - Institutional. (1 cr.; S-N only; Every Fall)
The purpose of the Institutional Introductory Pharmacy Experiences (I-IPPE) is to introduce
students to the fundamentals of pharmacy practice in the hospital setting. To complement their didactic curriculum, experiential experiences allow them to see pharmacy in action. The I-IPPE should be their opportunity to focus on the distributive and operational side of hospital pharmacy. While exposure to clinical services is an important part of hospital pharmacy, we can all agree even the most appropriately designed medication regimen is of no benefit to the patient, if it cannot be safely dispensed and administered.

PHAR 7355. Introductory Pharmacy Practice Experience 5 ? AS/IMUS. (2 cr.; S-N only; Every Fall)
Improving Medication Use Systems Introductory Pharmacy Practice Experience (IMUS-IPPE) is an 80-hour early experiential offering that exposes and advances student understanding of quality improvement in patient care in one of many possible pharmacy practice settings. All students will complete an IMUS-IPPE during one of the semesters during their P3 year. The purpose of the IMUS-IPPE is to give students the opportunity to develop continuous quality improvement (CQI) knowledge and skills via self-directed learning and participation in CQI initiatives projects in practice under the preceptorship of a pharmacist. Students will contribute to CQI initiatives improving patient care by participating on a project while learning about the organizations collective efforts related to quality improvement. Advanced Selective Introductory Pharmacy Practice Experience (AS-IPPE) is an 80-hour early experiential offering that exposes and advances student understanding of direct patient care in one of many possible pharmacy practice settings. All students will complete an AS-IPPE during one of the semesters during their P3 year. The purpose of the AS-IPPE is to introduce pharmacy students to direct patient care unique from dispensing functions in any pharmacy setting providing direct patient care. To complement their didactic curriculum, experiential rotations allow students to see pharmacy in action. Students completing an AS-IPPE will have the opportunity to focus their learning on a specific pharmacy interest area and related patient care clinical skills under the guidance of a preceptor.

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

PHAR 7514. Advanced Pharmacy Practice Experience 4. (5 cr.; S-N only; Every Fall)
This course is an experiential rotation in a pharmacy practice setting (acute care, institutional, community, ambulatory patient care, elective). Students are responsible for drug-related needs of individuals and populations. This is a five-week, full-time rotation. Students must be in good standing in the fourth year of the PharmD program and have met all institutional standards and requirements for practicing on-site prior to the start of their rotation.

PHAR 7515. Advanced Pharmacy Practice Experience 5. (5 cr.; S-N only; Every Fall)
This course is an experiential rotation in a pharmacy practice setting (acute care, institutional, community, ambulatory patient care, elective). Students are responsible for drug-related needs of individuals and populations. This is a five-week, full-time rotation. Students must be in good standing in the fourth year of the PharmD program and have met all institutional standards and requirements for practicing on-site prior to the start of their rotation.

PHAR 7516. Advanced Pharmacy Practice Experience 6. (5 cr.; S-N only; Every Fall)
This course is an experiential rotation in a pharmacy practice setting (acute care, institutional, community, ambulatory patient care, elective). Students are responsible for drug-related needs of individuals and populations. This is a five-week, full-time rotation. Students must be in good standing in the fourth year of the PharmD program and have met all institutional standards and requirements for practicing on-site prior to the start of their rotation.

Philosophy (PHIL)

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

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 2016, 1 sem programming, lab or field experience beyond 2012/2015 and 2016

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 5521. Quantum Mechanics I. (3 cr.; A-F or Audit; Fall Even Year)
Schrodinger equation, operator formulation, angular momentum, symmetries. prereq: 4021

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 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. prereq: AST 2050 and PHYS 2021

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 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 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 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 3701

PSY 8099. Research Project in Psychology. (1-3 cr.; max 12 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: psychology graduate 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 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 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 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 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

Safety (SAFE)

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 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 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 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

Courses listed in this catalog are current as of 2022-08-22. For up-to-date information, visit www.catalogs.umn.edu.
environmental health and safety programs. Corporate responsibility regarding environment, employee, and product. prereq: MEHS student or department approval and instructor consent

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

Social Work (SW)

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 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 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, 8101 or instructor consent

SW 5144. Grief, Loss and Coping in Social Work Practice. (; 3 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 of 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 or instructor consent

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. (; 3 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 of informed practice. prereq: Social Work graduate student or instructor consent

SW 5280. Substance Use Trends and Interventions in Social Work. (; 3 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 5500. Healthcare, Social Work, and Interdisciplinary Care. (; 3 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 8071. Mental Health Practice with Children and Youth. (; 3 cr.; Student Option; Every Fall & Summer) The course provides an overview of clinical social work practice with children, adolescents, and transitional age youth, as well as relevant clinical applications and skill development. Course topics include: diagnostic and assessment screening tools; historical and theoretical context of using diagnostic criteria; evidence-based and best practice interventions for children, adolescents, and transitional age youth; ethical, spiritual, cultural considerations in treatment planning; and self-awareness and self-care for clinicians. pre-req: graduate student or departmental consent

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. prereq: MSW students 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, families, and groups and to diverse populations. Development of counseling skills. prereq: SW grad student or instructor consent

SW 8235. American Indians and Social Policy. (; 3 cr.; A-F or Audit; Every Fall, Spring & Summer) Examines societal issues generated by systemic discrimination and explores methods for reducing discrimination. Particular focus on advanced social work practice with diverse populations. prereq: MSW students or instructor consent

SW 8331. Organization and Community 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. prereq: 5101, 8112 or advanced standing MSW student

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. prereq: 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. prereq: 8441 concurrent registration is required

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
**Sociology (SOC)**

**SOC 5893. 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

**Special Education (SPED)**

**SPED 5204. Assessment in the General 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 assessment strategies, large-scale and high stakes testing, rubrics, checklists and other evaluative tools and techniques. Field experience required for course completion. Pre-req: sped post-bac

**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 experience (option for post baccalaureate students at the 5000 level). Pre-req: 4433, postbac grad

**SPED 5433. Foundations in Special Education.** (3 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. Pre-req: Postbac or 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. Field experience is required for course completion. Pre-req: 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. Field experience (autonomous) required for course completion. Pre-req: 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. Field experience required for course completion. Pre-req: 5433 or 4433, postbac grad or instructor consent

**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. Field experience is required for course completion.

**Statistics (STAT)**

**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. Pre-req: 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. Pre-req: 3611, Math 3280 or Math 4326, a grade of C- or better 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. Pre-req: 5411 or 5511, Math 3280 or Math 4326, a grade of C- or better is required in all prerequisite courses

**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. Pre-req: 3611, Math 1297 or Math 1597, a grade of C- or better is required in all prerequisite courses, credit will not be granted if already received for STAT 4531

**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, correlation, and conditional expectation. Normal and related distributions. Limit theorems. Pre-req: 3611, Math 3298, a grade of C- or better 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. Pre-req: STAT 3612 and 5571 with a grade of C- or better, credit will not be granted if already received for STAT 4572

**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) Pre-req: 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

**Theatre (TH)**

**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. Pre-req: 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. pre-req: department approval; 1 cr for each 45 hrs work

Tribal Resource & Env Steward (TRES)

TRES 5100. Foundations of Indigenous Environmental Systems and Worldviews (Bioregionalism). (1-3 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. (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 resource director's basic functions and responsibilities, the types of programs and projects that tribal natural resource 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 5201. Integrated Ecosystems Stewardship 2. (1-3 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 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 program or instructor consent

Urban and Regional Studies (URS)

URS 4999. Honors Project. (1-3 cr.; max 4 cr.; A-F only; Periodic Fall, Spring & Summer)
Advanced individual project in any area of urban and regional studies demonstrating sound theoretical and research foundations and resulting in a written report or other expression of scholarly production. pre-req: instructor consent

Water Resources Science (WRS)

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. pre-req: 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. pre-req: instructor consent

WRS 8100. Interdisciplinary Seminar in Water Resources. (0.5-3 cr.; S-N only; Every Fall)
Interdisciplinary seminar in water resources science. pre-req: Graduate student

WRS 8333. FTE: Master’s. (1 cr.; No Grade Associated; Every Fall, Spring & Summer)
(No description) pre-req: Master's student, adviser and DGS consent

WRS 8444. FTE: Doctoral. (1 cr.; No Grade Associated; Every Fall, Spring & Summer)
(No description) pre-req: Doctoral student, adviser and DGS consent

WRS 8777. Thesis Credits: Master’s. (1-18 cr.; max 50 cr.; No Grade Associated; Every Fall, Spring & Summer)
(No description) pre-req: 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) pre-req: Max 18 cr per semester or summer; 24 cr required

Women’s Studies (WS)

WS 5897. Teaching Internship. (1-2 cr.; max 4 cr.; S-N only; Periodic Fall & Spring)
Practical experience assisting in teaching a course within the program. Before interning for a WS course, students must obtain a grade of at least a B+ in the course they are requesting to assist. pre-req: 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. pre-req: 90 cr or graduate student; instructor consent

Writing Studies (WRIT)

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. pre-req: 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. pre-req: 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. pre-req: Credit will not be granted if already received for Comp 8994; 8992; instructor consent