Spring 2025 Tech Electives

By utilizing this list, I acknowledge that:
- This list is *not* all-inclusive.
- Just because I *can* take a class, does not mean I *should* take a class.
- I am responsible for ensuring I meet pre-requisites.
  - Pre-reqs are enforced by the department offering the course.
- Class schedules and offerings may change; classes may not be available when I register.

* NOTE: The college of business does NOT allow non-business students to take more than three of 3000+ level courses in their college. (ACCT, FIN, MGMT, MIS, MKT, SCM, ENTSP) Please note that this is across the *college*, not individual course designator.

AERE 3210: Flight Structures Analysis
Cr. 3.
Prereq: EM 3240, Credit or enrollment in MATH 2660 or 2670

Introduction to elasticity, airworthiness, and flight loads. Introduction to fatigue. Materials selection for flight applications. Thin walled cross-sections under bending, torsion, and shear loads using classical methods. Shear center. Column buckling. Matrix methods of structural analysis.

AERE 3220: Aerospace Structures Laboratory
Cr. 2.
Prereq: Credit or concurrent enrollment in AERE 3210

Design of experiments. Data analysis. Strain gage installation. Measurement of stiffness/strength of aluminum. Analysis/fabrication/testing of riveted joints. Shear/bending measurements inbeam sections. Analysis/measurement of strains in frames. Buckling of columns. Stress concentration. Vibration testing of beams and plates. Fabrication/testing of composites.

AERE 3510: Astrodynamics I
(Cross-listed with I E). Cr. 3.
Prereq: ME 3450

Introduction to astrodynamics. Two-body Keplerian satellite and planetary motion. Geocentric and extraterrestrial trajectories and applications. Ballistic missiles.

AERE 3640X: Cyber-Physical Systems Application
(Cross-listed with CPS 3640X). Cr. 3.
Prereq: ENGR 1600 or equivalent course; credit or enrollment in MATH 2670; knowledge of Python.

Fundamental principles of cyber-physical systems and their system-level applications at an introductory level; introduction to radio control systems and control of actuators; computer programming of physical systems; data processing and communication; control loops; X-by-wire control systems; simulation; testing of control loops.

AERE 4230: Composite Flight Structures
Cr. 3
Prereq: EM 3240; MATE 2730 **Lecture Required**

Fabrication, testing and analysis of composite materials used in flight structures. Basic laminate theory of beams, plates and shells. Manufacturing and machining considerations of various types of composites. Testing of composites for material properties, strength and defects. Student projects required.

AERE 4330: Spacecraft Dynamics and Control
Cr. 3.
Prereq: ME 3450

Three-dimensional rotational kinematics and attitude dynamics of a rigid body in space. Classical stability analysis of spinning spacecraft with or without energy dissipation. Attitude dynamics, stability, and control of spacecraft in a circular orbit in the presence of gravity-gradient torques. Introduction to spacecraft attitude determination and control systems (ADCS) with emphasis on modern attitude determination algorithms. Simulation of spacecraft attitude dynamics and control problems of practical interest using programming and analysis software.

AERE 4520: Introduction To Systems Engineering And Analysis
Cr. 3
Prereq: Junior Classification in an Engineering Major

Principles of systems engineering to include problem statement formulation, stakeholder analysis, requirements definition, system architecture and concept generation, system integration and interface management, verification and validation, and system commissioning and decommissioning operations. Introduction to discrete event simulation processes. Students will work in groups to propose, research, and present findings for a systems engineering topic of current relevance.

AERE 4630: Introduction to Multidisciplinary Design Optimization
(Dual-listed with AERE 5630). Cr. 3
Prereq: Senior classification in College of Engineering or Permission of Instructor

Introduction to the theory and methods of Multidisciplinary Design Optimization (MDO), including system coupling, system sensitivity methods, decomposition methods, MDO formulations (such as multi-discipline feasible (MDF), individual discipline feasible (IDF) and all-at-once (AAO) approaches, and MDO search methods.

ABE 3420: Agricultural Tractor Power
Cr. 3
Prereq: CHE 3810 or ME 2310; Lab required

Thermodynamic principles and construction of tractor engines. Fuels, combustion, and lubrication. Kinematics and dynamics of tractor power applications; drawbar, power take-off and traction mechanisms.

ABE 4100: Electronic Systems Integration for Agricultural Machinery
(Dual-listed with ABE 5100). Cr. 3

System architecture and design of electronics used in agricultural machinery and production systems. Emphasis on information technology and systems integration for automated agriculture processes. Design of Controller Area Network (CAN BUS) communication systems and discussion of relevant standards (ISO 11783 and SAE J1939). Application of technologies for sensing, distributed control, and automation of agricultural machinery will be emphasized.

ABE 4780: Wood Frame and Agri-Industrial Structures
(Dual-listed with ABE 5780). Cr. 3
Prereq: E M 3240

Design of light-framed wood structures using LRFD and ASD design procedures. Includes analysis of wind, snow, dead, and live loads. Applications include animal housing, greenhouses, and storage structures. Fasteners, laminated posts, truss design and use of National Design Specifications.

AGEDS 3880: Agricultural Mechanics Applications
(2-3) Cr. 3. Repeatable, maximum of 2 times.
Prereq: <mark>Lab required</mark>
Introduction to SMAW (Arc), GMAW (Mig), GTAW (Tig), Oxy-Fuel welding, Oxy-Fuel cutting, and Plasma cutting theories and applications. Emphasis will be on theoretical foundation of welding, safety, welding skill development, and management of equipment, and materials. Introduction to small engines and applications. Emphasis will be on theory of operating systems, maintenance, troubleshooting, failure analysis, and safety.

ASTRO 3460: Introduction to Astrophysics
Cr. 3
Prereq: PHYS 2220 or (PHYS 2320 and 2320L) or PHYS 2420

An exploration of the universe beyond our Solar System, with emphasis on the astrophysics of stars and galaxies. Observable properties of stars, physics of stellar atmospheres and interiors. Birth, evolution and death of stars, to understand the past and future of our Sun, the Milky Way galaxy and the other galaxies in the universe. Basic concepts of cosmology, dark matter and dark energy. Use of computer models to calculate the structure and evolution of stars and protostars, and to analyze actual astronomical data obtained by professional astronomers.

BME 2200: Introduction to Biomedical Engineering
(Cross-listed with CH E). Cr. 3.
Prereq: BIOL 2120, ENGR 1600 or equiv, MATH 1660, CHEM 1670 or CHEM 1770, PHYS 2320, PHYS 2320L

Engineering analysis of basic biology and engineering problems associated with living systems and health care delivery. The course will illustrate biomedical engineering applications in such areas as: biotechnology, biomechanics, biomaterials and tissue engineering, and biosignal and image processing, and will introduce the basic life sciences and engineering concepts associated with these topics.

BME 3410: BioMEMs and Nanotechnology
Cr. 3
Prereq: BME2200

Overview of Micro-Electro-Mechanical-System (MEMS) technologies for bioengineering, fundamentals of microfluidic device design, fabrication, and characterization, survey of microfluidic functional building blocks for lab-on-a-chip applications including mixers, valves, channels, and chambers. Topics of nanotechnology in bioengineering, nanoscale building block technologies for bioengineering including self-assembling, surface chemical treatment, nano-imprinting, nano-particles, nano-tubes, nano-wires, and stimuli-responsive biomaterials.

C E 3320: Structural Analysis I
Cr. 3.
Prereq: EM 3240

Loads, shear, moment, and deflected shape diagrams for beams and framed structures. Deformation calculations. Approximate methods. Application of consistent deformation methods to continuous beams and frames. Application of displacement or slope deflection methods to continuous beams and frames without sway. Influence lines for determinate and indeterminate structures. Computer applications to analyze beams and frames. Validation of computer results.

[CON E 3800: Engineering Law](#)
Cr. 3.
Prereq: Junior classification

Introduction to law and judicial procedure as they relate to the practicing engineer. Contracts, professional liability, professional ethics, licensing, bidding procedures, intellectual property, products liability, risk analysis. Emphasis on development of critical thinking process, abstract problem analysis and evaluation.

[CPR E 2870X: Cyber-Physical System Fundamentals](#)
Cr. 3.
Prereq: Engr 160 or equivalent. ==*Lecture Required*==

Fundamentals of cyber-physical systems, including introduction to digital systems design, embedded platforms and programming, sensing and actuation, and performance analysis. Introduction to data communication concepts, including systems-level view of signal processing and electronic circuits, networking standards and protocols. Laboratory exercises with embedded circuits, signals, and measurement applications.

[ECON 3010: Intermediate Microeconomics](#)
Cr. 3-4.
Prereq: ECON 1010; ECON 2070 or MATH 1660

Theory of consumer and business behavior; optimal consumption choices and demand; theory of firm behavior; costs, production, and supply; competitive and imperfectly competitive markets; theory of demand for and supply of factors of production; general equilibrium analysis. ==Fall and spring require recitation and are 4 credits; summer is 3.0 credits==

[ECON 3020: Intermediate Macroeconomics](#)
Cr. 3.
Prereq: ECON 1010, ECON 1020; MATH 1600 or MATH 1650

Theory of income, employment, interest rates, and the price level; fiscal and monetary policy; budget and trade deficits; money and capital inflows, interest rates, and inflation.

[ECON 3200: Labor Economics](#)
Cr. 3.
Prereq: ECON 1010

Economic analysis of contemporary domestic and international labor market issues including labor supply and demand, unemployment, and employment in the U.S. and elsewhere; investments in and returns to education, training, health, immigration and migration; income inequality; labor productivity; out-sourcing and global competitiveness; work incentives; compensation including benefits; and labor policies such as minimum wages, over-time pay, discrimination, unions, and immigration. Examples drawn from the U.S. and other developed countries with reference to developing countries where relevant.
Meets International Perspectives Requirement.

ECON 3210: Economics of Discrimination
(Cross-listed with WGS). Cr. 3.
Prereq: ECON 1010

Economic theories of discrimination. Analysis of the economic problems of women and minorities in such areas as earnings, occupations, and unemployment. Public policy concerning discrimination. Poverty measurement and antipoverty programs in the U.S.
Meets U.S. Diversity Requirement.

ECON 3340: Entrepreneurship in Agriculture
Cr. 3.
Prereq: ECON 1010

Introduction to the process of entrepreneurship within the agricultural and food sectors. Emphasis on opportunity recognition and creation of concept for new startup ventures. Students will develop a business plan for a startup business or non-profit organization.

ECON 3440: Public Finance
Cr. 3.
Prereq: ECON 1010

The economic role of governments in market economies. Public goods, externalities, income distribution, and income maintenance programs. The effect of taxes on economic behavior, descriptions of the structure of the principal U.S. taxes, and current reform proposals.

ECON 3530: Money, Banking, and Financial Institutions
Cr. 3.
Prereq: ECON 1010; ECON 1020

Theoretical and applied analysis of money, banking, and financial markets; interest rates and portfolio choice; the banking industry in transition; the money supply process; the Federal Reserve System and the conduct of monetary policy; macro implications of monetary policy; international finance.

ECON 3550: International Trade and Finance
Cr. 3.
Prereq: ECON 1010; ECON 1020

Explanations of causes of international trade and the impact of trade on welfare and employment patterns. Analysis of government policies towards trade, such as tariffs, quotas, and free trade areas. Theory of balance of payments and exchange rate determination, and the role of government policies. Examination of alternative international monetary arrangements.
Meets International Perspectives Requirement.

ECON 3850: Economic Development
(Cross-listed with GLOBE).Cr. 3.
Prereq: ECON 1010; ECON 1020

Current problems of developing countries, theories of economic development, agriculture, and economic development, measurement and prediction of economic performance of developing countries, alternative policies and reforms required for satisfying basic needs of Third World countries, interrelationships between industrialized countries and the developing countries, including foreign aid.
Meets International Perspectives Requirement.

EE 3110: Electromagnetic Fields and Waves

Cr. 4

Prereqs: EE 2010; MATH2650; PHYS 2320; PHYS 2320L; credit or concurrent enrollment in MATH 2670

Fundamentals and applications of electric and magnetic fields and materials. Electrostatics and magentostatics, potentials, capacitance and inductance, energy, force, torque. Uniform plane electromagnetic waves, Poynting vector. Transmission lines: transient and sinusoidal steady-state conditions, reflection coefficient.

EE 3410: BioMEMs and Nanotechnology

(Cross-listed with BME). Cr. 3.

Prereq: BME 220

Overview of Micro-Electro-Mechanical-System (MEMS) technologies for bioengineering, fundamentals of microfluidic device design, fabrication, and characterization, survey of microfluidic functional building blocks for lab-on-a-chip applications including mixers, valves, channels, and chambers. Topics of nanotechnology in bioengineering, nanoscale building block technologies for bioengineering including self-assembling, surface chemical treatment, nano-imprinting, nano-particles, nano-tubes, nano-wires, and stimuli-responsive biomaterials.

EE 3510: Analysis of Energy Systems

Cr. 3.

Prereq: PHYS 2320

Energy-scientific, engineering and economic foundations. Energy utilization-global and national. Sectoral analysis of energy consumption. Relationship of energy consumption and production to economic growth and environment. Technology for energy production. Economic evaluation of energy utilization and production. Scientific basis for global warming. Environmental impact of energy production and utilization. Renewable energy.

Meets International Perspectives Requirement.

EM 3270: Mechanics of Materials Laboratory

Cr. 1.

Prereq: EM 3240

Experimental determination of mechanical properties of selected engineering materials. Experimental verification of assumptions made in 324. Use of strain measuring devices. Preparation of reports.

EM 3620: Principles of Nondestructive Testing

(Cross-listed with MAT E). Cr. 3.

Prereq: PHYS 1320 and PHYS 1320L or PHYS 2320 and PHYS 2320L

Radiography, ultrasonic testing, magnetic particle inspection, eddy current testing, dye penetrant inspection, and other techniques. Physical bases of tests, materials to which applicable, types of defects detectable, calibration standards, and reliability safety precautions.

EM 3620L: Nondestructive Testing Laboratory

(Cross-listed with MAT E). Cr. 1.

Prereq: Credit or concurrent enrollment in EM 3620 or MATE 3620

Application of nondestructive testing techniques to the detection and sizing of flaws in materials and to the characterization of material's microstructure. Included are experiments in hardness, dye penetrant, magnetic particle, x-ray, ultrasonic and eddy current testing. Field trips to industrial laboratories.

ENSCI 3450: Natural Resource Photogrammetry and Geographic Information Systems
(Cross-listed with NREM). Cr. 3. S.
Prereq: Junior classification <mark>Lab required</mark>

Measurement and interpretation of aerial photos in resource management. Introduction to Geographic Information Systems (GIS) using ArcGIS including digitizing, development and query of attribute tables, georeferencing, and use of multiple GIS layers in simple spatial analyses.

ENSCI 3600: Environmental Soil Science
(Cross-listed with AGRON). Cr. 3.

Application of soil science to contemporary environmental problems; comparison of the impacts that different management strategies have on short- and long-term environmental quality and land development. Emphasis on participatory learning activities. AGRON 1820 or ENSCI 2500 or GEOL 1010 recommended.

ENSCI 4040: Global Change
(Dual-listed with ENSCI 5040). (Cross-listed with AGRON, ENV S, MTEOR). Cr. 3.
Prereq: Four courses in physical or biological sciences or engineering; junior standing

Recent changes in global biogeochemical cycles and climate; models of future changes in the climate system; impacts of global change on agriculture, water resources and human health; ethical issues of global environmental change.

ENSCI 4110: Hydrogeology
(Dual-listed with ENSCI 5110). (Cross-listed with GEOL). Cr. 4.
Prereqs: Lab required

Physical principles of groundwater flow, nature and origin of aquifers and confining units, well hydraulics, groundwater modeling, and contaminant transport. Lab emphasizes applied field and laboratory methods for hydrogeological investigations.

*ENTSP 3130: Feasibility Analysis for New Ventures
Cr. 3.
Prereq: ENTSP 3100

Focuses on the knowledge and practical skills required for developing an idea for a new business venture, researching potential markets, analyzing competition, conducting formal feasibility analyses, and considering business plan implications. Includes discussion of basic business functions in terms of their application to conducting feasibility analyses and to exploiting related business opportunities.

ENV S 3240: Energy and the Environment
(Cross-listed with ENSCI, GEOL, MTEOR). Cr. 3.
Prereq: CHEM 1630 or CHEM 1770, MATH 1400

Exploration of the origin of Earth's energy resources and the environmental and climatic impacts of energy acquisition and consumption. Renewable and non-renewable energy resources within an Earth-system context. Various environmentally-relevant topics such as water quality and availability, habitat destruction, greenhouse-gas emissions, and health and safety hazards to wildlife and human communities.

ENV S 3420: World Food Issues: Past and Present
(Cross-listed with AGRON, FS HN, T SC). Cr. 3.
Prereq: Junior classification

Issues in the agricultural and food systems of the developed and developing world. Emphasis on economic, social, historical, ethical and environmental contexts. Causes and consequences of overnutrition/undernutrition, poverty, hunger and access/distribution. Explorations of current issues and ideas for the future. Team projects.
<mark>Meets International Perspectives Requirement.</mark>

ENV S 3630: U. S. Environmental History
(Cross-listed with HIST). Cr. 3.
Prereq: Sophomore classification

Survey of the interactions of human communities with the North American environment. Focus on the period from pre-settlement to the present, with a particular concentration on natural resources, disease, settlement patterns, land use, and conservation policies.

ENV S 4070: Watershed Management
(Cross-listed with ENSCI, NREM). Cr. 4.
Prereq: 1 course in BIOL

Managing human impacts on the hydrologic cycle. Field and watershed level best management practices for modifying the impacts on water quality, quantity and timing are discussed. Field project includes developing a management plan using landscape buffers.

ENV S 4240: Sustainable and Environmental Horticulture Systems
(Cross-listed with HORT). Cr. 3.

Inquiry into ethical issues and environmental consequences of horticultural cropping systems, production practices and managed landscapes. Emphasis on systems that are resource efficient, environmentally sound, socially acceptable, and profitable.

ENV S 4500: Issues in Sustainable Agriculture
(Cross-listed with AGRON). Cr. 3.

Agricultural science as a human activity; contemporary agricultural issues from agroecological perspective. Comparative analysis of intended and actual consequences of development of industrial agricultural practices.

ENV S 4840: Sustainable Communities
(Cross-listed with C R P). Cr.. 3.
Prereq: Junior classification

The history and theory of sustainable community planning. Procedural and substantive dimensions. Case studies of communities engaged in sustainability planning. Use and development of indicators.

IE 3050: Engineering Economic Analysis
Cr. 3.
Prereq: MATH 1660

Economic analysis of engineering decisions under uncertainty. Financial engineering basics including time value of money, cash flow estimation, and asset evaluation. Make versus buy decisions. Comparison of project alternatives accounting for taxation, depreciation, inflation, and risk.

[IE 4300: Entrepreneurial Product Engineering](#)
(Cross-listed with ENGR). Cr. 3.
Prereq: Junior Classification

Process of innovative product development in both entrepreneurial and intra-preneurial settings. Define, prototype and validate a product concept based on competitive bench-marking, market positioning and customer requirement evaluation in a target market into a product design that is consistent with defined business goals and strategies. Combination of lecture, discussion, problem solving and case study review.

[IE 4370: Reliability and Safety Engineering](#)
(Dual-listed with I E 5370). Cr. 3.
Prereq: STAT 2310 or STAT 3050 or STAT 5870

Mathematical basics for dealing with reliability data, theory, and analysis. Bayesian reliability analysis. Engineering ethics in safety evaluations. Case studies of accidents in large technological systems. Fault and event tree analysis.

[INDD 3300: Creative Thinking in Design](#)
(3-0) Cr. 3.

Exploration of strategies, methods, and processes associated with creative thinking skills and problem solving. Discussion of the nature of creativity and its implications in different contexts that cross content boundaries.

[INDD 5300: Design Thinking](#)
(3-0) Cr. 3.
Prereq: Senior or graduate standing in any ISU program

Exploration of design thinking process, toolkits, and mindsets as creative problem solving approaches for systems, products, and processes, across diverse contexts. Strategies for problem-framing, creative solutions and co-evolution process, with a focus on collaborative and interdisciplinary design to investigate real-world problems and opportunities.

[KIN 3550: Biomechanics](#)
(3-0) Cr. 3. F.S.SS.
Prereq: PHYS 1110 or PHYS 1150

Mechanical basis of human performance; application of mechanical principles to exercise, sport and other physical activities.

[MATE 3420: Structure/Property Relations in Nonferrous Metals](#)
Cr. 3.
Prereq: MATE 2150 or 2730 or 3920

Processing of metals and alloys to obtain desired mechanical properties by manipulation of their microstructure and composition of constituent phase(s). Relevance of defects to mechanical properties, plastic flow. Strengthening mechanisms in metals and alloys. Microstructure, heat treatment and mechanical properties of engineering alloys. Metal-matrix composites.

MATE 3500: Polymers and Polymer Engineering
Cr. 3.
Prereq: MATE 2160 or MATE 2730 or MA E 3920

Fundamental concepts of soft matter, including polymer, colloid and surfactant. Their physical and chemical properties, rheology and production methods. Applications of polymers in the chemical industry. Related topics in surface, diffusion and stability.

*MGMT 3200: Corporate Entrepreneurship, Innovation and Technology Management
(Cross-listed with ENTSP).
Cr. 3.
Prereq: sophomore classification

Entrepreneurial approaches aimed at the identification, development and exploitation of technical and organizational innovations, the management of new product or process developments, and the effective management of new ventures in the context of mid-size to large corporations in manufacturing as well as in service industries. Development of an awareness and understanding of the range, scope, and complexity of issues related to the creation of a corporate environment that is supportive of entrepreneurial endeavors as well as to gain insights concerning the effective implementation of technological and organizational innovations in corporate settings.

*MGMT 3700: Management of Organizations
Cr. 3.
Prereq: ECON 1010 or ECON 1020

A management functions approach is used to explain what managers do in organizations; how they deal with external constituents, how they structure their companies, and how they deal with employees. A contingency approach is used as a framework for understanding how to increase the effectiveness and efficiency of organizations in today's dynamic, highly competitive business environment.

*MGMT 3710: Organizational Behavior
Cr. 3.
Prereq: Sophomore classification

The study of individual attributes, interpersonal relations, and employee attitudes in organizations. Instructional emphasis is placed on how management concepts such as reward systems, job design, leadership, teams, etc., can be used to manage employee attitudes and behavior.

*MGMT 3720: Ethical and Responsible Management
Cr. 3.
Prereq: Sophomore Classification

Introduces the many aspects of ethical and responsible management in today's organization, including the ethical implications of business decision-making (and the implications of having multiple stakeholders); corporate social responsibility; ethical leadership and other leadership styles as they pertain to responsible management; and the role of corporate governance and ethical codes in developing and institutionalizing an ethical organization. Builds ethical decision-making strategies and awareness of one's own ethical leadership philosophy.

[*MGMT 3810: Managing Family Businesses](#)
(Cross-listed with ENTSP). Cr. 3.
Prereq: Sophomore classification

Introduction to the important role family businesses play in the domestic and global economies as well as the complex and unique challenges and opportunities encountered by such businesses and their family members and other employees. Explores best practices for successfully managing family businesses.

*[MKT 3400: Principles of Marketing](#)
Cr. 3.
Prereq: credit or current enrollment in ECON 1010

The role of marketing in society. Markets, marketing institutions, and marketing functions with emphases on product, price, marketing communication, and marketing channel decisions.

[*MKT 3420: Foundation Of Personal Selling](#)
Cr. 3.
Prereq: Sophomore status or above

The process of selling and how to sell effectively. Focus on selling in a business environment and applying to concepts to general interpersonal settings in personal life. Students will actively participate in class, collaborate with teammates to develop skills to sell ideas and become more effective in representing themselves and their company and its products and services. Develop skills necessary to build long-term, profitable relationships with clients.

[*MKT 3670: Consultative Problem Solving](#)
(Cross-listed with MIS). Cr. 3.
Prereq: Sophomore and above

Consultative problem-solving approach to address complex problems in marketing and related fields. Topics include problem definition, issue tree dis-aggregation, hypotheses development and the Pyramid Principle. Development of skills such as formulating problems, structuring and prioritizing problems, synthesizing results and communicating intuition from quantitative analyses.

[MATH 2070 Matrices and Linear Algebra](#)
Cr. 3.
Prereq: MATH1660 OR MATH 1660H

Systems of linear equations, determinants, vector spaces, linear transformations, orthogonality, least-squares methods, eigenvalues and eigenvectors. Emphasis on applications and techniques. ==Only one of MATH 2070 and MATH 3170 may be counted toward graduation.==

[MATH 3410: Introduction to the Theory of Probability and Statistics I](#)
(Cross-listed with STAT). (3-2) Cr. 4.
Prereq: MATH 2650 or MATH 2650H

Probability; distribution functions and their properties; classical discrete and continuous distribution functions; multivariate probability distributions and their properties; moment generating functions; transformations of random variables; simulation of random variables and use of the R statistical package. Credit for only one of the following courses may be applied toward graduation: STAT 3410, STAT 3470, STAT 4470, or STAT 5880.

MATH 3500: Number Theory
(Cross-listed with COM S). (3-0) Cr. 3. S.
Prereq: MATH 2010 or COM S 2300 or CPR E 3100

Divisibility, integer representations, primes and divisors, linear diophantine equations, congruences, and multiplicative functions. Applications to cryptography. Additional topics, chosen at the discretion of the instructor.

MATH 3650: Complex Variables with Applications
Cr. 3.
Prereq: MATH 2650

Functions of a complex variable, including differentiation, integration, series, residues, and conformal mappings.

MATH 3850: Introduction to Partial Differential Equations
Cr. 3.
Prereq: MATH 2650 and one of MATH 2660, MATH 2670

Method of separation of variables for linear partial differential equations, including heat equation, Poisson equation, and wave equation. Topics from Fourier series, Sturm-Liouville theory, Bessel functions, spherical harmonics, and method of characteristics.

MATH 4810: Numerical Methods for Differential Equations
(Dual-listed with MATH 5810). (Cross-listed with COM S). Cr. 3.
Prereq: MATH 2650 and either MATH 2660 or MATH 2670

First order Euler method, high order Runge-Kutta methods, and multistep methods for solving ordinary differential equations. Finite difference and finite element methods for solving partial differential equations. Local truncation error, stability, and convergence for finite difference method. Numerical solution space, polynomial approximation, and error estimate for finite element method. Computer programming required.

ME 3730: Science and Practice of Brewing
(Cross-listed with FS HN 373X). Cr. 3.
Prereq: CHEM 1670 or CHEM 1770 and PHYS 2210 or PHYS 2310 or BIOL 2110 or BIOL 2120; or permission by the instructor; 21 years of age for all students.

Introduction to brewing science and technology. Understanding the role of malts, hops, water, and yeast in production of ale and lager beers. Unit operations in brewing. Health, safety, and environmental sustainability in alcohol production and consumption. Weekly laboratory in practical aspects of beer production.

ME 4160: Mechanism Design and Analysis
Cr. 3. S.
Prereq: ME 3250

An introduction to the design and analysis of mechanisms and the use of prescribed design methodologies to identify design requirements and achieve desired motion profiles. Topics include fundamental mechanism kinematics; graphical and analytical mechanism synthesis methods; velocity and acceleration analysis; and the design of linkages, cams and gear trains. Significant amount of team-based problem solving and the development of physical and computational models to assist in the design process.

ME 4180: Mechanical Considerations in Robotics

(Dual-listed with ME 518).Cr. 3.
Prereq: Credit or enrollment in ME 4201

Three dimensional kinematics, dynamics, and control of robot manipulators, hardware elements and sensors. Laboratory experiments using industrial robots.

ME 4190: Computer-Aided Design

Cr. 3.
Prereq: ME 3250

Theory and applications of computer- aided design. Computer graphics programming, solid modeling, assembly modeling, and finite element modeling. Mechanical simulation, process engineering, rapid prototyping and manufacturing integration.

ME 4250: Optimization Methods for Complex Designs

(Dual-listed with ME 5250). Cr. 3.
Prereq: ME 1600, MATH 2650

Optimization involves finding the 'best' according to specified criteria. Review of a range of optimization methods from traditional nonlinear to modern evolutionary methods such as Genetic algorithms. Examination of how these methods can be used to solve a wide variety of design problems across disciplines, including mechanical systems design, biomedical device design, biomedical imaging, and interaction with digital medical data. Students will gain knowledge of numerical optimization algorithms and sufficient understanding of the strengths and weaknesses of these algorithms to apply them appropriately in engineering design. Experience includes code writing and off-the-shelf routines. Numerous case-studies of real-world situations in which problems were modeled and solved using advanced optimization techniques.

ME 4270: Vehicle Dynamics and Suspension Design

Cr. 3.
Prereq: ME 3450

Analysis and evaluation of the performance of cars, trucks and other surface vehicles. Computer simulation of ride, braking, and directional response. Considerations in the design and fabrication of suspension systems.

ME 4440: Elements and Performance of Power Plants

Cr. 3.
Prereq: ME 3320, credit or enrollment in ME 3350

Basic principles, thermodynamics, engineering analysis of power plant systems. Topics include existing power plant technologies, the advanced energyplex systems of the future, societal impacts of power production, and environmental and regulatory concerns.

ME 4750: Modeling and Simulation

Cr. 3.
Prereq: ME 4210, credit or enrollment in ME 4360

Introduction to computer solution techniques required to simulate flow, thermal, and mechanical systems. Methods of solving ordinary and partial differential equations and systems of algebraic equations; interpolation, numerical integration; finite difference and finite element methods.

MTEOR 3010: General Meteorology
Cr. 4.
Prereq: MATH 1660, credit or enrollment in PHYS 2320

Global distribution of temperature, wind, and atmospheric constituents; atmospheric thermodynamics, radiative transfer, global energy balance, storms and clouds, introductory dynamics.

MTEOR 4320: Instrumentation and Measurements
Cr. 3.
Prereq: Credit or enrollment in MATH 2660, PHYS 2320

Principles of meteorological sensing and data analysis. Thermometry, barometry, hygrometry, anemometry, precipitation measurements, radiometry, radar, remote sensing, visibility, and cloud height. Calibration and measurement uncertainties. Digital signal processing. Field trip to the National Weather Service. Labs emphasize dataloggers and modern weather stations.

NREM 3130: Native Land, Water, and Resources
(Cross-listed with AM IN). Cr. 3.

Examines Native land rights, water rights, and natural resources. Topics may include Native relations to landscapes, cultural resources and infrastructure projects, land rights, water usage agreements, and resource policies as they apply to on- and off-reservation Native communities. AM IN 210 recommended.

NREM 3450: Natural Resource and Geographic Information Systems
Cr. 3
Prereqs: Junior classification; lab required

Measurement and interpretation of aerial photos in resource management. Introduction to Geographic Information Systems (GIS) using ArcGIS including digitizing, development and query of attribute tables, georeferencing, and use of multiple GIS layers in simple spatial analyses.

NREM 3850: Natural Resource Policy
(Dual-listed with NREM 5850). Cr. 3.

Development, theory and practice of natural resource policy. Integrative approach with topical policy studies in North American wildlife, forestry, and water. Policy formation, the role of science, introduction to federal law compliance.

NS 3300: Naval Ship Systems II (Weapons)
Cr. 3.
Prereq: PHYS 2210, sophomore classification

Introduction to the theory and principles of operation of naval weapon systems. Included coverage of types of weapons and fire control systems, capabilities and limitations; theory of target acquisition, identification and tracking; basics of naval ordnance.

PHYS 3040: Thermal Physics
Cr. 3.
Prereq: PHYS 2220 or (PHYS 2320 and PHYS 2320L) or PHYS 2420, MATH 2660 or MATH 2670

Concepts of temperature, entropy, and other characteristic thermodynamic functions, with application to macroscopic properties of matter. The laws of thermodynamics. Introduction to statistical mechanics, including quantum statistics. Application to black body radiation, crystalline vibrations, magnetic ions in solids, electronic heat capacity of metals. Phase transformations and chemical reactions.

PHYS 3610: Classical Mechanics
Cr. 3.
Prereq: PHYS 2220 or (PHYS 2320 & 2320L) or PHYS 2420, MATH 2650, credit/ enrollment in MATH 2660 or MATH 2670

Newtonian mechanics including forced oscillations, central forces and orbital motion, collisions, moving frames of reference, Lagrange's equations.

*SCM 3010: Supply Chain Management
Cr. 3.
Prereq: ECON 1010 and STAT 2260

Various supply chain activities and integration of supply chain management with supply and demand, both within and between firms. Exposure to a wide range of supply chain management terminology, analytical tools, and theories related to four key elements of supply chain management: purchasing, operations, distribution, and integration. Specific topics include strategic sourcing, supply management, demand forecasting, resource planning, inventory management, process management, logistics, location analysis, process integration, and performance measurement.

STAT 3010: Intermediate Statistical Concepts and Methods
Cr. 4.
Prereq: STAT 1010 or STAT 1040 or STAT 1050 or STAT 2010; Lab required

Statistical concepts and methods used in the analysis of observational data. Analysis of single sample, two sample and paired sample data. Simple and multiple linear regression including polynomial regression and use of indicator variables. Model building and analysis of residuals. Introduction to one-way ANOVA, tests of independence for contingency tables, and logistic regression. Credit for only one of the following courses may be applied toward graduation: STAT 3010, STAT 3260, STAT 4010, or STAT 5870.

TSM 3100: Total Quality Improvement
Cr. 3.
Prereq: STAT 1010 or STAT 1040, junior classification

Introduction to the fundamental concepts of TQM - Deming style of management, statistical studies to understand the behavior of products, processes, or services, and how to define and document processes and customer focus. Introduction to continuous improvement tools and methods - emphasis on critical thinking and problem solving skills.

TSM 3220: Preservation of Grain Quality
Cr. 3.
Prereq: MATH 1400 or higher

Principles and management for grain quality preservation: quality measurement; drying and storage; fans and airflow through grain; handling methods; insect pest control; and grain quality monitoring.

TSM 457: Feed Safety, Ingredient Quality and Analytics
(Dual-listed with TSM 557). Cr. 3. S.
Prereq: Junior classification

Concepts of feed and grain safety and quality, including hazards and risks associated with common feeds and feed ingredients. Methods to monitor, manage, and mitigate hazards and risks in the context of feed and grain industries. Government regulations applicable to feed and grain safety. Differences between safety and quality factors, how they are measured and then used for decision-making (marketing, processing, or safe-use).

TSM 3700: Occupational Safety
Cr. 3.
Prereq: TSM 2700; Junior classification or waiver to use ME 2700

Identifies safety and health risks in industrial work environments. Focus on how managers and supervisors meet their responsibilities for providing a safe workplace for their employees. Includes the identification and remediation of workplace hazards.