CIVIL ENGINEERING AND MECHANICAL ENGINEERING DEPARTMENT

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Liz Muleski

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Undergraduate Degrees:

- Bachelor of Science in Civil Engineering
- Bachelor of Science in Mechanical Engineering

Master's Program in Civil or Mechanical Engineering

The UMKC Civil & Mechanical Engineering Master's Programs offer graduate students the opportunity to get a state-of-the-art education in dynamic, challenging and professionally significant specialty areas.

Graduate Programs

- Engineering and Construction Project Management Certificate (http://catalog.umkc.edu/colleges-schools/computing-engineering-school-of/civil-engineering-mechanical-engineering-department/civil-engineering/engineering-construction-project-management-certificate/)
- Master of Science in Civil Engineering
- Master of Science in Mechanical Engineering

Doctoral Program in Civil or Mechanical Engineering

For the Doctoral Program in Civil or Mechanical Engineering, admission information can be found at the School of Graduate Studies website under the link for prospective students: http://sgs.umkc.edu (http://sgs.umkc.edu/). The telephone number is (816) 235-1111.

UMKC offers an Interdisciplinary Ph.D. (IPHD) program which consists of two disciplines. Students in civil or mechanical engineering are encouraged to choose *Engineering* as the Primary Discipline. Admission requirements and Co-Discipline options can be found at the School of Graduate Studies website under the link for *Engineering*.

- Doctoral Studies in Engineering

Graduate

- Graduate Programs
  - Engineering and Construction Project Management Certificate (http://catalog.umkc.edu/colleges-schools/computing-engineering-school-of/civil-engineering-mechanical-engineering-department/civil-engineering/engineering-construction-project-management-certificate/)
  - Master of Science in Civil Engineering
  - Doctoral Studies in Civil Engineering
  - Graduate Courses in Civil Engineering (CIV-ENGR)
- Mechanical Engineering
  - Graduate Programs
    - Master of Science in Mechanical Engineering
    - Doctoral Studies in Mechanical Engineering

Admissions

Engineering and Construction Project Management Certificate

The Engineering and Construction Project Management Certificate is a 12 credit hour graduate certificate offered through the School of Computing & Engineering at the University of Missouri-Kansas City. The certificate is especially appropriate for post-baccalaureate working professionals in the Kansas City area who wish to pursue further studies in engineering project management, specifically in construction management. The certificate consists of 9 credit hours of required courses and 3 credit hours of an elective course at the 5500-level or above. Students must maintain 3.0 graduate grade point average (GPA) while enrolled.

Admission Requirements

Either a baccalaureate degree in engineering or a baccalaureate degree in another field combined with construction-related work experience is required. A grade point average (GPA) of at least 3.0 in the last 60 credit hours of undergraduate coursework is required. Pre-program requirements may be specified in case the Bachelor's degree is not in civil or mechanical engineering. The following documents are required for admission consideration:

- Application for admission
- Official transcripts of all college coursework

In addition, a statement of purpose is required for admission.

CONDITIONAL admission may be granted when minimum GPA requirements are not met; however, other indicators promise applicant's success in the program.

After admission, the student is required to meet with a faculty advisor.

Master's Program in Civil or Mechanical Engineering

The UMKC Civil & Mechanical Engineering Master's Programs offer graduate students the opportunity to get a state-of-the-art education in dynamic, challenging and professionally significant specialty areas.

Degrees Offered

- Master of Science in Civil Engineering (MSCE)
- Master of Science in Mechanical Engineering (MSME)

Assistantships

The school has numerous assistantship positions available each semester. Typically, awards are for quarter-time or half-time support and may include tuition fee waivers.

Admission Requirements

A baccalaureate degree in civil or mechanical engineering or related disciplines with a grade point average (GPA) of at least 3.0 in the last 60 hours of undergraduate engineering coursework is required. Pre-program requirements may be specified in case the Bachelor's degree is in a discipline different to which the candidate is applying.

The following documents are required for admission consideration:

- Application for admission
- Official transcripts of all college coursework
- TOEFL or IELTS scores are required for international students without prior U.S. degrees. The minimum required score is 79 (TOEFL) or 6.0 (IELTS). *English language proficiency requirements may be waived for applicants with a baccalaureate degree from an ABET-accredited program.*
- Official results of the Graduate Record Exam (GRE) are required for all applicants. A cumulative score of at least 302 (verbal + quantitative) and a minimum of 158 on the quantitative portion of the examination is required. *GRE requirements may be waived for applicants with a baccalaureate degree from an ABET-accredited program who have passed the Fundamentals of Engineering (FE) exam.*

In addition, three letters of recommendation from professors at previous institutions or mentors at work are highly encouraged.

CONDITIONAL admission may be granted when the minimum GPA and GRE requirements are not met; however, other indicators promise applicant's success in the program. To be fully admitted as a "Regular Master's Degree Seeking" student, the candidate must obtain a grade of "B" or better in the first nine-hours of coursework; submit a satisfactory GRE score or an FE certificate, as specified above, within the first semester of their program; and complete any other conditions.

Doctoral Program in Civil or Mechanical Engineering

For the Doctoral Program in Civil or Mechanical Engineering, admission information can be found at the School of Graduate Studies website under the link for prospective students: http://sgs.umkc.edu (http://sgs.umkc.edu/). The telephone number is (816) 235-1111.

UMKC offers an Interdisciplinary Ph.D. (IPHD) program which consists of two disciplines:

- Primary Discipline
- Co-Discipline

Students in civil or mechanical engineering are encouraged to choose *Engineering* as the Primary Discipline. Admission requirements and Co-Discipline options can be found at the School of Graduate Studies website under the link for *Engineering*.

Graduate Academic Regulations

- With permission of the student's graduate advisor, up to six credit hours of transfer graduate coursework may be transferred from other non-University of Missouri institutions.
- With permission of the student's graduate advisor, up to 14 credit hours of transfer graduate coursework may be transferred from other University of Missouri institutions.
- However, at least 16 credit hours of graduate coursework must be taken at UMKC.

A graduate student must maintain a cumulative GPA of 3.0 for all graduate coursework taken during the course of graduate studies. Should the cumulative GPA fall below 3.0, the student will be placed on probation. A student on probation must bring the cumulative GPA to a 3.0 by the end of the next semester or face possible dismissal. Students should apply for graduation when they register for their final semester of coursework. All students must complete and file with the Department Office both the UMKC Application for Graduation form and the Departmental Program of Study form. Students selecting the *project* or *thesis* option must also file a Departmental Report of the Master's Examining Committee form. Students selecting the *thesis* option must file a Master's Thesis Report form and have their thesis approved by the UMKC Graduate School.

Transfer of Graduate Credits

- With permission of the student's graduate advisor, up to six credit hours of transfer graduate coursework may be transferred from other non-University of Missouri institutions.
- With permission of the student's graduate advisor, up to 14 credit hours of transfer graduate coursework may be transferred from other University of Missouri institutions.
- However, at least 16 credit hours of graduate coursework must be taken at UMKC.

Academic Standing

A graduate student must maintain a cumulative GPA of 3.0 for all graduate coursework taken during the course of graduate studies. Should the cumulative GPA fall below 3.0, the student will be placed on probation. A student on probation must bring the cumulative GPA to a 3.0 by the end of the next semester or face possible dismissal.

Application for Graduation

Students should apply for graduation when they register for their final semester of coursework. All students must complete and file with the Department Office both the UMKC Application for Graduation form and the Departmental Program of Study form. Students selecting the *project* or *thesis* option must also file a Departmental Report of the Master's Examining Committee form. Students selecting the *thesis* option must file a Master's Thesis Report form and have their thesis approved by the UMKC Graduate School.

Civil Engineering Courses

CIV-ENGR 111 First Year Cornerstone Credit: 1
An exploration of the diverse emphasis specific career opportunities of Civil Engineers, with a goal of providing students the needed fundamental skills, knowledge and resources for identifying the most appropriate career path(s) consistent with the student's interests, skills, and objectives.

CIV-ENGR 113 Engineering Measurements Credit: 1
This course provides a fundamental introduction to the elements of surveying. Basics including terminology, coordinate systems, equipment, legal descriptions, and calculations will be taught in the classroom. Field laboratory sessions will introduce the students to setting up basic equipment, running a level loop, and laying out a site based on plan designs.

CIV-ENGR 190 Special Topics Credits: 1-3
Selected introductory topics in the area of computing. May be repeated for credit when topic varies.

CIV-ENGR 275 Engineering Statics Credits: 3
Fundamentals of statics; static equilibrium; internal forces; introduction to elements of mechanics of elastic materials, and properties of areas.
Prerequisites: PHYSICS 240.

CIV-ENGR 276 Strength Of Materials Credits: 3
The course introduces and emphasizes the concepts and analysis methods for stress and strain, torsion, bending and shear stresses in beams, combined stresses, and deflection theory using a calculus based methodology. Introduction to buckling and energy methods may be included.
Prerequisites: CIV-ENGR 275.

CIV-ENGR 318 GIS for Engineers Credits: 3
This course covers the fundamental concepts and methods for use of GIS software used to solve engineering applications and problems. The course uses module based practical learning to apply and integrate foundational knowledge, develop the skills required to model various types of imagery data, incorporate this data into projects for management and design, and provide the skills necessary for students to depict ideas and design graphically. A personal computer capable of running the software is required for the course. Non-engineering majors by instructor permission only.
Prerequisites: SCE Student.

CIV-ENGR 319 Engineering Computation and Statistics Credits: 3
A review of descriptive statistics, statistical distribution functions and application to engineering problems. Introduction to hypothesis testing, analysis of variance, correlation/regression and design of factorial experiments.
Prerequisites: MATH 268 or MATH 220.

CIV-ENGR 321 Structural Analysis Credits: 4
This course introduces the basic analysis and computer methods that are required to analyze basic structural elements and simple structures. Topics covered in this course include design loads, analysis of statically determinate beams, frames and trusses, shear and moment diagrams, influence diagrams, beam deflections, statically indeterminate structures (beams and frames), displacement methods, introduction to energy and matrix methods.
Prerequisites: CIV-ENGR 276.

CIV-ENGR 323 Structural Steel Design Credits: 3
Basic principles of structural steel design. Design of beams, axially loaded members, columns, and bolted and welded connections.
Prerequisites: CIV-ENGR 321.

CIV-ENGR 335 Soil Mechanics Credits: 3
Detailed study of physical and mechanical properties of soil governing its behavior as an engineering material. Machine Shop Safety is required prior to taking this class.
Prerequisites: CIV-ENGR 276, CHEM 211, CHEM 211L.

CIV-ENGR 342 Introduction to Environmental Engineering Credits: 3
Methods for determining and characterizing water quality, effects of pollution on streams and lakes, and an introduction to engineering systems for the distribution, collection and treatment of water and wastewater.
Prerequisites: CIV-ENGR 351 or MEC-ENGR 351; and CHEM 211 and CHEM 211L.

CIV-ENGR 351 Fluid Mechanics Credits: 3
Concepts of the statics and dynamics of fluids, with emphasis on principles of continuity, momentum and energy. Boundary layers, dimensional analysis and drag are covered briefly. Thorough treatment of pipe flow.
Prerequisites: CIV-ENGR 275.

Co-requisites: MATH 345 or MEC-ENGR 272.

CIV-ENGR 357 Engineering Hydraulics Credits: 3
Analysis and design of closed conduit systems for water supply; fundamentals of open channel flow; principles of pumping and hydropower generation; transients and control of surge pressures in pipelines.
Prerequisites: CIV-ENGR 351 or MEC-ENGR 351.

CIV-ENGR 378WI Civil Engineering Materials Credits: 3
This course provides students with a working knowledge of the design and performance of Asphaltic Concrete (AC) and Portland Cement Concrete (PCC) mixtures through understanding the properties and requirements of the component materials and their effects on subsequent performance. An understanding of the design, production process, construction, durability, and operations and maintenance will be provided. A significant portion of this course requires hands-on laboratory testing and analysis. Roadway and highway pavements will provide a primary context within which theses concrete systems will be studied. Machine Shop Safety is required prior to taking this course.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 276.

CIV-ENGR 390 Engineering Coop/Internship Credits: 0
Students may participate in structured Engineering Coop/Internship under the supervision of employer. They must carry out significant professional responsibilities and whatever additional assignments are determined by the employer.
Prerequisites: Departmental consent.

CIV-ENGR 400 Problems Credits: 1-4
Directed investigation of civil engineering problems.
Prerequisites: Departmental consent.

CIV-ENGR 401ES Special Topics in Civil Engineering Credits: 3
Hydraulic conductivity measurements. Seepage analysis and control. Earth dam and embankment design. Computer applications.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 401HA Hydrologic Analysis and Design Credits: 3
Practical implementation of hydrologic and hydraulic system design in accordance with published design criteria and using methods and numerical modeling accepted by local, state, and national government agencies.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 401SD Special Topics In Civil Engineering Credits: 3
Study of soil behavior under cyclic and dynamic loading conditions. Foundation design for vibratory loadings. Introductory earthquake engineering including dynamic ground response for determination of dynamic soil properties. Evaluation of soil liquefaction potential during earthquakes by both laboratory and in situ filed methods. Design consideration for embankments and earth retaining structures under seismic loading conditions. Construction blasting and vibration effects on underground systems.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 401SV Topics in Civil Engineering Credit: 1
This course provides a fundamental introduction to the elements of surveying. Basics including terminology, coordinate systems, equipment, legal descriptions, and calculations will be taught in the classroom. Field laboratory sessions will introduce the students to setting up basic equipment, running a level loop, and laying out a site based on plan designs.

CIV-ENGR 404 Project Management of Integrated Design and Construction Credits: 3
Provide a body of knowledge that includes the principles, knowledge areas, skills, and tools applicable to successful project management for the performance of integrated design and construction of capital projects, specifically as applicable to the post-award period. This post-award period is the time from the formal project award by the owner through project design and construction, testing, commissioning, close-out and completion of the project warranties.

CIV-ENGR 405 Capital Project Delivery Methods Credits: 3
Provide a body of knowledge that acquaints students with the capital project delivery methods in both public and private business sectors of the U.S design – construction industry. Project delivery means how a capital project comprising both design and construction is planned, procured, contracted and implemented by an owner to achieve desired objectives. Delivery methods discussed in this class include traditional design – bid- build, design – build, design-build plus added services such as operations and maintenance, CM @ Risk and other approaches. Roles and responsibilities of owners, owner consultants, and design and construction firms are presented and discussed.

CIV-ENGR 406 Construction Project Risk Management Credits: 3
Risk management skill sets are necessary tools for the successful project manager. Project Management Institute's (PMI) 6 steps of project risk management constitute the basis of the content, which includes an expanded knowledge of risk identification, qualitative and quantitative risk analysis, risk control, contract risks, and risk transfer options. Business and project risks such as client selection, project planning, and project execution, will be considered as well as legacy risks that remain with the business and participants beyond the project completion. Different risk management strategies will be discussed, including risk avoidance, risk mitigation, and risk transfer.
Prerequisites: Senior Standing.

CIV-ENGR 409 Fundamentals of Engineering Review Credit: 1
This course consists of a series of lectures and is intended as a review class for all the subjects included in the Fundamentals of Engineering exam. Classes specifically focus on the review of equations and formulas included in the reference handbook published by NCEES.

CIV-ENGR 411 Civil Engineering Systems Design I Credits: 2
Comprehensive and realistic design project using the systems approach. Design choices and their effect upon the environment. Design constraints include constructability, minimization of environmental impact and cost-effectiveness. Managerial and professional aspects of design practice.
Prerequisites: CIV-ENGR 467 and CIV-ENGR 497.

Co-requisites: CIV-ENGR 422WI and CIV-ENGR 432.

CIV-ENGR 412 Civil Engineering Systems Design II Credits: 3
Continuation of CIV-ENGR 411.
Prerequisites: CIV-ENGR 411 and departmental consent.

CIV-ENGR 415 Engineering Leadership and Ethics Credits: 3
Analysis of leadership, including 360-degree assessment of students' leadership. Discussion of leadership cases and application to engineering careers. Frequent analysis of engineering ethics cases using the NSPE Code.

CIV-ENGR 417 Advanced Structural Analysis Credits: 3
The course is designed as a continued study of structural analysis methods with emphases on indeterminate structures (trusses, beam/columns, and frames), advanced analysis methods, and introduction to nonlinear structural effects including geometric nonlinearity and inelasticity. Advanced structural analysis methods including force, displacement, matrix, energy, and limit analysis methods will be introduced and practiced. Both computer based and hands-on analysis will be involved.
Prerequisites: CIV-ENGR 321

CIV-ENGR 421 Matrix Methods of Structural Analysis Credits: 3
The basic components of this class are matrix theories and applied computer analysis methods using a computer-based structural analysis software. These include: (1) study of matrix formulation of direct stiffness method, virtual work principle and formulation of displacement-based frame elements, theories and significance of geometric and material nonlinearity; (2) Sap2000-based analysis of 2D/3D trusses and 2D/3D frames considering different loading and material/geometric nonlinearity.
Prerequisites: CIV-ENGR 321.

CIV-ENGR 422WI Reinforced Concrete Design Credits: 3
Basic principles of reinforced concrete design. Design of beams for flexture and shear; design of short and slender columns. Bond stress development. Footing design.
Prerequisites: CIV-ENGR 321.

CIV-ENGR 423 Advanced Structural Steel Design Credits: 3
Design of steel structures and bridges. Topics include composite beams, plate girder design, and moment resistant connections.
Prerequisites: CIV-ENGR 323.

CIV-ENGR 425 Prestressed Concrete Credits: 3
Design and behavior of prestressed concrete structures; material and system of pretensioned and post tensioned systems; prestress losses; flexure, shear, bond, deflections and partial prestress in determinate structures; indeterminate beams-introduction.
Prerequisites: CIV-ENGR 422WI.

CIV-ENGR 427 Advanced Reinforced Concrete Design Credits: 3
Advanced topics in the design of footings, retaining walls, two-way floor slabs, torsion and continuous structures, shear friction, strut and tie design, precast design.
Prerequisites: CIV-ENGR 422WI.

CIV-ENGR 429 Design of Structures for Blast and Fire Credits: 3
General overview of Blast Design; risk assessment and design criteria; simplifies Blast Effects Analysis; ground shock, material response; antiterrorism design considerations; weapons effects and mitigation; internal explosions; progressive collapse analysis; and introduction to Fire Design.

CIV-ENGR 431 Fundamentals of Geomaterial Characterization Credits: 3
A geomaterial is any construction material comprised primarily of soil. This course overviews state-of-the-art instrumental techniques for analysis of the physio-chemical properties of soils, aggregates, hydraulic concrete, and asphaltic concrete. Evaluation techniques will be applied to determining beneficial reuse opportunities for industrial by-product materials from the Kansas City region.
Prerequisites: CIV-ENGR 335, CIV-ENGR 378WI.

CIV-ENGR 432 Foundation Engineering Credits: 3
Design of basic foundation structures, footings, retaining walls, pile foundations, dams.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 436 Advanced Soil Mechanics Credits: 3
Theoretical soil mechanics as applied to solution of specific engineering problems.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 442 Hydraulic Structures Credits: 3
A review of the history and hydraulic design procedures for a variety of hydraulic structures including spillways, water measurement structures, canal structures and energy dissipation structures.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 446 Limnology Credits: 3
Physical, biological and chemical issues important in surface fresh waters. Includes carbonate chemistry, algal assay and thermocline analysis.
Prerequisites: CHEM 211, MATH 345.

CIV-ENGR 447 Contracts and Law for Engineers Credits: 3
This course covers a broad range of substantive legal topics giving the student a grounding in the legal implications of certain situations that they may encounter during their careers. The course includes coverage of basic contract law, environmental regulations and compliance, construction law, antitrust law, intellectual property law, civil procedure, employment law, business entities (corporate law) product liability and criminal law and procedure. The objective of the course is to provide students with a fundamental understanding of the wide range of federal and state laws governing behavior in our complicated and rule of law driven society.
Prerequisites: Senior standing.

CIV-ENGR 449 Environmental Compliance, Auditing and Permitting Credits: 3
This course provides a high level overview of the most important statutes that have been enacted to protect the environment. The course covers regulation of hazardous waste, the Clean Air and Clean Water Acts, the Resource Conservation and Recovery Act, the All Appropriate Inquiry Rule and the law addressing sites contaminated with hazardous substances and the technology options employed to remediate those sites. In addition, the course provides coverage of environmental audits and emergency planning for extremely hazardous substances, the regulation of underground storage tanks, safe drinking water and the National Environmental Policy Act among other statutes.
Prerequisites: Senior standing.

CIV-ENGR 452 Hydraulics of Open Channels Credits: 3
This is a first course in the fundamentals of open channel (free surface) water flow. Over ninety-nine percent of all the water that is moved on the planet's surface is by free surface flow. Study of free surface flow is essential to the study of storm water drainage systems, flood control, water and wastewater treatment and the study of the form and processes of river evolution. This class provides the fundamental physical principles of free surface flow as a prelude to a significant number of other topics that pertain to engineering and geomorphic analysis.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 453 Hydraulics and Variability of Rivers Credits: 3
Introduction to the concepts of alluvial channel behavior, evolution and change due to natural and man-induced modifications to streams and watersheds. Numerous case studies of river behavior are studied from the perspective of hydraulics, geomorphology and sediment transport.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 454 River Stability and Scour Credits: 3
Bridge hydraulics, stream stability, scour at bridge piers and abutments, hydraulic modeling of floods, countermeasures for protection of bridge infrastructure.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 456 Urban Hydrology Credits: 3
Analysis of urban drainage systems in accordance with published municipal criteria. This course is an in-depth course for senior undergraduate students interested in the hydrological sciences and for graduate students specializing in water resources. Specifically this course will focus on the engineering procedures and techniques specified by municipalities to design and maintain efficient, safe, storm drainage systems. This course also focuses on the unique issues associated with estimating and designing for rainfall/runoff in urban metropolitan areas, including channel and reservoir routing of floods through stream channels, retention structures, culverts, and storm sewers.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 463 Construction Law Credits: 3
This course introduces professional, ethical, and legal concepts of the professional practice of engineering, and the role of the consulting engineer, specifically in the A/E/C industry during the design, procurement, and construction processes. A conceptual framework is developed for understanding the industry standard agreements (AIA, EJCDC, ConCensus) and the various participants roles and duties in project execution. The engineer's "professional standard of care" is examined and revisited throughout the semester, specifically what it means to be a "Professional Engineer". Emphasis is placed on project and contract management and the applicable law.

CIV-ENGR 466 Green Building and Sustainable Infrastructure Credits: 3
This class will discuss various green rating systems for buildings and infrastructure. Upon completion of this course students will be prepared for the LEED Green Associate Exam. The course will also discuss infrastructure project sustainability from a life cycle perspective. A semester project will involve stormwater management using "green" techniques and methods to mitigate the urban heat island. Upon completion of the course, students will better understand what sustainability means and how it applies in the context of our built environment and have a good idea of how technology will impact our sustainable future.
Prerequisites: Junior standing.

CIV-ENGR 467 Introduction to Construction Management Credits: 3
Structure of the construction industry; construction drawings and specifications; estimating and bidding; construction contracts, bonds and insurance; planning and scheduling of construction operations; project management; computer techniques.

CIV-ENGR 468 Construction Planning and Scheduling Credits: 3
This course is intended to provide an in-depth examination of the construction planning and scheduling process, as it relates to civil engineering projects. Topics will include planning and scheduling of construction operations by the critical path method, Network diagramming, scheduling computations, and time-cost trade-offs. Manpower and equipment leveling. Computer and noncomputer techniques.
Prerequisites: CIV-ENGR 467.

CIV-ENGR 469 Construction Methods and Equipment Credits: 3
Introduction to methods used to plan, construct, and manage heavy civil projects. Topics will include development, project control, equipment productivity, earthmoving fundamentals, formwork design, and other issues in heavy civil projects.
Prerequisite: CIV-ENGR 467.

CIV-ENGR 470 Corrosion Engineering Credits: 3
This course will cover the physical interaction of metallic materials with their environments, called corrosion. Corrosion is an electrochemical process and the thermodynamics and kinetics of corrosion processes will be discussed. Students will be expected to identify different forms of corrosion and be able to select appropriate materials for their working environment to prevent corrosion related problems. Second half of the class will concentrate on corrosion of metals in concrete and prevention methods.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 378WI.

CIV-ENGR 471 Advanced Portland Cement Concrete Credits: 3
This course will cover topics such as cement chemistry, concrete proportioning, aggregates, mineral and chemical admixtures, fresh and hardened properties of concrete, and durability of concrete. Design and proportioning of concrete mixtures for desired fresh and hardened properties will be emphasized. Specialty concrete types such as high strength/high performance concrete, lightweight concrete, pervious concrete, high volume fly ash concrete, and fiber reinforced concrete will also be covered.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 378WI.

CIV-ENGR 473 Durability of Civil Engineering Materials Credits: 3
This course will explore the identification, causes of, and remediation of material-related durability deterioration in civil engineering projects. The primary focus will be on reinforced concrete, plain concrete, and soil for a variety of applications. Course content will be delivered primarily through laboratory activities and handouts. Lab activities will use advanced analysis techniques and help the students identify and measure deterioration mechanisms. Various non-destructive evaluation techniques will be discussed. Students have hands on experiences with samples production, data collection, and data analysis for all of the lab activities.
Prerequisites: CIV-ENGR 335, CIV-ENGR 378WI.

CIV-ENGR 475 Seismic Design of Structures Credits: 3
Introduction to basic analysis and design principles for the seismic design of buildings (concrete, steel, wood). General seismic principles, codes and loads, static lateral force procedure, dynamic lateral force procedure, topics in rigidities of buildings.
Prerequisites: CIV-ENGR 323 (or CIV-ENGR 422WI), and MEC-ENGR 285.

CIV-ENGR 481 Introduction to Transportation Credits: 3
Principles of highway engineering and traffic analysis, road/vehicle performance, geometric alignment of highways, traffic analysis and queuing theory, signal design, statistical analysis of traffic data and highway drainage.

CIV-ENGR 484 Pavement Materials Design, Maintenance, and Rehabilitation Credits: 3
Traffic loading and volume, stress and deflection, characterization of pavement materials, design of flexible and rigid pavements, design of overlays, evaluation of pavement performance, maintenance techniques, and rehabilitation options.
Prerequisites: CIV-ENGR 335, CIV-ENGR 378WI.

CIV-ENGR 487 Applied Finite Element Analysis Credits: 3
The study of advanced simulation techniques for the solution to engineering problems. The use of Finite Element Method toward solving mechanical,structural,vibration and potential flow problems will be explored. Current commercial simulation tools will be used extensively.
Prerequisites: MEC-ENGR 272 and MEC-ENGR 130.

CIV-ENGR 491 Internship Credits: 0-6
For International students who must register to cover off-campus employment which is approved as related to their degree by their departmental advisor and ISAO.
Prerequisites: Departmental consent.

CIV-ENGR 497 Engineering Hydrology Credits: 3
Fundamental concepts of hydrology in engineering; computation principles of runoff from rainfall; measurement of hydrologic quantities; quantitative and statistical estimation of design stream-flow magnitude and frequency; principles of unsteady routing of hydrographs.
Prerequisites: CIV-ENGR 319; and CIV-ENGR 351 or MEC-ENGR 351.

CIV-ENGR 5500 Problems Credits: 1-6
Supervised investigation in civil engineering to be presented in the form of a report.
Prerequisites: Graduate standing.

CIV-ENGR 5501 Advanced Topics in Civil Engineering Credits: 1-3
Current technical developments in civil engineering.

CIV-ENGR 5501AE Advanced Topics in Civil Engineering Credits: 1-3

CIV-ENGR 5504 Project Management of Integrated Design and Construction Credits: 3
Provide a body of knowledge that includes the principles, knowledge areas, skills, and tools applicable to successful project management for the performance of integrated design and construction of capital projects, specifically as applicable to the post-award period. This post-award period is the time from the formal Project award by the owner through Project design and construction, testing, commissioning, close-out and completion of the Project warranties.

CIV-ENGR 5505 Capital Project Delivery Methods Credits: 3
Provide a body of knowledge that acquaints students with the capital project delivery methods in both public and private business sectors of the U.S design – construction industry. Project delivery means how a capital project comprising both design and construction is planned, procured, contracted and implemented by an owner to achieve desired objectives. Delivery methods include traditional design – bid- build, design – build, design-build plus added services such as operations and maintenance, CM @ Risk and other approaches. Roles and responsibilities of owners, owner consultants, and design and construction firms are presented and discussed. Owner procurement approaches, project risk.

CIV-ENGR 5506 Construction Project Risk Management Credits: 3
Risk management skill sets are necessary tools for the successful project manager. Project Management Institute's (PMI) 6 steps of project risk management constitute the basis of the content, which includes an expanded knowledge of risk identification, qualitative and quantitative risk analysis, risk control, contract risks, and risk transfer options. Business and project risks such as client selection, project planning, and project execution, will be considered as well as legacy risks that remain with the business and participants beyond the project completion. Different risk management strategies will be discussed, including risk avoidance, risk mitigation, and risk transfer.

CIV-ENGR 5515 Engineering Leadership & Ethics Credits: 3
Analysis of leadership, including 360-degree assessment of students' leadership. Discussion of leadership cases and application to engineering careers. Frequent analysis of engineering ethics cases using the NSPE Code.
Prerequisites: Graduate status.

CIV-ENGR 5516 Advanced Engineering Mathematics Credits: 3
The class is a review of and introduction to advanced mathematical theories and methods for graduate students in Civil and Mechanical Engineering. The basic topics include 2nd-order ODE/PDEs, advanced linear algebra, continuous and discrete Fourier transform, advanced probability and statistics methods, and commonly numerical methods (e.g. linear and generalized linear regression, iterative methods, and maximum likelihood estimation. Successful completion of Calculus III and working knowledge of a mathematical software package (Matlab preferred) is recommended.

CIV-ENGR 5517 Advanced Structural Analysis Credits: 3
The course is designed as a continued study of structural analysis methods with emphases on indeterminate structures (trusses, beam/columns, and frames), advanced analysis methods, and introduction to nonlinear structural effects including geometric nonlinearity and inelasticity. Advanced structural analysis methods including force, displacement, matrix, energy, and limit analysis methods will be introduced and practiced. Both computer based and hands on analysis will be involved.
Prerequisites: Undergraduate coursework in structural analysis strongly recommended.

CIV-ENGR 5521 Matrix Methods of Structural Analysis Credits: 3
An introduction to the fundamentals of stiffness and flexibility methods for analysis of truss and frame structures. Application of the computer programs to three dimensional structures.
Prerequisites: CIV-ENGR 321.

CIV-ENGR 5523 Advanced Structural Steel Design Credits: 3
Design of steel building structures. Topics include composite deck and beam design, stability design, plastic design, plate girder design, simple and eccentric shear connections, and partial and fully restrained moment resistant connections.
Prerequisites: CIV-ENGR 323.

CIV-ENGR 5526 Prestressed Concrete Credits: 3
Design and behavior of prestressed concrete structures; material and system or pretensioned and post tensioned systems; prestress losses; flexure, shear, bond, deflections and partial prestress in determinate structures; indeterminate beams-introduction.
Prerequisites: CIV-ENGR 422WI.

CIV-ENGR 5527 Advanced Reinforced Concrete Design Credits: 3
Advanced Topics in the design of footings, retaining walls two way floor slabs, torsion and continuous structures, shear friction, strut and tie design, precast design.
Prerequisites: CIV-ENGR 422WI.

CIV-ENGR 5529 Advanced Design of Structures for Blast and Fire Credits: 3
General overview of Blast Design; risk assessment and design criteria; simplified Blast Effects Analysis; ground shock, material response; antiterrorism design considerations; weapons effects and mitigation; internal explosions; progressive collapse analysis; and introduction to Fire Design.

CIV-ENGR 5531 Fund of Geomaterial Characterization Credits: 3
A geomaterial is any construction material comprised primarily of soil. This course overviews state-of-the-art instrumental techniques for analysis of the physio-chemical properties of soils, aggregates, hydraulic concrete, and asphaltic concrete. Evaluation techniques will be applied to determining beneficial reuse opportunities for industrial by-product materials from the Kansas City region. Prerequisites are CE 335 Soil Mechanics and CE378 Civil Engineering Materials, or equivalent. 3 credit hours.
Prerequisites: CIV-ENGR 335, CIV-ENGR 378WI.

CIV-ENGR 5532 Foundation Engineering Credits: 3
Design of basic foundation structures, footings, retaining walls, pile foundations, dams.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 5536 Advanced Soil Mechanics Credits: 3
Theoretical soil mechanics as applied to solution of specific engineering problems.
Prerequisites: CIV-ENGR 335.

CIV-ENGR 5542 Hydraulic Structures Credits: 3
A review of the history and hydraulic design procedures for a variety of hydraulic structures including spillways, water measurement structures, canal structures and energy dissipation structures.
Prerequisites: CIV-ENGR 452 (or CIV-ENGR 5552).

CIV-ENGR 5544 Unit Processes in Environmental Engineering Credits: 3
Typical chemical and physical relationships are applied to unit processes of water and wastewater. Troubleshooting for operation problems is emphasized.
Prerequisites: CIV-ENGR 342.

CIV-ENGR 5545 Environmental Engineering Microbiology Credits: 3
Theory and application of fundamental principles of microbiology, toxicology, ecology, and aquatic biology of the microorganisms of importance to environmental engineers.
Prerequisites: CE342.

CIV-ENGR 5546 Limnology Credits: 3
A survey of the physical, biological, and chemical issues important in surface fresh waters. Includes carbonate chemistry, algal assay and Thermocline analysis.
Prerequisites: CHEM 211, MATH 345.

CIV-ENGR 5547 Contracts and Law for Engineers Credits: 3
This course covers a broad range of substantive legal topics giving the student a grounding in the legal implications of certain situations that they may encounter during their careers. The course includes coverage of basic contract law, environmental regulations and compliance, construction law, antitrust law, intellectual property law, civil procedure, employment law, business entities (corporate law) product liability and criminal law and procedure. The objective of the course is to provide students with a fundamental understanding of the wide range of federal and state laws governing behavior in our complicated and rule of law driven society.

CIV-ENGR 5549 Environmental Compliance, Auditing, & Permitting Credits: 3
This course provides a high level overview of the most important statutes that have been enacted to protect the environment. The course covers regulation of hazardous waste, the Clean Air and Clean Water Acts, the Resource Conservation and Recovery Act, the All Appropriate Inquiry Rule and the law addressing sites contaminated with hazardous substances and the technology options employed to remediate those sites. In addition, the course provides coverage of environmental audits and emergency planning for extremely hazardous substances, the regulation of underground storage tanks, safe drinking water and the National Environmental Policy Act among other statutes.

CIV-ENGR 5552 Hydraulics of Open Channels Credits: 3
This is a first course in the fundamentals of open channel (free surface) water flow. Over ninety-nine percent of all the water that is moved on the planet's surface is by free surface flow. Study of free surface flow is essential to the study of storm water drainage systems, flood control, water and wastewater treatment and the study of the form and processes of river evolution. This class provides the fundamental physical principles of free surface flow as a prelude to a significant number of other topics that pertain to engineering and geomorphic analysis.
Prerequisites: CIV-ENGR 351.

CIV-ENGR 5553 Hydraulics and Variability of Rivers Credits: 3
This course introduced concepts of alluvial channel behavior, evolution and change due to natural and man-induced modifications to streams and watersheds. Numerous case studies of river behavior are studied from the perspective of hydraulics, geomorphology and sediment transport.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 5554 River Stability and Scour Credits: 3
Bridge hydraulics, stream stability, scour at bridge piers and abutments, hydraulic modeling of floods, countermeasures for protection of bridge infrastructure.
Prerequisites: CIV-ENGR 452 or CIV-ENGR 5552.

CIV-ENGR 5556 Urban Hydrology Credits: 3
Analysis of urban drainage systems in accordance with published municipal criteria. This course is an in-depth, follow on course for senior undergraduate students interested in the hydrological sciences and for graduate students specializing in water resources. Specifically this course will focus on the engineering procedures and techniques specified by municipalities to design and maintain efficient, safe, storm drainage systems. This course also focuses on the unique issues associated with estimating and designing for rainfall/runoff in urban metropolitan areas, including channel and reservoir routing of floods through stream channels, retention structures, culverts, and storm sewers.
Prerequisites: CIV-ENGR 357.

CIV-ENGR 5563 Construction Law Credits: 3
This course introduces professional, ethical, and legal concepts of the professional practice of engineering, and the role of the consulting engineer, specifically in the A/E/C industry during the design, procurement, and construction processes. A conceptual framework is developed for understanding the industry standard agreements (AIA, EJCDC, ConCensus) and the various participants roles and duties in project execution. The engineer's "professional standard of care" is examined and revisited throughout the semester, specifically what it means to be a "Professional Engineer". Emphasis is placed on project and contract management and the applicable law. Skills are developed in finding online resources of law, legal, and practice advice relevant to the practice of engineering and the construction industry

CIV-ENGR 5565 Project Finance Credits: 3
This class introduces students to the financial concepts faced by engineers in the businesses in which they work and for the projects to which they are assigned. Throughout the course students are reminded of the impact of two key variables – money and time – on their work. While not attempting to turn good engineers into mediocre accountants, the course includes a strong emphasis on managerial accounting. Students will learn how to read and apply financial statements and how to use these same financial concepts in developing pro formas to evaluate and support major capital investments. The effect of time on the value of money, appropriate discount factors, and the internal rate of return will be explored in the class. Students will learn to combine these financial factors with electronic spreadsheets to evaluate business opportunities and practices. All students will be required to develop a comprehensive financial model to evaluate/justify a real world capital project.

CIV-ENGR 5566 Green Building and Sustainable Infrastructure Credits: 3
This course provides a broad overview of what sustainability means to construction and our built environment. Specific green infrastructure rating systems of LEED and Envision will be discussed in detail to quantify the "greenness" of construction of buildings residential subdivisions, highways, roads, and airports. Upon completion of this course students will have a substantial background and understand the aspects needed for the LEED Green Associates and Envision ISI exams. Two major additional aspects of green building important to sustainable infrastructure include stormwater management using "green" techniques and methods to mitigate the urban heat island. The course will also discuss infrastructure project sustainability from a life cycle cost perspective and determining the life cycle inventory of various materials. Upon completion of the course, students will better understand what sustainability means and how it applies in the context of our built environment and have a good idea of how technology will impact our sustainable future.

CIV-ENGR 5567 Introduction to Construction Management Credits: 3
This course will introduce the students to basic construction management related topics including structure of the construction industry, construction drawings and specifications, estimating and bidding, construction contracts, bonds and insurance, planning and scheduling of construction operations, project management, computer techniques.

CIV-ENGR 5568 Construction Planning and Scheduling Credits: 3
This course is intended to provide an in-depth examination of the construction planning and scheduling process, as it relates to civil engineering projects. Topics will include planning and scheduling of construction operations by the critical path method, Network diagramming, scheduling computations, and time-cost trade-offs. Manpower and equipment leveling. Computer and noncomputer techniques.
Prerequisites: CIV-ENGR 467 or CIV-ENGR 5567.

CIV-ENGR 5569 Construction Methods and Equipment Credits: 3
Introduction to methods used to plan, construct and manage heavy civil projects. Topics will include development, project control, equipment productivity, earthmoving fundamentals, formwork design, and other issues in heavy civil projects.
Prerequisites: CIV-ENGR 467 or CIV-ENGR 5567.

CIV-ENGR 5570 Corrosion Engineering Credits: 3
This course will cover the physical interaction of metallic materials with their environments, called corrosion. Corrosion is an electrochemical process and the thermodynamics and kinetics of corrosion processes will be discussed. Students will be expected to identify different forms of corrosion and be able to select appropriate materials for their working environment to prevent corrosion related problems. Second half of the class will concentrate on corrosion of metals in concrete and prevention methods.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 378WI.

CIV-ENGR 5571 Advanced Portland Cement Concrete Credits: 3
This course will cover topics such as cement chemistry, concrete proportioning, aggregates, mineral and chemical admixtures, fresh and hardened properties of concrete, and durability of concrete. Design and proportioning of concrete mixtures for desired fresh and hardened properties will be emphasized. Specialty concrete types such as high strength/high performance concrete, lightweight concrete, pervious concrete, high volume fly ash concrete, and fiber reinforced concrete will also be covered.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 378WI.

CIV-ENGR 5573 Durability of Civil Engineering Materials Credits: 3
This course will explore the identification, causes of, and remediation of material-related durability deterioration in civil engineering projects. The primary focus will be on reinforced concrete, plain concrete, and soil for a variety of applications. Course content will be delivered primarily through laboratory activities and handouts. Lab activities will use advanced analysis techniques and help the students identify and measure deterioration mechanisms. Various non-destructive evaluation techniques will be discussed. Students have hands on experiences with samples production, data collection, and data analysis for all of the lab activities.
Prerequisites: CIV-ENGR 335, CIV-ENGR 378WI.

Cross Listings: CIV-ENGR 473.

CIV-ENGR 5575 Seismic Design of Structures Credits: 3
Introduction to basic analysis and design principles for the seismic design of buildings (concrete, steel, wood). General seismic principles, codes and loads, static lateral force procedure, dynamic lateral force procedure, topics in rigidities of buildings.
Prerequisites: CIV-ENGR 323 (or CIV-ENGR 422WI), MEC-ENGR 285.

CIV-ENGR 5582 Advanced Traffic Engineering Credits: 3
This course covers the review of traffic flow characteristics, the field survey practices and studies, traffic signal designs, freeway operation, and the introduction to Intelligent Traffic Systems (ITS).
Prerequisites: CIV-ENGR 319.

CIV-ENGR 5584 Pavement Materials, Design, Maintenance, and Rehabilitation Credits: 3
This course will explore the identification, causes of, and remediation of material-related durability deterioration in civil engineering projects. The primary focus will be on reinforced concrete, plain concrete, and soil for a variety of applications. Course content will be delivered primarily through laboratory activities and handouts. Lab activities will use advanced analysis techniques and help the students identify and measure deterioration mechanisms. Various non-destructive evaluation techniques will be discussed. Students have hands on experiences with samples production, data collection, and data analysis for all of the lab activities.
Prerequisites: CIV-ENGR 378WI.

CIV-ENGR 5585 Principles of Railroad Engineering Credits: 3
The engineering analysis and design of railroad systems including the study of the dynamics of track/trains; wheel/rail interaction related to acceleration and braking; horizontal and vertical geometric design of railroads and rail-bed design, rail structures; freight and passenger operations; and, rail-highway interaction and safety.

CIV-ENGR 5599 Thesis Research Credits: 1-6
Independent investigation in the field of civil engineering to be presented in the form of a thesis.

CIV-ENGR 5602 Directed Reading in Civil Engineering Credits: 1-3
Faculty supervised readings course.
Prerequisites: Graduate standing.

CIV-ENGR 5607 Numerical Methods in Engineering Credits: 3
Classification and numerical solution of engineering problems--ordinary and partial differential equations, algebraic equations. Includes initial, boundary, eigen-# and characteristic-value problems.
Prerequisites: MATH 345.

CIV-ENGR 5622 Theory of Elasticity Credits: 3
Stress and strain at a point. General equations of elasticity. Plane stress, plain strain problems; torsion of prismatic bars. Energy methods.

CIV-ENGR 5623 Theory of Plates and Shells Credits: 3
Bending of plates with various loading and boundary conditions. Deformations, stresses in thin shells.
Prerequisites: CIV-ENGR 5622.

CIV-ENGR 5624 Theory of Elastic Stability Credits: 3
Buckling of columns, beams, rings, curved bars, thin plates, shells.
Prerequisites: CIV-ENGR 5622.

CIV-ENGR 5625 Advanced Prestressed Concrete Credits: 3
Design and behavior of prestressed concrete structures; material and system of pretensioned and post tensioned systems; prestress losses; flexure, shear, bond, deflections and partial prestress in determinate structures; indeterminate beams-introduction.
Prerequisites: CIV-ENGR 422WI.

CIV-ENGR 5629 Adv. Design of Structures for Blast and Fire Credits: 3
General overview of Blast Design; risk assessment and design criteria; simplified Blast Effects Analysis; ground shock, material response; antiterrorism design considerations; weapons effects and mitigation; internal explosions; progressive collapse analysis; and introduction to Fire Design.

CIV-ENGR 5645 Water Quality Modeling Credits: 3
Derivation and application of models for describing oxygen budget, nutrient exchange, and biological productivity in streams, lakes and estuaries.
Prerequisites: CIV-ENGR 342.

CIV-ENGR 5646 Physiochemical Treatment Processes Credits: 3
Fundamental principles, analysis and modeling of physical and chemical processes for water and wastewater treatment.
Prerequisites: CIV-ENGR 342.

CIV-ENGR 5647 Biochemical Treatment Processes Credits: 3
Biochemical principles, kinetic models and energy considerations in the design of biological wastewater treatment processes.
Prerequisites: CIV-ENGR 342.

CIV-ENGR 5648 Environmental Engineering Practicum Credits: 3
Numerical water quality modeling of actual site data for wasteload allocation.
Prerequisites: CIV-ENGR 5645.

CIV-ENGR 5649 Design of Water and Wastewater Treatment Facilities Credits: 3
Development of design criteria and their application to the design of water and wastewater treatment facilities.
Prerequisites: CIV-ENGR 5646 or CIV-ENGR 5647.

CIV-ENGR 5651 Fundamentals of Fluid Mechanics Credits: 3
Fundamentals of fluid motion, lecture and laboratory. Instrumentation, technique and analysis for experimental studies in fluid mechanics.

CIV-ENGR 5655 Sediment Transport Credits: 3
The study of sediment transport in rivers: the relationship between sediment transport and the fundamentals of fluvial geomorphology. Computation of sediment transport and sediment transport modeling.
Prerequisites: CIV-ENGR 452 (or CIV-ENGR 5552).

CIV-ENGR 5656 Advanced Hydraulic Engineering Credits: 3
Rapidly varied flow and design of transition structures. Hydraulic design of spillways, reservoirs and related structures.

CIV-ENGR 5675 Advanced Seismic Design of Structures Credits: 3
Introduction to basic analysis and design principles for the seismic design of buildings (concrete, steel, wood). General seismic principles, codes and loads, static lateral force procedure, dynamic lateral force procedure, topics in rigidities of buildings.
Prerequisites: CIV-ENGR 323 (or CIV-ENGR 422WI), MEC-ENGR 285.

CIV-ENGR 5679 Dynamics of Structures Credits: 3
Study of the dynamic behavior of structures. Analysis of equivalent lumoed parameter systems for the design of structures in a dynamic environment.
Prerequisites: CIV-ENGR 276 (or CIV-ENGR 421), MEC-ENGR 484 (or MATH 345, MEC-ENGR 285).

Cross Listings: MEC-ENGR 5679.

CIV-ENGR 5681 Traffic Flow Theory Credits: 3
This course covers the review of macroscopic and microscopic traffic flow characteristics, the traffic flow models, and the traffic simulation applications.
Prerequisites: CIV-ENGR 319.

CIV-ENGR 5682 Transportation Network Modeling Credits: 3
This course is about modeling, solving, and understanding network flow problems, especially in the transportation discipline. This course covers equilibrium traffic assignment, network design, fleet assignment, fleet routing, and crew scheduling.
Prerequisites: CIV-ENGR 319.

CIV-ENGR 5699 Research and Dissertation Credits: 1-9
Doctoral dissertation research.

Mechanical Engineering Courses

MEC-ENGR 130 Engineering Graphics Credits: 3
Introduction to Engineering Graphics with the use of the Computer Aided Design tools AutoCAD and SolidWorks. Introduction to 2D design with AutoCAD includes: basic features, layer control, geometric constructions, othrographic projections, dimensioning and notes, tolerancing, section views, and working drawings. Introduction to 3D design with SolidWorks includes: part modeling, revolved features, sweeps, lofts, assembly modeling and engineering drawings. No previous 2D or 3D CAD experience is necessary to take this class.
Prerequisites: School of Computing and Engineering Student.

MEC-ENGR 131 Engineering Graphics-3D design Credit: 1
Introduction to Engineering Graphics using the 3D Computer Aided Design tool SolidWorks. Introduction to 3D design with SolidWorks includes: part modeling,revolved features,sweeps,lofts,assembly modeling,and engineering drawings. Some previous 2D AutoCAD experience is required to take this class. NOTE: This class starts halfway through the semester by joining in with MEC-ENGR 130 when they finish AutoCAD and begin SolidWorks.
Prerequisites: Departmental consent.

MEC-ENGR 219 Computer Programming for Engineers Credits: 3
Analysis and synthesis of structured computer algorithms for solving engineering problems using high level programming tools such as Excel, Matlab, Fortran and/or C++.
Prerequisites: MATH 266 (preferred) or MATH 220.

MEC-ENGR 270 Engineering Analysis I Credits: 3
This is an applied course with emphasis on physics and engineering applications. Topics include engineering applications using conics, parametric equations, polar coordinates, vectors, solid analytic geometry, vector valued functions, multi-variable functions, partial derivatives (including applications), multiple integration, vector calculus including Green's Theorem, Curl and Divergence, line and surface integrals and Stoke's Theorem.
Prerequisites: MATH 268.

MEC-ENGR 272 Engineering Analysis Credits: 3
An applied course using differential equations in solutions to engineering problems. Topics include applications in first-order differential equations, linear higher-order equations, Laplace transform, Series solutions of linear ODEs (Taylor, Power, and Fourier), Numerical solutions, introduction to systems of differential equations.
Prerequisites: MATH 268 or MATH 220.

MEC-ENGR 285 Engineering Dynamics Credits: 3
Fundamentals of engineering dynamics, including kinematics and kinetics of particles and rigid bodies. Analysis based on forces and accelerations as well as energy and momentum methods.
Prerequisites: CIV-ENGR 275.

MEC-ENGR 299 Engineering Thermodynamics Credits: 3
Fluid properties, work and heat, first law, second law, entropy, applications to vapor and ideal gas processes.
Prerequisites: MATH 268 (preferred) or MATH 220; and PHYSICS 250.

MEC-ENGR 306 Numerical Analysis Credits: 3
Principles, analysis and application of numerical methods for the solution of engineering problems. Computer implementation.
Prerequisites: MEC-ENGR 272 or MATH 345; E&C-ENGR 216 or MATH 345L.

MEC-ENGR 324 Engineering Materials Credits: 3
The nature of the structure of engineering materials. The relationship of material structure to the physical properties. Mechanical behavior of engineering materials.
Prerequisites: CHEM 211, CHEM 211L, CIV-ENGR 276.

MEC-ENGR 324L Engineering Materials Lab Credit: 1
Introduction to the laboratory techniques used in studying the physical and mechanical properties of engineering materials. The material testing in this course is primarily of metallic materials. Physical and mechanical property variations as a result of various processing techniques are studied. Recommended preparation: Machine Shop Safety.
Co-requisites: MEC-ENGR 324.

MEC-ENGR 351 Fluid Mechanics Credits: 3
Concepts of the statics and dynamics of fluids, with emphasis on principles of continuity, momentum and energy. Boundary layers, dimensional analysis and drag are covered briefly. Thorough treatment of pipe flow.
Prerequisites: MEC-ENGR 272 or MATH 345 and CIV-ENGR 275.

MEC-ENGR 352 Mechanical Instrumentation Lab Credits: 3
Static and dynamic errors: measurement and propagation of uncertainty: experiment design; instrumentation selection and calibration; measurement of voltage, resistance, amperage, displacement, velocity, acceleration, force, and strain
Prerequisites: CIV-ENGR 276, Machine Shop Safety

MEC-ENGR 353 Heat Transfer and Fluid Mechanics Lab Credits: 2
The course emphasis is on experiments related to thermodynamics, heat transfer, and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluids measurements are discussed.
Prerequisites: MEC-ENGR 351.

Co-requisites: MEC-ENGR 399.

MEC-ENGR 356 Mechanical Component Design Credits: 3
Introduction to mechanical engineering design and its impact on human history, principles of design with ductile and brittle materials for static and dynamic loading, classical and reliability-based factors of safety, fracture mechanics in design, application to the design of selected machine components.
Prerequisites: CIV-ENGR 276.

MEC-ENGR 360 Applied Thermodynamics Credits: 3
Gas and vapor mixtures, cycles, availability, imperfect gases, thermodynamic relations, combustion, chemical equilibrium, power systems and design projects. Effects of design choices on the earth and living systems.
Prerequisites: MEC-ENGR 299.

MEC-ENGR 380 Manufacturing Methods Credits: 3
Introduction to manufacturing processes with emphasis on those aspects most relevant to methods, problems in force analysis, and practicum and experimentation in machine tool applications.
Prerequisites: MEC-ENGR 324.

Co-requisites: MEC-ENGR 324L.

MEC-ENGR 385 System Dynamics Credits: 3
Kinematics of mechanical systems. Introduction to the modeling and analysis of dynamic mechanical systems. Computer analysis.
Prerequisites: MEC-ENGR 272 (or MATH 345), and MEC-ENGR 285.

MEC-ENGR 399 Heat Transfer Credits: 3
Fundamentals of conduction, convection, and radiation heat transfer. Use of nondimensional parameters. Theory of heat exchangers.
Prerequisites: MATH 250 or MEC-ENGR 270; and MEC-ENGR 299, MEC-ENGR 351.

MEC-ENGR 399L Heat Transfer and Fluids Lab Credit: 1
Project-based course associated with MECH-ENGR 399. Course emphasis is on experiments related to thermodynamics, heat transfer and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluid measurements are discussed.
Co-requisites: MEC-ENGR 399.

MEC-ENGR 400 Problems Credits: 1-6
Special design, experimental and analytical problems in mechanical engineering.
Prerequisites: Departmental consent.

MEC-ENGR 401CD Topics in Mechanical Engineering -- Applied CFD Credits: 3
The fundamentals of computational fluid mechanics. Introduction to the governing equations and boundary conditions of viscous fluid flows, turbulence and its modelling, and how to solve a fluid flow problem using commercially available CFD software.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 401T Topics in Mechanical Engineering Credits: 3
This course covers the application of Newton's laws and thermodynamics to analysis of fluid flow in turbomachinery.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 406 Introduction to Biomaterials Credits: 3
The course covers the basics of biomaterials science and principles of biological systems followed by characterization of biomaterials, tissue engineering and bioprinting application, and drug delivery and challenges in clinical applications.
Prerequisites: MEC-ENGR 285 or MEC-ENGR 299.

MEC-ENGR 407 Advanced Dynamics and Modeling Credits: 3
Fundamental principles of advanced rigid body dynamics with applications. Special mathematical techniques including Lagrangian and Hamiltonian methods.
Prerequisites: MEC-ENGR 285 and MEC-ENGR 306.

MEC-ENGR 411 Introduction to Biomechanics Credits: 3
This course is to provide students with an introduction to the engineering principles of biomechanics.
Prerequisites: MEC-ENGR 219 or E&C-ENGR 216; or MEC-ENGR 285.

Co-requisites: MATH 300 or CIV-ENGR 319.

MEC-ENGR 412 Biodynamics Credits: 3
Introduction to musculoskeletal biomechanics including: computational biomechanics, movement simulation, motor control and musculoskeletal tissues. Recommended preparation: MEC-ENGR 411.

MEC-ENGR 413 Experimental Biomechanics of Human Motion Credits: 3
The purpose of this course is to provide an opportunity for students to gain a hands-on, in-depth understanding of the experimental measurement and analysis techniques used to quantify the biomechanics of human motion.
Prerequisites: MEC-ENGR 411.

MEC-ENGR 414 Material Science for Advanced Applications Credits: 3
Study of the physical and mechanical metallurgy of alloy systems of interest in engineering applications.
Prerequisites: MEC-ENGR 324.

MEC-ENGR 415 Control Systems Theory Credits: 3
Introduction to feedback control theory for linear dynamic systems. Topics include root locus analysis, frequency response analysis, and controller design.
Prerequisites: MEC-ENGR 385.

MEC-ENGR 416 Biomedical Device Design Credits: 3
Project based course which exposes students to the entire design process from problem definition to prototype validation for biomedical device applications. Projects in the course are sponsored by real clients from the local biomedical industry, medical clinicians, and/or research labs. The course will cover the following main components: Problem Definition, Concept Generation and Evaluation, Detailed Design, Prototyping and Testing, Project Management, Regulations and Standards, and Technical Communication. Prerequisites: Senior standing.

MEC-ENGR 420 Human Powered Vehicle Design Lab Credits: 3
Introduction to the science of human powered vehicles (HPV) providing the background necessary for the design of such vehicles. Students will learn and utilize engineering design practices and apply them toward the creation of an aerodynamic, highly engineered land based HPV.
Prerequisites: MATE111A Machine Shop Safety, Consent of instructor.

MEC-ENGR 424 Non-Metallic Engineering Materials Credits: 3
Structures, properties and applications of ceramics, glasses, cermets, polymers and composite materials.
Prerequisites: MEC-ENGR 324.

MEC-ENGR 425 Failure Analysis Credits: 3
Organize and perform a failure investigation. In addition, the course will cover the general procedures for a failure investigation and various failure mechanisms such as ductile fracture, brittle fracture, fatigue, wear, corrosion and elevated temperature.
Prerequisites: MEC-ENGR 324, MEC-ENGR 380.

MEC-ENGR 426 Introduction to Manufacturing Management Credits: 3
The objective of this course is to expose the student to various manufacturing management tools and techniques. Focus is on both the technical tools used in manufacturing as well as on the management tools needed to implement change in the manufacturing environment. As part of this course, students will research a successful company and present an analysis of manufacturing tools and techniques used.

MEC-ENGR 440 Heating and Air Conditioning Credits: 3
General principles of thermodynamics, heat transfer, and fluid dynamics are used to calculate building loads, size equipment and ducts, and evaluate system performance in maximizing human comfort. Consideration of indoor air quality and human health.
Prerequisites: MEC-ENGR 360, MEC-ENGR 399.

MEC-ENGR 441 Intermediate Fluid Mechanics Credits: 3
Topics in potential and viscous flow theory, and computational fluid dynamics.
Prerequisites: MEC-ENGR 351.

MEC-ENGR 444 Composite Materials Credits: 3
A survey of composite materials used in engineering, emphasizing fiber-reinforced composites as well as laminate and particulate composites.
Prerequisites: MEC-ENGR 324.

MEC-ENGR 451 Power Plant Design Credits: 3
Preliminary component and system design. Optimum design of boilers, steam turbines, condensers and cooling towers and their integration into a system to minimize production costs and impact on the environment.
Prerequisites: MEC-ENGR 360, MEC-ENGR 399.

MEC-ENGR 452 Advanced Mechanics of Materials Credits: 3
Shear center; unsymmetric bending; curved beams; beams on elastic foundations; thick-walled cylinders. Energy methods. Torsion of noncircular sections. Theories of failure. Plate theory.
Prerequisites: CIV-ENGR 276.

MEC-ENGR 454 Power Generation Systems Credits: 3
Fundamentals of the power industry in a format suitable for all engineering disciplines. Survey of electric power systems, including fossil and nuclear steam cycles, combustion turbines, combines cycles, and renewable such as solar and wind. Introduction to major machinery components, systems, controls, and an overview of fuels, emissions, and emission control technologies.
Prerequisites: MEC-ENGR 299.

MEC-ENGR 455 Digital Control of Mechanical Systems Credits: 3
Introduction to digital control systems. Topics include Z-transforms, sampling, stability analysis, and digital controller design.
Prerequisites: MATH 345, MEC-ENGR 415.

MEC-ENGR 457 Mechatronic System Design Credits: 3
Theory and application of mechatronic systems through course instruction, laboratory activities, and student projects.
Co-requisites: MEC-ENGR 415.

MEC-ENGR 458 Modern Control Systems Credits: 3
Controller design for multiple-input/multiple-output systems; controllability and observability; stochastic control problems; regulators and tracking controllers; observers.
Prerequisites: MEC-ENGR 415.

MEC-ENGR 459 Robotics and Unmanned Systems Credits: 3
Students will develop, implement, and evaluate various path following (point mass, rigid body, and Dubin's) and trajectory generation (configuration spaces, roadmaps, cell decomposition, etc.) concepts on simulation and experimental platforms.
Prerequisites: MEC-ENGR 306, MEC-ENGR 457.

MEC-ENGR 460 Electromechanical Conversion Credits: 3
This course describes the operation and control of electro-mechanical devices such as motors transformers to mechanical civil engineering students, including an introduction to programmable logic controllers and variable speed drives.
Prerequisites: MEC-ENGR 220, MEC-ENGR 285.

MEC-ENGR 462 Applied Computational Fluid Dynamics Credits: 3
The fundamentals of computational fluid mechanics. Introduction to the governing equations and boundary conditions of viscous fluid flows, turbulence and its modelling, and how to solve a fluid flow problem using commercially available CFD software.
Prerequisites: MEC-ENGR 351 or CIV-ENGR 351; MEC-ENGR 360.

MEC-ENGR 464 Turbomachines Credits: 3
This course covers the practical application of thermodynamics, fluid dynamics, and dimensional analysis to the design of pumps, fans, compressors, and turbines.
Prerequisites: MEC-ENGR 351 or CiV-ENGR 351; MEC-ENGR 360.

MEC-ENGR 466 Applied Optimization and Decision Modeling Credits: 3
Introduction to mathematical programming techniques and applications. Linear and integer programming, transporation models, multiple objective and goal programming.
Prerequisites: MEC-ENGR 306.

MEC-ENGR 467 Fuel Cells and Renewable Energy Systems Credits: 3
This course will provide an overview of the fundamental phenomena that govern the design and operation of fuel cells. The thermodynamics of fuel cell systems will be explored including operation of ideal fuel cells and the physical and chemical phenomena that lead to losses within the fuel cell. The course will provide the methods and techniques required to analyze the performance of low, medium, and high temperature fuel cells within an overall energy system. The fueling of fuel cells from renewable resources will also be discussed.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 470 Experimental Design & Analysis Credits: 3
Presentation of concepts and methods of statistical analysis and the design of experiments. Concepts, techniques, interpretation, and use of results are stressed. Focus is on experimental strategy and objectives, and the application of the methods discussed, rather than the mechanics of derivation. Major sections include: a review of hypothesis testing and basic analysis of variance techniques; single factor experiments including 2k and 3k design, confounding, and Taguchi philosophy; nested and split plot designs; analysis of covariance and an introduction to response surface methods.

MEC-ENGR 484 Vibration Analysis Credits: 3
Vibration theory with application to mechanical systems.
Prerequisites: MEC-ENGR 306, MEC-ENGR 385.

MEC-ENGR 486 Applied Finite Element Analysis Credits: 3
The study of advanced simulation techniques for the solution to engineering problems. The use of Finite Element Method toward solving mechanical, structural, vibration and potential flow problems will be explored. The use of current commercial simulation tools will be used extensively.
Prerequisites: MEC-ENGR 306, MEC-ENGR 324, MEC-ENGR 385, MEC-ENGR 399.

MEC-ENGR 491 Internship Credits: 0-6
For International students who must register to cover off-campus employment which is approved as related to their degree by their departmental advisor and ISAO.
Prerequisites: Departmental consent.

MEC-ENGR 492 Mechanical Design Synthesis I Credits: 3
Introduction to and application of the Engineering Design Process including: product development, needs identification, benchmarking, information gathering, concept generation, creativity methods, concept selection, professional and ethical responsibilities, and computer-aided design and rapid prototyping applications. A comprehensive design project including 3D CAD models and functioning prototypes is required.
Prerequisites: MEC-ENGR 130 or MEC-ENGR 131; senior standing.

Co-requisites: MEC-ENGR 356 and MEC-ENGR 324.

MEC-ENGR 493 Intermediate Dynamics Credits: 3
Theoretical discussion of kinematics and dynamics of rigid bodies in three-dimensional space. General theory of rotating coordinate frames, Euler's angles, Euler's equations of motion, angular momentum, work-energy principles, and Kane's method.
Prerequisites: MEC-ENGR 285.

MEC-ENGR 494 Robotic System Identification Credits: 3
Students will develop, implement, and evaluate various system identification and parameter estimation techniques. Students will quantify estimation accuracy through both theoretical and experimental exercises.
Prerequisites: MEC-ENGR 285, MEC-ENGR 306, MEC-ENGR 352.

MEC-ENGR 496WI Mechanical Design Synthesis Credits: 3
Modern design theories and methodologies, with emphasis on the initial stages of the design process. Effect of design choices on the earth and living systems. Principles of embodiment design and life-cycle considerations. A comprehensive group design project is required. The course satisfies the Writing Intensive requirement.
Prerequisites: ANCH 309 or MEC-ENGR 492; MEC-ENGR 356.

MEC-ENGR 5500 Problems Credits: 1-6
Supervised investigation in mechanical engineering to be presented in the form of a report.

MEC-ENGR 5501 Advanced Topics In Mechanical Engineering Credits: 3

MEC-ENGR 5501AD Advanced Topics in Mechanical Engineering Credits: 3
Advanced Topics in Mechanical Engineering

MEC-ENGR 5501CD Advanced Topics in Mechanical Engineering Credits: 3
Advanced Topics in Mechanical Engineering

MEC-ENGR 5501MS Advanced Topics in Mechanical Engineering Credits: 3

MEC-ENGR 5501SM Advanced Topics in Mechanical Engineering Credits: 2
This course is for high school science teachers who have attended the ASM International Second Year Teachers Camp and have demonstrated the use of camp material in the classroom.

MEC-ENGR 5501TC Advanced Topics in Mechanical Engineering Credits: 2
This course is for high school science teachers who have attended the ASM International Teachers camp and have demonstrated the use of camp material in the classroom.

MEC-ENGR 5505 Imaging Techniques in Materials Science Credits: 3
Introduction to imaging techniques, including x-rays, neutron beams, electron beams and acoustic energy, to study material properties and structure.
Prerequisites: MEC-ENGR 324.

MEC-ENGR 5506 Introduction to Biomaterials Credits: 3
The course covers the basics of biomaterials science and principles of biological systems followed by characterization of biomaterials, tissue engineering and bioprinting application, and drug delivery and challenges in clinical applications. Knowledge of engineering materials or thermodynamics is helpful.

MEC-ENGR 5507 Advanced Dynamics and Modeling Credits: 3
Fundamental principles of advance rigid body dynamics with applications. Special mathematical techniques including Lagrangian and Hamiltonian methods.

MEC-ENGR 5511 Introduction to Biomechanics Credits: 3
This course is to provide students with an introduction to the engineering principles of biomechanics.

MEC-ENGR 5512 Biodynamics Credits: 3
Introduction to musculoskeletal biomechanics including: computational biomechanics, movement simulation, motor control and musculoskeletal tissues.
Prerequisites: MEC-ENGR 5511.

MEC-ENGR 5513 Experimental Biomechanics of Human Motion Credits: 3
The purpose of this course is to provide an opportunity for students to gain a hands-on, in-depth understanding of the experimental measurement and analysis techniques used to quantify the biomechanics of human motion.
Prerequisites: MEC-ENGR 5511.

MEC-ENGR 5514 Material Science for Advanced Application Credits: 3
Study of the physical and mechanical metallurgy of alloy systems of interest in engineering applications.
Prerequisites: MEC-ENGR 324.

MEC-ENGR 5516 Biomedical Device Design Credits: 3
Project based course which exposes students to the entire design process from problem definition to prototype validation for biomedical device applications. Projects in the course are sponsored by real clients from the local biomedical industry, medical clinicians, and/or research labs. The course will cover the following main components: Problem Definition, Concept Generation and Evaluation, Detailed Design, Prototyping and Testing, Project Management, Regulations and Standards, and Technical Communication.

MEC-ENGR 5525 Failure Analysis Credits: 3
Organize and perform a failure investigation. In addition, the course will cover the general procedures for a failure investigation and various failure mechanisms such as ductile fracture, brittle fracture, fatigue, wear, corrosion and elevated temperature.
Prerequisites: MEC-ENGR 324, MEC-ENGR 380.

MEC-ENGR 5526 Introduction to Manufacturing Management Credits: 3
The objective of this course is to expose the student to various manufacturing management tools and techniques. Focus is on both the technical tools used in manufacturing as well as on the management tools needed to implement change in the manufacturing environment. As part of this course, students will research a successful company and present an analysis of manufacturing tools and techniques used.

MEC-ENGR 5533 Advanced Thermodynamics Credits: 3
Statistical methods of evaluating thermodynamic properties. Elements of quantum mechanics, statistical mechanics and kinetic theory applied to topics of engineering thermodynamics.
Prerequisites: MEC-ENGR 360, MEC-ENGR 399.

MEC-ENGR 5542 Introduction to Computational Fluid Dynamics and Heat Transfer Credits: 3
Introduction to the principles and development of the finite-difference approximations to the governing differential equations of viscous and inviscid fluid flow, as well as heat transfer. Introduction to discretization methods and the calculation of flow fields, convection, diffusion and conduction.
Prerequisites: MEC-ENGR 399, MEC-ENGR 441.

MEC-ENGR 5543 Industrial Refrigeration Credits: 3
Introduction to and analysis of the thermodynamic cycles and equipment used in Industrial Refrigeration. Applications of Industrial Refrigeration are also discussed.
Prerequisites: MEC-ENGR 299.

MEC-ENGR 5547 Contracts and Law for Engineers Credits: 3
This course covers a broad range of substantive legal topics giving the student a grounding in the legal implications of certain situations that they may encounter during their careers.The course includes coverage of basic contract law, environmental regulations and compliance, construction law, antitrust law, intellectual property law, civil procedure, employment law, business entities (corporate law) product liability and criminal law and procedure.The objective of the course is to provide students with a fundamental understanding of the wide range of federal and state laws governing behavior in our complicated and rule of law driven society.

MEC-ENGR 5549 Environmental Compliance, Auditing & Permitting Credits: 3
This course provides a high level overview of the most important statutes that have been enacted to protect the environment. The course covers regulation of hazardous waste, the Clean Air and Clean Water Acts, the Resource Conservation and Recovery Act, the All Appropriate Inquiry Rule and the law addressing sites contaminated with hazardous substances and the technology options employed to remediate those sites. In addition, the course provides coverage of environmental audits and emergency planning for extremely hazardous substances, the regulation of underground storage tanks, safe drinking water and the National Environmental Policy Act among other statutes.
Prerequisites: CIV-ENGR 211, MEC-ENGR 285.

MEC-ENGR 5554 Power Generation Systems Credits: 3
Fundamentals of the power industry in a format suitable for all engineering disciplines. Survey of electric power systems, including fossil and nuclear steam cycles, combustion turbines, combines cycles, and renewable such as solar and wind. Introduction to major machinery components, systems, controls, and an overview of fuels, emissions, and emission control technologies.
Prerequisites: MEC-ENGR 299.

MEC-ENGR 5557 Mechatronics System Design Credits: 3
Theory and application of mechatronic systems through course instruction, laboratory activities, and student projects.
Prerequisites: MEC-ENGR 352 and MEC-ENGR 415.

MEC-ENGR 5558 Intermediate Dynamics Credits: 3
Development of kinematics and dynamics of rigid bodies in three-dimensional space including: general theory of rotating coordinate frames, Eulers angles, Eulers equations of motion, angular momentum, work-energy principles, and Kane's method for creation and simulation of dynamic models.
Prerequisites: MEC-ENGR 285.

MEC-ENGR 5559 Robotics and Unmanned Systems Credits: 3
Students will develop, implement, and evaluate various path following (point mass, rigid body, and Dubin’s) and trajectory generation (configuration spaces, roadmaps, cell decomposition, etc.) concepts on simulation and experimental platforms.
Prerequisites: MEC-ENGR 306, MEC-ENGR 457.

MEC-ENGR 5562 Applied Computational Fluid Dynamics Credits: 3
The fundamentals of computational fluid mechanics. Introduction to the governing equations and boundary conditions of viscous fluid flows, turbulence and its modelling, and how to solve a fluid flow problem using commercially available CFD software. Recommended preparation: MEC-ENGR 360 and MEC-ENGR 351.

MEC-ENGR 5563 Engineer in Society - Construction Law Credits: 3
This course introduces professional, ethical, and legal concepts of the professional practice of engineering, and the role of the consulting engineer, specifically in the A/E/C industry during the design, procurement, and construction processes. A conceptual framework is developed for understanding the industry standard agreements (AIA, EJCDC, ConCensus) and the various participants roles and duties in project execution. The engineer’s “professional standard of care” is examined and revisited throughout the semester, specifically what it means to be a “Professional Engineer”. Emphasis is placed on project and contract management and the applicable law. Skills are developed in finding online resources of law, legal, and practice advice relevant to the practice of engineering and the construction industry

MEC-ENGR 5564 Turbomachines Credits: 3
This course covers the practical application of thermodynamics, fluid dynamics, and dimensional analysis to the design of pumps, fans, compressors, and turbines. Recommended preparation: MEC-ENGR 360 and MEC-ENGR 351.

MEC-ENGR 5565 Project Finance Credits: 3
This class introduces students to the financial concepts faced by engineers in the businesses in which they work and for the projects to which they are assigned. Throughout the course students are reminded of the impact of two key variables – money and time – on their work. While not attempting to turn good engineers into mediocre accountants, the course includes a strong emphasis on managerial accounting. Students will learn how to read and apply financial statements and how to use these same financial concepts in developing pro formas to evaluate and support major capital investments. The effect of time on the value of money, appropriate discount factors, and the internal rate of return will be explored in the class. Students will learn to combine these financial factors with electronic spreadsheets to evaluate business opportunities and practices. All students will be required to develop a comprehensive financial model to evaluate/justify a real world capital project.

MEC-ENGR 5567 Fuel Cells and Renewable Energy Systems Credits: 3
This course will provide an overview of the fundamental phenomena that govern the design and operation of fuel cells. The thermodynamics of fuel cell systems will be explored including operation of ideal fuel cells and the physical and chemical phenomena that lead to losses within the fuel cell. The course will provide the methods and techniques required to analyze the performance of low, medium, and high temperature fuel cells within an overall energy system. The fueling of fuel cells from renewable resources will also be discussed.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 5568 Introduction to Nuclear Engineering Credits: 3
This course provides an overview of nuclear engineering for non-nuclear engineers. The course deals primarily with nuclear reactors including topics dealing with nuclear and reactor physics, reactor kinetics and controls and radiation environment. The general reactor types are covered in some detail with other topics dealing with licensing, waste management, quality assurance, balance of plant systems (turbine island), and significant nuclear accidents are also covered. Recent design innovations including small modular reactors and fusion are discussed.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 5570 Experimental Design & Analysis Credits: 3
Presentation of concepts and methods of statistical analysis and the design of experiments. Concepts, techniques, interpretation, and use of results are stressed. Focus is on experimental strategy and objectives, and the application of the methods discussed, rather than the mechanics of derivation. Major sections include: a review of hypothesis testing and basic analysis of variance techniques; single factor experiments including 2k and 3k design, confounding, and Taguchi philosophy; nested and split plot designs; analysis of covariance and an introduction to response surface methods.

MEC-ENGR 5572 Advanced Statistics Credits: 3
The objective of this course is to review the concepts and methods of undergraduate first course in statistical analysis and extend the student's understanding to cover topics typically covered in a second course in applied engineering statistics. Concepts, techniques, interpretation, and use of results are stressed. Focus is on the application of the methods discussed, rather than the mechanics of derivation.
Prerequisites: CIV-ENGR 319.

MEC-ENGR 5574 Linear Programming for Engineering Optimization Credits: 3
This course will cover techniques and applications of engineering optimization using linear programming techniques. The main topics will be the simplex algorithm, sensitivity analysis, duality, network models, and integer programming. Main applications will include transportation, shipments, and utility planning. Stochastic models, game theory, non-linear programming, and heuristic optimization techniques will be briefly mentioned, but not explored in detail. At the conclusion of the course the student should be able to formulate and solve optimization problems in several areas of engineering.
Prerequisites: MEC-ENGR 306.

MEC-ENGR 5586 Applied Finite Element Analysis Credits: 3
The study of advanced simulation techniques for the solution to engineering problems. The use of Finite Element Method toward solving mechanical, structural, vibration and potential flow problems will be explored. The use of current commercial simulation tools will be used extensively.
Prerequisites: CIV-ENGR 275, MATH 5517, MEC-ENGR 130.

MEC-ENGR 5594 Robotic System Identification Credits: 3
Students will develop, implement, and evaluate various system identification and parameter estimation techniques. Students will quantify estimation accuracy through both theoretical and experimental exercises. Prerequisites: MEC-ENGR 285, MEC-ENGR 306, MEC-ENGR 352.

MEC-ENGR 5595 Microscale Heat Transfer Credits: 3
Review of existing models. Concept of thermal lagging and the second-law admissibility. Applications to low temperatures, thermal processing of thin-film devices; amorphous materials; advanced composites.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 5599 Research Credits: 1-99
Independent investigation in field of mechanical engineering to be presented as a thesis.

MEC-ENGR 5601 Doctoral Topics In Mechanical Engineering Credits: 3

MEC-ENGR 5603 Directed Readings in Mechanical Engineering Credits: 1-3
Faculty supervised readings course.
Prerequisites: Graduate standing.

MEC-ENGR 5610 Seminar Credit: 1
Review recent investigations, projects of major importance in mechanical engineering.

MEC-ENGR 5616 Theory of Plasticity Credits: 3
Plastic yield conditions and stress-strain relations. Behavior of elastic-perfectly plastic members. Plain strain in plastic members.
Prerequisites: MEC-ENGR 5621, MEC-ENGR 5622.

MEC-ENGR 5618 Multibody System Dynamics Credits: 3
Fundamental principles of advanced rigid body dynamics with applications. Special mathematical techniques including Lagrangian and Hamiltonian methods.
Prerequisites: MEC-ENGR 285.

MEC-ENGR 5621 Continuum Mechanics Credits: 3
Introductory course in the mechanics of continuous media. Basic concepts of stress, strain, constitutive relationships; conservation laws are treated using Cartesian tensor notation. Examples from both solid and fluid mechanics investigated.
Prerequisites: CIV-ENGR 276, MATH 345, MEC-ENGR 351.

MEC-ENGR 5622 Theory of Elasticity Credits: 3
Stress and strain at a point. General equations of elasticity. Plane stress, plain strain problems; torsion of prismatic bars. Energy methods.
Prerequisites: MEC-ENGR 5621.

MEC-ENGR 5623 Theory Of Plates And Shells Credits: 3
Bending of plates with various loading and boundary conditions. Deformations,stresses in thin shells.
Prerequisites: MEC-ENGR 5621.

MEC-ENGR 5624 Theory of Elastic Stability Credits: 3
Buckling of columns, beams,rings, curved bars, thin plates, shells.
Prerequisites: MEC-ENGR 5621.

MEC-ENGR 5627 Dynamics of Machinery Credits: 3
Dynamic balancing or rotating and reciprocating components of turbo-machinery and internal combustion engines. Gas torque analysis, vibration stress analysis and equivalent systems. Numerical and graphical techniques.
Prerequisites: MEC-ENGR 484.

MEC-ENGR 5630 Boundary Layer Theory Credits: 3
Fluid motion at high Reynolds Number. Derivation of Navier-Stokes equations and boundary layer equations. Methods of solution. Transition to turbulent flow. Completely developed turbulent flow.
Prerequisites: MEC-ENGR 441.

MEC-ENGR 5636 Heat Transfer-Convection Credits: 3
Concepts including fluid dynamics, conservation laws, thermal boundary layer theory, forced convection in laminar and turbulent flows, and free convection will be developed and applied.
Prerequisites: MEC-ENGR 399

MEC-ENGR 5637 Heat Transfer-Radiation Credits: 3
Advanced study of engineering radiation heat transfer. Concepts of electromagnetic theory. Development of thermal radiation laws from thermodynamic laws. Analysis of grey and non-grey systems with intervening gases. Study of recent literature.
Prerequisites: MEC-ENGR 399.

MEC-ENGR 5639 Introduction to Two Phase Flow Credits: 3
The fundamental principles of two-phase flow with applications to a variety of homogeneous mixture as well as separated liquid-liquid, gas-solid, liquid-solid, and gas-liquid flow problems, including steady or transient, laminar or turbulent conditions.
Prerequisites: MEC-ENGR 441.

MEC-ENGR 5643 Industrial Refrigeration Credits: 3
Introduction to and analysis of the thermodynamic cycles and equipment used in Industrial Refrigeration. Applications of Industrial Refrigeration are also discussed.

MEC-ENGR 5660 Combustion Credits: 3
Study of advanced topics in flames and combustion. Detonation and deflagrations, supersonic combustion, air pollution.
Prerequisites: MEC-ENGR 441.

MEC-ENGR 5679 Dynamics of Structures Credits: 3
Study of the dynamic behavior of structures. Analysis of equivalent lumped parameter systems for the design of structures in a dynamic environment.
Prerequisites: CIV-ENGR 276 (or CIV-ENGR 421), MEC-ENGR 484 (or MATH 345, MEC-ENGR 285).

MEC-ENGR 5685 Advanced Vibration Analysis Credits: 3
Advanced topics in vibration theory and its application to Mechanical systems. Topics include vibration analysis of multi-degree of freedom, distributed and nonlinear systems, random vibration analysis, and vibration control.
Prerequisites: MEC-ENGR 484.

MEC-ENGR 5699 Research And Dissertation Credits: 1-9
Doctoral dissertation research.