Materials Engineering

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Program Codes:
20FS1434MS (MS)
20FS1434PHD (PhD)

The Department of Civil and Materials Engineering (CME) offers programs leading to the Master of Science and Doctor of Philosophy degrees in Materials Engineering. Study and research is available in the areas of metallurgy, ceramics, nanomaterials, electronic materials, composites, welding and joining, solidification, corrosion, and processing. The department also offers programs leading to degrees in Civil Engineering at both the master's and doctoral levels. Consult the appropriate sections of the catalog for more information. Updated information about the faculty, staff, curriculum, and courses is found on the CME home page http://www.cme.uic.edu/CME/WebHome.

Admission and Degree Requirements

- MS in Materials Engineering (http://catalog.uic.edu/gcat/colleges-schools/engineering/mate/ms)
- PhD in Materials Engineering (http://catalog.uic.edu/gcat/colleges-schools/engineering/mate/phd)

Courses

CME 400. Advanced Design of Reinforced Concrete Structures. 3 or 4 hours.
Design of reinforced concrete building structures, including design for lateral loads due to wind, structural systems for reinforced concrete buildings, shear walls, and design for seismic forces. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 310 or the equivalent.

CME 401. Advanced Design of Metal Structures. 3 or 4 hours.
Plate girders; unsymmetrical bending; torsion of thin-walled structures; lateral-torsional instability; composite construction. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 301.

CME 402. Geometric Design of Highway Facilities. 3 or 4 hours.
Elements of geometric design. Driver, vehicle and roadway system characteristics. Horizontal and vertical alignment design. Intersection design and operation. Capacity and level of service. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 302.

CME 403. Hydraulic Design. 3 or 4 hours.
Groundwater hydraulics, movement, recharge and well design; migration and drainage; design of dams, spillways and turbines; wave and coastal engineering design. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 311.

CME 404. Railroad Track Engineering. 3 hours.
Railroad track engineering concepts including track components, response of track to wheel loads, design and analysis of railroad tracks, construction, evaluation, and maintenance of railroad tracks, load distribution, and track substructures. Course Information: Prerequisite(s): CME 315; or consent of the instructor. Recommended Background: Basic knowledge of strength of materials, soil mechanics, and structures.

CME 405. Foundation Analysis and Design. 3-4 hours.
Site characterization; analysis and design of shallow foundations, deep foundations and earth retaining structures; foundations on difficult soils; effects of construction; instrumentation and monitoring. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 315.

CME 406. Bridge Design. 3 or 4 hours.
Theory and design procedures related to the analysis and design of modern bridges. Using the AASHTO Code, includes concrete and steel structures, construction practices and procedures. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 301 and CME 310.

CME 407. Soil and Site Improvement Methods. 3 or 4 hours.
Compaction, preloading, vertical drains, grouting, admixture stabilization, thermal stabilization, soil reinforcement, geosynthetics; construction of embankments on soft clay, embankments on mechanically stabilized earth walls, hydraulic barriers; case studies. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 315.

CME 408. Traffic Engineering and Design. 3 or 4 hours.
Highway Traffic control with an emphasis on highway capacity analysis and Traffic Signal Design. Queuing theory, traffic flow theory, corridor management, and Taffic Safety. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Field work required. Prerequisite(s): CME 302 or consent of the instructor.

CME 409. Structural Analysis II. 3 or 4 hours.
Approximate analysis of structures including trusses and multistory frames. Influence lines, cables and arches. Principles of limit analysis for structures and structural elements. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 205 or consent of the instructor.

CME 410. Design of Prestressed Concrete Structures. 3 or 4 hours.
Principles of prestressed concrete. Analysis and design of statically determinate prestressed concrete members. Introduction to design and detailing of connections. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 310.

CME 411. Chemistry for Environmental Professionals. 3 hours.
Introductory atmospheric chemistry, aspects of air pollution, chemistry related to natural water and water treatment; priority organic pollutants and heavy metals. Course Information: Same as EOHS 440. Prerequisite(s): One year of college chemistry.

CME 413. Design of Wood Structures. 3 hours.
Covers the properties and behavior of wood as a structural material; the focus will be on the analysis of structural wood elements. Course Information: Prerequisite(s): CME 301; or CME 310; or consent of the instructor.

CME 414. Design of Masonry Structures. 3 hours.
Material characteristics of masonry as an engineering material, design of masonry members subjected to axial loads, bending, combined axial and bending loads, design of masonry shear walls, and design of multi-story masonry buildings. Course Information: Prerequisite(s): CME 301; or CME 310; or consent of the instructor.

CME 415. Environmental Geotechnology. 3 or 4 hours.
Environmental laws and regulations, sources and types of waste materials, waste materials in geotechnical engineering applications, geotechnical management of municipal, industrial, mine and nuclear wastes. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 315.

CME 420. Water and Wastewater Analysis Laboratory. 0-4 hours.
Laboratory class for environmental engineering. Analysis of water, wastewater and soil for nutrients, pollutants, physical parameters and biological parameters. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 216; or graduate standing. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

CME 421. Water Treatment Design. 3 or 4 hours.
Water quality control systems. Physical-chemical unit processes applied to systems designed for treatment of municipal and industrial waters. Course Information: 3 undergraduate hours. 4 graduate hours. Field trip required at nominal fee. Prerequisite(s): CME 322. Students in programs outside stated restrictions may be admitted with the consent of the instructor.

CME 422. Wastewater Treatment Design. 3 or 4 hours.
Processes involved in the biological treatment of wastewater. Aerobic and anaerobic treatment, sludge stabilization, and nutrient removal. Course Information: 3 undergraduate hours. 4 graduate hours. Field trip required. Prerequisite(s): CME 322 or the equivalent.

CME 423. Management of Solid and Hazardous Wastes. 3 hours.
Management of solid and hazardous waste, including radioactive waste: landfills, incineration, recycling, composting, source reduction, groundwater and air pollution impacts, control, regulations, siting, health impacts. Course Information: Same as EOHS 472, and GEOG 444.

CME 425. Environmental Remediation Engineering. 3 or 4 hours.
Sources of contamination, regulations, site characterization, impact assessment, waste disposal and containment options, waste treatment options, case studies. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 315.

CME 427. Engineering Hydrology. 3 or 4 hours.
Processes, techniques and concepts in hydrology of interest to the engineer: precipitation, interception, evaporation, groundwater, unit hydrographs, flood routing, and statistics. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 311.

CME 430. Theory of Elasticity I. 3 or 4 hours.
The boundary value problems of linear elasticity. Uniqueness of solution. Reduction to two dimensions: the plane problems, torsion, bending. Polar coordinates and general orthogonal coordinates. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 205 and Math 220; or the equivalents.

CME 431. Introduction to Continuum Mechanics. 3 or 4 hours.
Vectors and tensors, stress, principal stresses and principal axes, deformation, compatability conditions, constitutive equations, isotropy and mechanical properties of fluids and solids. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 203 and CME 211; or CME 203 and ME 211.

CME 432. Energy Methods in Mechanics. 3 or 4 hours.
Variational theorems of elasticity. Applications to establish approximate systems and their solution. Beams (including shear deformation.) Introduction to instability theory. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 205.

CME 433. Fracture Mechanics and Failure Analysis I. 3 or 4 hours.
Classical theory of strength of materials. Fracture mechanisms maps. Continuum damage mechanics. Introduction to fracture mechanics. Singular problems of elasticity. Stress intensity. Energy release rates. Irwin-Orowan, Barenblatt-Dugdale theories. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 430.

CME 434. Finite Element Analysis I. 3 or 4 hours.
Establishment of basic finite element, matrix relations for one-dimensional heat conduction problems: Truss, beam and frame structural systems. Solution methods of the resulting equations. Introduction to two-dimensional analysis. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 109; and CME 205 or ME 347.

CME 435. Theory of Vibrations I. 3 or 4 hours.
Analytical and numerical treatment of linear, discrete systems. Nonlinear discrete systems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 200 or the equivalent and MATH 220.

CME 440. Cities and Sustainable Infrastructure. 0-4 hours.
Integrated urban infrastructure planning based on sustainability and resilience; energy, water and transportation systems; design of green buildings; urban network design; methods of environmental assessment and infrastructure economics. Course Information: 3 undergraduate hours; 4 graduate hours. Prerequisite(s): CME 302 and CME 311; or consent of the instructor For graduate students: consent of instructor.

CME 450. Probability and Reliability in Structural Design. 3 or 4 hours.
Maximum uncertainty principle and probability distributions of random variables. Distributions of extremes and their applications. Statistics of failure. The weakest link theory. Time to failure. Structural reliability. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Consent of the instructor.

CME 453. Experimental Stress Analysis. 0-4 hours.
Structural similitude and dimensional analysis. Strain measurement techniques. Introduction to photoelasticity. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 430. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

CME 454. Structural Analysis and Design of Tall Buildings. 3 or 4 hours.
State-of-the-art introduction to structural analysis and design of tall buildings. Load impact on different structural systems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 401 or CME 409 or the equivalent, or consent of the instructor. Recommended background: Major structural analysis and design courses.

CME 460. Crystallography and X-Ray Diffraction. 4 hours.
Fundamentals of crystallography. Theory of x-ray diffraction, experimental methods and applications. Course Information: Prerequisite(s): CME 260. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 470. Physical and Mechanical Properties of Materials. 4 hours.
Basic metallurgical phenomena; kinetics and phase stability; diffusion and transformation rates. Mechanical properties of materials; creep; fatigue and fracture. Course Information: Prerequisite(s): CME 260. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 471. Thermodynamics of Materials. 0-4 hours.
Application of chemical and thermodynamic principles to processing and characterization of materials. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 260. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 480. Welding Metallurgy. 4 hours.
Metallurgy of metals joining processes. Selection of processes and design of products manufactured by joining processes. Course Information: Prerequisite(s): CME 260. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 490. Undergraduate Senior Design Thesis I. 0-8 hours.
Introduction to engineering design and research methods: design tools, product conception and development, simulation, optimization, technical reports and presentations, literature survey and undergraduate thesis. Course Information: Credit only given to non-degree students. No graduation credit given to students enrolled in Engineering. Extensive computer use required. Prerequisite(s): Consent of the instructor.

CME 491. Undergraduate Senior Design Thesis II. 0-8 hours.
Introduction to engineering design and research methods: design tools, product conception and development, simulation, optimization, technical reports and presentations, literature survey and undergraduate thesis. Course Information: Extensive computer use required. Prerequisite(s): Consent of the instructor.

CME 493. Seminar. 1-3 hours.
Topics of mutual interest to a faculty and a group of students. Offered as announced in the Timetable.

CME 494. Special Topics in Civil Engineering, Mechanics, and Materials. 1-4 hours.
Subject matter varies from section to section and from semester to semester, depending on the specialities of the instructor. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

CME 496. Special Problems. 1-4 hours.
Special problems or reading by special arrangement with a faculty member. Course Information: Prerequisite(s): Consent of the instructor.

CME 497. Capstone Design. 2 or 3 hours.
Application of principles of engineering and design methods to the solution of a large-scale design program. Communicating design solutions through verbal and written media. Course Information: Previously listed as CME 397.

CME 500. Design of Concrete Plate and Shell Structures. 4 hours.
Practical design of reinforced concrete slabs, walls, and shells of single and double curvatures. Includes barrel roofs, domes, and storage tanks. Course Information: Prerequisite(s): CME 310.

CME 501. Urban Transportation. 4 hours.
Transportation technology, and its relation to travel and location phenomena in large urban areas, as a basis for planning, operating and design of multimodal transportation systems. Course Information: Prerequisite(s): Grade of C or better or concurrent registration in CME 302; and MATH 210 and ECON 120. Recommended background: For transportation and urban planning majors.

CME 502. Bridge Design II. 4 hours.
Theory and design procedures related to the analysis and design of modern bridges, using AASHTO code. Includes concrete and steel structures, construction practices and procedures. Course Information: Prerequisite(s): CME 406.

CME 503. Advanced Transportation Demand Analysis. 4 hours.
Advanced quantitative analysis and modeling of transportation demand for planning purposes. Disaggregate choice models, traveler behavior and values, activity-based and microsimulation approach to demand modeling. Course Information: Extensive computer use required. Prerequisite(s): CME 508.

CME 505. Advanced Soil Mechanics. 4 hours.
Soil structure, stresses in soil mass, fluid flow, consolidation, drained and undrained shear strength, stressstrain relations, laboratory determination of strength and compressibility of soils. Course Information: Prerequisite(s): CME 315. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 506. Physical/Chemical Principles in Environmental Systems. 4 hours.
Physical and chemical principles in natural and engineered environmental systems. Environmental process equilibria and rates. Reactor design and mass transfer in environmental systems. Multiphase environmental processes. Course Information: Prerequisite(s): CME 216.

CME 507. Sustainable Transportation Systems. 4 hours.
Transportation network analysis, mobile source emission modeling and life-cycle based transportation energy modeling. Course Information: Prerequisite(s): Credit or concurrent registration in CME 501; and credit or concurrent registration in CME 508. Recommended Background: Transportation engineering, urban planning, and environmental engineering.

CME 508. Urban Travel Forecasting. 4 hours.
Theory and method of forecasting travelers' choices of route, mode, destination, departure time, trip frequency and origin location in congested urban transportation networks. Course Information: Prerequisite(s): CME 302 and MATH 210 and ECON 120. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CME 509. Transportation Networks. 4 hours.
Application of constrained optimization methods to the analysis, planning and design of urban transportation networks. Course Information: Prerequisite(s): CME 501 and ECON 501 and MATH 484 and CME 508.

CME 510. Advanced Design of Prestressed Concrete Structures. 4 hours.
Analysis and design of indeterminate prestressed concrete members. Composite beams, torsion, deflections and design and detailing of connections, special topics such as anchorage zone design. Course Information: Prerequisite(s): CME 410.

CME 516. Design of Landfills and Impoundments. 4 hours.
Regulatory overview, site selection, waste characterization, design and construction of landfill and impoundment components, operations, performance monitoring, closure plans, long-term impacts and monitoring, economic analysis. Course Information: Prerequisite(s): CME 315.

CME 518. Pollution Prevention Engineering. 4 hours.
Pollution prevention concepts, planning and economics. Improved manufacturing operations and life cycle assessment. Design for the environment, resource conservation and sustainable development. Course Information: Prerequisite(s): CME 216.

CME 519. Earthquake Resistant Design for Structural Steel Systems. 4 hours.
Design of steel of buildings for earthquake resistance. Topics include: behavior of various steel systems subjected to earthquake ground motion, seismic design of steel systems using the current codes, current research and innovative steel systems. Course Information: Prerequisite(s): CME 301; and CME 520; or CME 494 or authorized equivalent courses or consent of the instructor.

CME 520. Earthquake Engineering of Concrete Structures. 4 hours.
Earthquake phenomena; response spectrum and design spectrum concepts; dynamic response of structures to earthquakes, methods of analysis; code approach to earthquake resistant design; alternative approaches. Course Information: Prerequisite(s): CME 310.

CME 521. Environmental Microbiology. 4 hours.
Microbial cell structure and function, applications of molecular biology in microbial ecology, biogeochemical cycles. Course Information: Prerequisite(s): Credit or concurrent registration in CME 422; or consent of the instructor. Recommended background: A basic understanding of biology.

CME 523. Environmental Organic Chemistry. 4 hours.
Properties and behavior of environmental organic pollutants. Theory and estimation techniques. Concepts of environmental fate assessment. Applications of fate models. Course Information: Same as EOHS 543. Prerequisite(s): EOHS 440 or CME 411.

CME 524. Water Chemistry. 4 hours.
Chemical equilibria and kinetic principles as applied to processes occurring in natural and engineered water systems. Course Information: Same as EOHS 542. Prerequisite(s): EOHS 440 or CME 411.

CME 525. Applied Environmental Biotechnology. 4 hours.
Advanced biological treatment processes for environmental restoration. Stoichiometry of biological reactions, kinetics, bioremediation, biochemical pathways for pollutant biodegradation, biological nutrient removal. Course Information: Prerequisite(s): Credit or concurrent registration in CME 521; or consent of the instructor.

CME 526. Air Quality Management II. 2 hours.
Air quality management: Integration of diverse aspects. Data interpretation; standards setting; policy implementation; equipment design; hazardous spill modeling; indoor air pollution; case studies. Course Information: Same as EOHS 532. Prerequisite(s): EOHS 431 or CME 419.

CME 528. Environ Fate & Trans Processes. 4 hours.
Understanding of the coupled physical transport and biogeochemical reactions of fluids, particles, chemicals, and biota in water, air, and soil environments relevant to environmental engineering and science applications. Course Information: Prerequisite(s): Graduate students in College of Engineering or the Graduate College or consent of instructor.

CME 530. Theory of Elasticity II. 4 hours.
Review of complex variable theory. Complex variable formulation of plane problems. Singularities and crack problems. Course Information: Prerequisite(s): CME 430.

CME 531. Nonlinear Continuum Mechanics. 4 hours.
Matrices and general tensors, isotropic tensor functions, representation theorem, kinematics, polar decompositions, Cauchy-Green tensors, Cauchy stress, Piola-Kirchoff stresses, constitutive laws, frame indifference, hyperelastic materials and universal solutions. Course Information: Prerequisite(s): CME 430 or CME 431.

CME 533. Fracture Mechanics and Failure Analysis II. 4 hours.
Thermodynamics of irreversible processes. Damage parameter. Eshelby tensor. Crack-damage interaction. Dynamic crack growth. Quasistatic crack propagation. Crack layer theory. Crack driving forces. Fractographic analysis. Course Information: Prerequisite(s): CME 433.

CME 534. Finite Element Analysis II. 4 hours.
Application of the finite element method to the analysis of complex continuum and structural linear systems. Introduction to error analysis and convergence of the finite element solutions. Course Information: Same as ME 534. Prerequisite(s): CME 434.

CME 535. Theory of Vibrations II. 4 hours.
Harmonic vibrations; vibrations of a string; vibrations of a beam; vibrations of a membrane; periodic systems; floquet waves; nonlinear vibrations. Course Information: Same as ME 535. Prerequisite(s): CME 435 or ME 408 or the equivalent.

CME 536. Nondestructive Testing of Concrete. 4 hours.
Strength and durability of concrete structures by nondestructive evaluation of the material through acoustic, magnetic, thermal, electrical, optical phenomena; nondestructive methodologies for evaluation of concrete structures. Course Information: Prerequisite(s): CME 310.

CME 537. Plasticity I. 4 hours.
Basic postulates of plasticity. Yield condition and associated flow rules. Isotropic and kinematic hardening rules. Bounding problems. Finite element applications. Slip line theory.

CME 539. Elastic Stability. 4 hours.
Elastic stability of columns, beams, and frames. Limitations of elastic theory, plastic buckling. Eigenproblems and their numerical solution. Elastic stability analysis by the finite element method. Course Information: Prerequisite(s): CME 432.

CME 540. Interdisciplinary Approaches to the Study of Integrated Human/Natural Landscapes. 3 hours.
Examination of ecological, biogeochemical and evolutionary principles; techniques and philosophies of ecological remediation, restoration and conservation; environmental regulation and policy; sustainability in theory and practice. Course Information: Same as EAES 540 and BIOS 540. Prerequisite(s): Consent of the instructor.

CME 541. Mechanics of Composite Materials. 4 hours.
Anisotropic elastic materials; stress analysis for isotropic materials; Stroh formalism for anisotropic materials; singularities at free-edges; stress analysis in composites; wave propagation in composites. Course Information: Prerequisite(s): CME 430 or equivalent.

CME 544. Structural Dynamics. 4 hours.
Formulation and solution methods for time dependent systems. Pertinent numerical techniques and their application to seismic analysis, blast loading and heat transfer problems. Course Information: Prerequisite(s): CME 434.

CME 546. Research Methods for Landscape Ecological and Anthropogenic Processes. 4 hours.
Students will develop the skills to choose and utilize relevant methods and tools used in the study and management of altered natural landscapes to achieve research and management objectives through hands-on interdisciplinary laboratory modules. Course Information: Same as BIOS 546 and EAES 546. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory/Discussion.

CME 547. Field Experiences in Landscape Ecological and Anthropogenic Processes. 4 hours.
Evaluation of the issues and needs of various landscape restorations and related urban-impacted sites in the Chicago metropolitan area based upon selected readings, site visits and presentations and discussions with the site manager/coordinators. Course Information: Same as BIOS 547 and EAES 547. Prerequisite(s): Consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture/Discussion and one practice.

CME 548. Capstone Project in Landscape, Ecological and Anthropogenic Processes. 4 hours.
Interdisciplinary capstone project course that explores a "real-world" environmental issue selected by the students and approved by the faculty. Students will conduct research and analysis collaboratively and develop solutions and recommendations. Course Information: Same as BIOS 548 and EAES 548. Prerequisite(s): Grade of B or better in BIOS 540 or Grade of B or better in CME 540 or Grade of B or better in EAES 540 or Grade of B or better in UPP 555; and Grade of B or better in BIOS 546 or Grade of B or better in CME 546 or Grade of B or better in EAES 546 or Grade of B or better in UPP 555; and Grade of B or better in BIOS 547 or Grade of B or better in CME 547 or Grade of B or better in EAES 547 or Grade of B or better in UPP 555. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Studio.

CME 549. Subsurface Flow and Contaminant Transport Modeling. 4 hours.
Definitions, basic principles, fluid flow in vadose zone, groundwater flow, contaminant transport in vadose zone, contaminant transport in groundwater, numerical models and field implementation, case studies. Course Information: Prerequisite(s): CME 415 or consent of the instructor.

CME 550. Dynamics of Floating Offshore Structures. 4 hours.
Covers environmental loads and dynamics of floating structures in fluid. Course Information: Same as ME 550. Prerequisite(s): ME 210 and CME 211 and ME 211 and MATH 220; or consent of the instructor.

CME 554. Nonlinear Finite Element Analysis. 4 hours.
Nonlinear elastostatics, consistent linearization, Newton and modified-Newton methods, line search techniques, arc-length methods. Hyperelasticity, B-bar type methods. Finite deformation elastodynamics, semi-discretization, time-stepping algorithms. Course Information: Prerequisite(s): CME 531 and CME 534; or consent of the instructor.

CME 567. Principles of Computational Transportation Science. 4 hours.
Builds on the fundamentals of transportation science and emphasizes its high-level computational aspects. Topics covered include database design and theory, spatial and temporal information systems issues and travel modeling. Course Information: Same as CS 567 and UPP 567. Prerequisite(s): Grade of B or better or concurrent registration in UPP 560. Open only to Ph.D. students; or consent of the instructor.

CME 568. Kinetics of Reactions and Phase Transformations in Metals. 4 hours.
Nucleation and growth kinetics, order of transformation, grain growth recovery, recrystallization, solidification, phase transformation in solids, precipitation hardening, spinodal decomposition and martensitic transformations. Course Information: Prerequisite(s): Consent of the instructor.

CME 570. Diffusion Phenomena in Materials. 4 hours.
Diffusion mechanisms in crystals; Kirkendall effect; diffusion in ionic solids; diffusion in gases and liquids; diffusion through porous media; kinetics of diffusion controlled processes.

CME 572. Advanced Thermodynamics of Materials. 4 hours.
Treatment of multicomponent system thermodynamics with emphasis on metallurgical process applications. Development of relation between structure of metallic solutions, molten salts, and quasi-chemical models.

CME 575. Molecular Mechanics of Nanomaterials. 4 hours.
Molecular forces and interactions in nanomaterials, surface driven phenomena, superelasticity. Quantitative methods of molecular statics and dynamics, transition-state theory, and Monte-Carlo methods. Course Information: Prerequisite(s): Consent of the instructor. Recommended background: PHYS 245.

CME 580. Infrastructure Management. 4 hours.
Integrated approach to the management of infrastructure systems: design, construction, operations, maintenance and rehabilitation of facilities. Performance of facilities, approaches to management, and available tools and developing technologies. Course Information: Same as UPP 569. Prerequisite(s): IE 201 or the equivalent or consent of instructor. Recommended background: Familiarity with computer spreadsheets.

CME 581. Vadose Zone Hydrology. 4 hours.
Soil physics and biochemical processes. Flow and contaminants transport in Vadose Zone. Theory of Soil Water Movement. Course Information: Prerequisite(s): CME 311; and graduate standing; or consent of the instructor.

CME 582. Lake and Watershed Management. 4 hours.
Lake and watershed processes influencing water quality, diffuse pollution, integrated management and sustainable development of Lotic and Lentic water resources, watershed restoration. Course Information: Prerequisite(s): CME 311; and graduate or professional standing; or consent of the instructor.

CME 594. Advanced Special Topics in Civil Engineering, Mechanics and Materials. 1-4 hours.
Subject matter varies from section to section and from semester to semester, depending on the specialities of the instructor. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Graduate standing and consent of the instructor.

CME 596. Independent Study. 1-4 hours.
Special problems of reading by special arrangement with a faculty member. Course Information: Prerequisite(s): Consent of the instructor.

CME 598. Master's Thesis Research. 0-16 hours.
M.S. thesis work under the supervision of a faculty member. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term.

CME 599. Ph.D. Thesis Research. 0-16 hours.
Ph.D. thesis work under the supervision of an advisor. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term.