

Biosystems Engineering—BE

419 Applications of Geographic Information Systems to Natural Resources Management

Spring. 4(2-4) Interdepartmental with Fisheries and Wildlife; Forestry; Geography; Park, Recreation and Tourism Resources; Resource Development. Administered by Department of Fisheries and Wildlife. RB: (GEO 221)

The application of geographic information systems, remote sensing, and global positioning systems to integrated planning and management for fish, wildlife, and related resources.

430 Power and Control Hydraulics

Fall. 3(2-2) P: (CE 321 or CHE 311 or ME 332) SA: AE 430

Hydraulic fluid properties. Pump and motor performance parameters. Control valves and hydraulic circuitry components. Analysis and design of hydraulic systems.

431 Bio-resource Optimization

Fall. 3(2-2) P: (BE 230) and (MTH 235 or MTH 255H or LBS 220) Not open to students with credit in BE 831.

Optimal engineering solutions to problems with conflicting objectives and biological constraints. Linear and goal programming, problem formulation, project management, risk and uncertainty.

438 Design of Machinery Structures

Fall. 3(3-0) P: (BE 331 or concurrently) SA: AE 438 Not open to students with credit in ME 471.

Design of structural components and systems in machines. Tension, compression, torsion, bending and combined loadings. Joint connections.

443 Restoration Ecology

Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife; Zoology. Administered by Department of Fisheries and Wildlife. RB: (CSS 210 or BE 230) and (FOR 404 or FW 364 or ZOL 355)

Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.

452 Watershed Concepts

Fall, Spring, Summer. 3(3-0) Interdepartmental with Resource Development; Crop and Soil Sciences; Forestry; Fisheries and Wildlife. Administered by Department of Community, Agriculture, Recreation and Resource Studies. P: (RD 324 and ZOL 355) RB: organic chemistry

Watershed hydrology and management. The hydrologic cycle, water quality, aquatic ecosystems and social systems. Laws and institutions for managing water resources.

456 Electric Power and Control

Spring. 3(2-2) P: (ECE 201 or ECE 345) SA: AE 356

Alternating current circuits, power distribution, electrical machines, protection, and programmable motor controllers. Design project related to food and agricultural industries.

460 Natural Resource Economics

Spring. 3(3-0) Interdepartmental with Resource Development; Environmental Economics and Policy; Park, Recreation and Tourism Resources. Administered by Department of Community, Agriculture, Recreation and Resource Studies. P: (EC 201) and (RD 302 or EEP 255)

Economic framework for analyzing natural resource management decisions. Spatial and inter-temporal allocation of renewable and nonrenewable resources. Special emphasis on institutions, externalities, and public interests in resource management.

477 Food Engineering: Fluids

Fall. 3(2-2) Interdepartmental with Food Science. P: (BE 350 and BE 351) RB: (CE321 or CHE311 or ME332) SA: FE 465

Unit operations, process engineering, equipment, and industrial practices of the food industry. Manufactured dairy products: thermal processing, pipeline design, heat exchange, evaporation, dehydration, aseptic processing, membrane separation, cleaning, and sanitation.

478 Food Engineering: Solids

Spring. 3(2-2) P: (BE 350) and (BE 351)

Analysis and design of unit operations and complete systems for handling, processing, and manufacturing bulk, granular, and solid food products. Material variability and microbial, chemical, and physical hazards.

481 Land and Water Conservation Engineering

Fall. 3(2-2) P: (CSE 131) and (CE 321 or CHE 311) SA: AE 481

Hydrology of small watersheds. Flood routing. Quantifying runoff, infiltration, evapotranspiration. Drainage design Global Positioning Systems. Geographic Information Systems and applications in engineering projects. Irrigation efficiency.

482 Non-point source pollution control

Spring. 3(2-2) P: (BE 481 or CE 421)

Identification, estimation, and control of non-point source pollution from agricultural and urban sources. Geographic Information Systems (GIS) based computer models of watersheds. Engineering design of practices and structures to control non-point source pollution. Development of watershed management plans.

485 Biosystems Design Techniques

Fall. 2(1-2) P: (BE 130 and BE 333) and (BE 331 or BE 350 or BE 351) and (BE 431 or concurrently) Not open to students with credit in BE 486.

Engineering design process. Problem identification, analysis, design, modeling, materials, cost estimation, final specifications. Safety, environmental and ethical considerations.

486 Biosystems Design Fundamentals

Fall. 3(3-0) P: (BE 230 and BE 350) SA: AE 486

Concepts, methods, and procedures of the total design process from problem identification to final specifications.

487 Biosystems Design Project (W)

Spring. 3(0-6) P: (BE 485) and completion of Tier I writing requirement. R: Open only to seniors in the College of Engineering. SA: AE 488

Individual or team design project selected in BE 486. Information expansion, development of alternatives, and evaluation, selection, and completion of a design project.

490 Independent Study

Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. P: (BE 230 or BE 350) R: Approval of department; application required. SA: AE 490

Supervised individual student research and study in biosystems engineering.

491 Special Topics in Biosystems Engineering

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P: (BE 230 or BE 331 or BE 350) R: Approval of department. SA: AE 491

Special topics in biosystems engineering.

BUILDING CONSTRUCTION MANAGEMENT BCM

Department of Biosystems and Agricultural Engineering College of Agriculture and Natural Resources

101 Principles of Building Construction Management

Fall, Summer. 2(2-0) R: Not open to seniors.

Historical developments, current issues and trends in commercial and residential construction industries.

124 Residential Construction Materials and Methods

Spring, Summer. 3(3-0) RB: (BCM 101) SA: BCM 126

Properties of construction materials and their application in residential construction.

210 Commercial Construction Methods

Fall. 3(3-0) P: (BCM 101 or concurrently and BCM 124) C: BCM 211 concurrently.

Commercial construction: principles, materials, assemblies and commercial blueprints.

211 Building Codes

Fall. 3(3-0) P: (BCM 101 or concurrently and BCM 124) SA: BCM 227 C: BCM 210 concurrently.

Construction codes: structural, mechanical, electrical and plumbing. Building safety and accessibility.

222 Statics and Strengths of Materials

Spring. 3(3-0) P: (BCM 210 and BCM 211) and (MTH 124 or MTH 132 or LBS 118) and (PHY 183 or PHY 231 or PHY 231B or PHY 231C) Not open to students with credit in ME 221 or ME 222.

Equilibrium of forces. Free body diagrams. Force components. Bending moments. Stress and strain. Mechanical properties of materials. Beams and trusses. Computer applications. Indeterminate structures.

- 230 Utility Systems**
 Spring. 4(4-0) P: (BCM 210 and BCM 211)
 Heating, cooling, ventilating, electrical, gas, lighting, water, waste water, telecommunications, fire protection, safety security and sound control systems in residential and commercial construction. Applicable codes.
- 305 Site Construction and Measurement**
 Fall. 3(2-2) P: (BCM 230) R: Open only to juniors or seniors in the Building Construction Management major.
 Site construction methods, materials and equipment for buildings, soil, foundation, erosion and storm water. Layout, leveling, surveying and underground utilities.
- 315 Construction Quantity Surveying**
 Spring. 3(2-2) P: (BCM 305) and (CSE 101 or CSE 131 or CSE 231 or CSS 110 or LBS 126) R: Open only to juniors and seniors in the Building Construction Management and Civil Engineering major. SA: BCM 324
 Measurement of quantities for construction projects. Work breakdown structure. Industry standards.
- 322 Structural Systems**
 Fall. 3(3-0) P: (BCM 222) or (ME 221 or ME 222) R: Open only to juniors or seniors in the Building Construction Management and Civil Engineering majors. Not open to students with credit in CE 406.
 Structural design using wood, steel and concrete. Beams, columns, footings, and foundation walls. Loading, soils.
- 325 Real Estate Principles and Construction Finance**
 Fall. 4(4-0) P: (EC 201 or EC 202 or EC 251H or EC 252H) and (MTH 124 or MTH 132 or LBS 118) R: Open only to juniors or seniors in the Building Construction Management major or approval of department.
 Financial methods and instruments utilized in construction, rehabilitation, development, and purchase of real estate. Terms, contracts, valuation, brokerage, taxation, risk, and interest rate analysis.
- 328 Construction Presentation Graphics**
 Fall, Spring. 2(1-2) P: (BCM 230) and (CSE 101 or CSE 131 or CSE 231 or CSS 110 or LBS 126) R: Open only to juniors or seniors in the Building Construction Management major.
 Graphic communication methods used in construction organizations.
- 353 Land Development**
 Spring. 3(3-0) P: (BCM 211 and BCM 305) and (BCM 325 or UP 458) R: Open only to juniors or seniors in the Building Construction Management or Civil Engineering or Landscape Architecture or Urban and Regional Planning major. SA: BCM 352, BCM 403
 Methods and practices of land development. Market research. Financial feasibility. Land use regulations. Legal documentation. Site analysis and design. Case studies.
- 385 Construction Documents and Contracts (W)**
 Spring. 3(3-0) P: (BCM 305) Completion of Tier I writing requirement. R: Open only to juniors and seniors in Building Construction Management, Civil Engineering and Landscape Architecture. SA: BCM 422
 Construction contracts for commercial and residential projects. Contract procedures, bidding, changes, substitutions. Specifications. Insurance, bonding, claims, disputes, and payments. Responsibilities of owners and contractors.
- 401 Construction Safety Management**
 Spring. 3(3-0) P: (BCM 305) RB: (BCM 385 or BCM 423 or concurrently) R: Open only to juniors or seniors in the Building Construction Management or Civil Engineering major.
 Construction safety with Occupational Safety and Health Administration (OSHA) emphasis. General safety and health provisions, records, and safety management programs. Personnel protection and life saving equipment. Economic impact of safety program.
- 411 Construction Project Scheduling**
 Fall. 3(2-2) P: (STT 200 or STT 201 or STT 315 or STT 421) and (BCM 315 and BCM 322) R: Open only to juniors or seniors in the Building Construction Management or Civil Engineering major. SA: BCM 311
 Basic construction project scheduling procedures. Work breakdown structure, critical path method and scheduling logic. Activity durations, status reports, resource allocation and control.
- 415 Cost Estimating and Analysis**
 Fall. 3(2-2) P: (BCM 315 and BCM 385) SA: BCM 324
 Estimation of construction project costs: direct and indirect, labor, material, and equipment. Overhead and profit. Bidding. Computer-based estimating.
- 423 Construction Project Management**
 Fall, Spring. 3(3-0) P: (BCM 385 and BCM 411 or concurrently and BCM 415 or concurrently) R: Open only to seniors in the Building Construction Management or Civil Engineering major.
 Construction management principles and practices. Project planning and controls.
- 435 Residential Building Projects (W)**
 Spring. 3(1-4) P: (ACC 201 and ACC 202) or (ACC 230) and (BCM 328 and BCM 353 and BCM 423 or concurrently) and completion of Tier I writing requirement. R: Open only to seniors in the Building Construction Management major.
 Development of a residential project and business plan.
- 436 Commercial Building Projects (W)**
 Spring. 3(1-4) P: (ACC 201 and ACC 202) or (ACC 230) and (BCM 328 and BCM 353 and BCM 423 or concurrently) and completion of Tier I writing requirement. R: Open only to seniors in the Building Construction Management major.
 Evaluation, procurement and management of commercial building projects.
- 490 Independent Study**
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to Building Construction Management majors. Approval of department; application required.
 Special problems in acquisition and development of residential land, design, construction technology, building materials, finance, marketing, construction management, or land use codes and regulations.
- 491 Special Topics in Building Construction Management**
 Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P: (BCM 210) R: Open only to Building Construction Management majors. Approval of department.
 Topics such as computer methods in building construction management, construction technology, solar energy, special land use codes or new technology management.
- 493 Professional Internship in Building Construction Management.**
 Fall, Spring, Summer. 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in Building Construction Management. Approval of department; application required. A student may earn a maximum of 6 credits in all enrollments for any or all of these courses: ABM 493, AEE 493, ANR 493, ANS 493, BCM 493, CSS 493, EEP 493, FIM 493, FSC 493, FW 493, HRT 493, PKG 493, PLP 493, PRR 493, and RD 493.
 Supervised professional experiences in agencies and businesses related to a student's major field of study.
- 810 Construction Systems**
 Fall, Spring. 1(0-2) R: Open only to graduate students in Building Construction Management, Civil Engineering, and Interior Design and Facilities Management majors. Not open to students with credit in BCM 124 or BCM 210.
 Construction materials and methods in the U.S. Steel and wood construction.
- 811 Advanced Project Scheduling**
 Fall. 3(2-2)
 Critical path analysis for effective and logical scheduling of construction projects. Identification of project activities and their relationships. Schedule development, analysis, and updating. Relationship of project costs and resources to the schedule. Effective communication of schedule information.
- 817 Construction Management Information Systems**
 Spring. 3(2-2) R: Open only to graduate students in Building Construction Management, Civil Engineering, and Interior Design and Facilities Management majors.
 Information generation and utilization for the management of construction projects. Integration of construction management software, conceptual modeling and knowledge-based models.
- 822 Legal Issues in Construction**
 Spring. 3(3-0) RB: A degree or experience in construction management, civil engineering, human environment and design, interior design, architecture, urban planning, landscape architecture or law.
 Application of Michigan and Federal case law to construction and development claims and litigation.

Building Construction Management—BCM

- 823 Advanced Construction Project Management**
Fall, Spring. 3(3-0) RB: (BCM 411 and BCM 415) R: Open only to graduate students in Building Construction Management.

Project management issues, services and documentation. Bidding, cost accounting, scheduling. Project planning and controlling.

- 890 Special Problems**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department; application required.

Individual study in land acquisition and development, design, construction, management, finance, marketing, and structural analysis.

- 891 Advanced Topics in Building Construction Management**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to graduate students in College of Agriculture and Natural Resources. Approval of department.

Advanced topics in building construction management.

- 892 Construction Management Research Seminar**
Fall. 2(2-0) R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering, or College of Human Ecology.

Current areas and topics of research in construction management. Resources of research results, analysis of existing research and development of preliminary proposal.

- 898 Master's Research**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to master's students in the Building Construction Management major.
Master's degree research paper.

- 899 Master's Thesis Research**
Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to master's students in Building Construction Management.
Master's thesis research.

CELL AND MOLECULAR BIOLOGY CMB

College of Natural Science

- 800 Cell and Molecular Biology Seminar**
Fall, Spring. 1(1-0) A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.

Current literature in such areas of cell and molecular biology as gene expression, intracellular transport, cell signalling, regulation of cell growth and cell structure.

- 880 Laboratory Rotation**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.

Participation in research projects in laboratories of Cell and Molecular Biology faculty.

- 890 Independent Study**
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 8 credits in all enrollments for this course.
Non-thesis research for Plan B master's students.

- 892 Research Forum**
Fall. 1(1-0) A student may earn a maximum of 4 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.

Advanced graduate students present their laboratory research.

- 899 Master's Thesis Research**
Fall, Spring, Summer. 1 to 9 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Master's thesis research.

- 999 Doctoral Dissertation Research**
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to students in the Cell and Molecular Biology major.
Doctoral dissertation research.

CHEMICAL ENGINEERING CHE

Department of Chemical Engineering and Materials Science College of Engineering

- 201 Material and Energy Balances**
Fall, Spring. 3(4-0) P: (MTH 133) and (CEM 142 or CEM 143 or CEM 152) and (CSE 101 or concurrently or CSE 131 or concurrently)

Chemical engineering calculations. Synthesis of chemical process systems. Analysis of chemical processes using material and energy balances. Enthalpy calculations for changes in temperature, phase transitions, and chemical reactions.

- 301 Chemical Engineering as a Profession**
Fall. 1(2-0) P: (CHE 201 or concurrently) RB: Junior standing in chemical engineering R: Open only to students in the Chemical Engineering major.

Professional aspects of chemical engineering. Communication skills, professionalism and ethics, teamwork skills, contemporary engineering issues, career planning, project management, industrial processes.

- 311 Fluid Flow and Heat Transfer**
Fall. 4(5-0) P: (CHE 201 or concurrently and MTH 235 or concurrently) R: Open only to students in the College of Engineering.

Thermodynamics of fluid flow. Laminar and turbulent flow. Design of flow systems. Heat transfer in solids and flowing fluids. Interphase heat transfer. Radiant heat transfer. Multiple effect evaporation. Design of heat exchange equipment.

- 312 Mass Transfer and Separations**
Spring. 4(5-0) P: (CHE 201 and MTH 235 or concurrently) R: Open only to students in the College of Engineering.

Diffusion. Mass transfer coefficients. Design of countercurrent separation systems, both stagewise and continuous. Distillation, absorption, extraction. Multicomponent separations. Batch processes. Computer-aided design methods.

- 316 Unit Operations Laboratory**
Spring. 3(1-6) P: (CHE 311 and CHE 312 or concurrently and CHE 321 or concurrently and CHE 431 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering.

Momentum, heat, and mass transfer. Separation processes: distillation, filtration, and drying. Reactor kinetics. Automatic process control. Laboratory problems requiring team effort.

- 321 Thermodynamics for Chemical Engineering**
Spring. 4(5-0) P: (CHE 201)
First and second laws. Thermodynamics of flow and energy conversion processes. Properties of single and multi-component systems. Phase equilibria. Chemical equilibria in reacting systems.

- 422 Transport Phenomena**
Spring. 3(3-0) P: (CHE 311 and CHE 312)
Mathematical and physical analogies among mass, energy and momentum transfer processes. Dimensional analysis and solutions to multivariable boundary value problems. Numerical solutions to nonlinear problems.

- 431 Chemical Reaction Engineering**
Spring. 3(3-0) P: (CHE 311 and CHE 312 or concurrently and CHE 321 or concurrently) R: Open only to juniors or seniors in the Chemical Engineering major.

Design and analysis of homogeneous flow and batch reactors. Chemical kinetics and equilibria. Reaction rate expressions from mechanisms and experimental data. Mass and heat transfer in heterogeneous reactors. Heterogeneous reactor design. Catalysis.

- 432 Process Dynamics and Control**
Fall. 3(3-0) P: (CHE 431)
Mathematical modeling of process dynamics. Control theory. Design of control systems and specification of control hardware. Integration of control theory with modern practice.

- 433 Process Design and Optimization I**
Fall. 4(5-0) P: (CHE 432 or concurrently) and completion of Tier I writing requirement. R: Open only to students in the Department of Chemical Engineering.

Applications of chemical engineering principles in design calculations. Selection of optimum design. Influence of design on capital investment, operating cost, product loss and quality. Mathematical programming methods for optimization.

- 434 Process Design and Optimization II**
Spring. 2(0-4) P: (CHE 433)
Design project requiring an integrated design of chemical engineering processes. Process and project engineering. Instrumentation and control systems. Flowsheet layout and optimization. Process simulation.