

826. Tropical Biology: An Ecological Approach
Spring, Summer. 8 Credits. Interdepartmental with Zoology.
R: Approval of department; application required. Principles of tropical ecology at the population, community, and ecosystem levels. Given at various sites in Costa Rica by the organization for Tropical Studies. QA: BOT 826

827. Tropical Managed Ecosystems
Spring, Summer. 8(4-8)
R: Approval of department; application required. The scientific and social dimensions of sustainable development in the tropics. Given at various sites in Costa Rica by the organization for Tropical Studies.

830. Paleobotany
Fall of even-numbered years. 3(2-3) Interdepartmental with Geological Sciences.
R: Open only to graduate students. Approval of department.
Survey of fossil plants: preservation, occurrence, geological relations, taphonomy, whole plant reconstruction, evolutionary history, and paleoecology. QA: BOT 830, GLG 830

842. Application of Ecological Principles
Spring. 2 credits. Given only at W.K. Kellogg Biological Station. A student may earn a maximum of 8 credits in all enrollments for this course. Interdepartmental with Zoology.
R: Approval of department.
Workshops and discussions with experts from industry, regulatory agencies, conservation groups, and academe on application of basic ecology and evolutionary biology to real-world problems.

844. Organelle Genetics
Spring of even-numbered years. 3(3-0)
Interdepartmental with Zoology.
P: BCH 811 or BOT 856, ZOL 341.
organization, structure, function, heredity, molecular biology and manipulation of chloroplasts and mitochondria. Biological interaction between nucleus and organelles. QA: BOT 856, ZOL 441 QA: BOT 844

847. Advanced Mycology
Spring of even-numbered years. 5(2-6)
P: BOT 402.
Classification, morphology and relationships of fungi; physiology, genetics, and molecular biology of fungi; identification techniques within selected orders. QA: BOT 320 QA: BOT 847, BOT 848

849. Evolutionary Biology
Spring. 3(3-0) Interdepartmental with Zoology.
P: ZOL 341, STT 422 or concurrently. C: STT 422
Major conceptual, theoretical and empirical questions in evolutionary biology. Readings and lectures are synthesized in student discussions and on paper. QA: ZOL 441, STT 423

856. Plant Molecular Biology
Spring. 3(3-0) Interdepartmental with Biochemistry.
P: ZOL 341.
Recent advances in genetics and molecular biology of higher plants. QA: ZOL 441 QA: BOT 856

860. Ecology and Evolution in Terrestrial Systems
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Zoology, and Crop and Soil Sciences.
P: STT 422.
Field experimental and quantitative approaches to ecological and evolutionary mechanisms. QA: STT 423 QA: BOT 839

863. Environmental Plant Physiology
Spring of even-numbered years. 3(3-0)
Interdepartmental with Horticulture.
P: BOT 301 or BOT 414 or BOT 415.
Interaction of plant and environment. Photobiology, thermophysiology, and plant-water relations. QA: BOT 301, BOT 413, BOT 414, BOT 415 QA: BOT 863

865. Plant Growth and Development
Fall. 3(3-0)
P: BOT 415.
Physiology and biochemistry of growth and development as regulated by internal and external factors. Biosynthesis and action of plant hormones. Environmental factors: light and temperature. QA: BOT 415 QA: BOT 865

880. Plant Virology
Fall of odd-numbered years. 4(2-4)
P: BCH 462, BOT 810.
Biology and molecular aspects of viruses causing plant disease. QA: BOT 405, BCH 453 QA: BOT 880

881. Molecular and Biochemical Plant Pathology
Spring of even-numbered years. 3(2-2)
P: BCH 462, ZOL 341, BOT 810; BOT 414 or BOT 415.
Biochemical and molecular bases of host-pathogen interactions. Mechanisms of pathogenicity and the nature of disease resistance. QA: BCH 453, ZOL 441, BOT 415, BOT 405 QA: BOT 881

884. Prokaryotic Diseases of Plants
Fall of even-numbered years. 4(2-4)
P: BOT 810.
Description of prokaryotic genera associated with plant diseases, identification, physiology, and genetics. Laboratory techniques. QA: BOT 405 QA: BOT 884

885. Plant Diseases in the Field
Summer. 2(1-3)
P: BOT 810. R: Open only to graduate students.
Diagnosis of plant diseases and disorders in a field setting. Field trips and independent study are required. QA: BOT 405 QA: BOT 885

899. Masters Thesis Research
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 24 credits in all enrollments for this course.
R: Open only to graduate students.
Research in anatomy, bryology cell biology, ecology, genetics, molecular biology, morphology, mycology, paleobotany, pathology, physiology and systematics. QA: BOT 899

999. Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to doctoral students.
Research in anatomy, bryology cell biology, ecology, genetics, molecular biology, morphology, mycology, paleobotany, pathology, physiology and systematics. QA: BOT 999

BUILDING CONSTRUCTION MANAGEMENT BCM

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

126. Residential Construction Materials, Methods and Drafting
Fall, Spring, Summer. 5(3-4)
R: Open only to Building Construction Management students. Not open to students with credit in HED 150. Materials, methods, codes and drafting in residential construction. QA: BCM 214, BCM 215, BCM 415

227. Commercial Building Construction Methods
Fall, Spring. 3(3-0)
P: BCM 126. R: Open only to Building Construction Management students.
Methods, codes, and plans for constructing commercial buildings. Construction system details: site preparation, foundations, floors, framing systems, and roof systems. QA: BCM 215, BCM 214 QA: BCM 217

230. Utilities
Fall, Spring. 3(3-0)
P: BCM 227. R: Not open to freshmen. Open only to Building Construction Management students and Civil Engineering majors.
Heating, cooling, plumbing and electrical utilities in residential and light commercial construction utilizing applicable codes. QA: BCM 216, BCM 217 QA: BCM 412

250. Construction Mechanics and Equipment Management
Fall. 3(2-3)
R: Open only to Building Construction Management or Agricultural Technology and Systems Management students.
Principles, applications, techniques, tools, materials and resources in building construction mechanics and light construction equipment management. QA: BCM 201, BCM 327

252. Current Issues in the Building and Housing Industries
Fall. 3(3-0)
Impacts of government policies and regulations on the building and housing industries. Land use, construction technology, energy. Economics, demographics, and lifestyle choices. QA: BCM 200

311. Quantitative Methods in Technology Management
Fall, Spring. 3(3-0)
P: MTH 116 or MTH 120; CPS 100 or CPS 130 or CPS 131. R: Not open to freshmen and sophomores.
Technology management methods including linear programming, scheduling, decision theory, queuing and simulation. Applications in building construction management, agriculture and associated industries. QA: MTH 108, MTH 111, CPS 115, CPS 100 QA: ATM 311

322. Structural Design
Fall, Spring. 4(5-0)
P: BCM 227; PHY 231 or PHY 231B. R: Open only to Building Construction Management or Agricultural Technology and Systems Management majors.
Mechanics, material strengths and section properties developed and applied to structural design using wood, steel and concrete. Beams, columns, footings, and foundation walls. QA: BCM 215, PHY 237 QA: BCM 312, BCM 313

324. Construction Estimation
Fall, Spring. 4(3-2)
P: BCM 230, BCM 322. R: Open only to Building Construction Management or Civil Engineering majors.
Estimating construction projects: labor, material, overhead, and profit in unit and detailed formats. Job cost accounting and control. Estimation software. QA: BCM 217, BCM 412 QA: BCM 416

325. Construction and Real Estate Finance
Fall, Spring. 4(4-0)
P: EC 201 or EC 202; MTH 116 or MTH 120. R: Open only to Building Construction Management, Civil Engineering, and College of Business majors.
Financial methods and instruments utilized in construction, rehabilitation, development, and purchase of real estate. Terms, contracts, valuation, brokerage, taxation, risk, and interest rate analysis. QA: MTH 109, MTH 110, MTH 111, EC 201, EC 202 QA: BCM 417, FI 395

340. Residential Design Evaluation
Fall. 3(3-0)
P: BCM 126 or HED 160. R: Not open to freshmen and sophomores. Open only to Building Construction Management and Human Environment and Design majors.
Qualitative methods for evaluating residential building designs. Design impacts on building occupants: children, families, singles, handicappers, elderly. QA: BCM 215

Descriptions—Building Construction Management of Courses

349. Construction Renovation Spring, 3(3-0)

P: BCM 227. R: Open only to Building Construction Management or Human Environment and Design majors or to juniors and seniors in Historic Preservation Specializations.

Preservation, rehabilitation, remodeling and restoration of existing buildings. Analysis of building adaptability and design. Economic feasibility and codes. Historical and social considerations.

QP: BCM 217 QA: BCM 239, BCM 339

351. Concepts of Fire Safe Construction Fall, 3(3-0)

P: BCM 126. R: Open only to Building Construction Management majors.

Safety and fire integrity of structures: principles, terminology, and techniques of construction affecting life. Applicable codes. Materials and assemblies. Suppression and detection systems.

QP: BCM 215, BCM 217, BCM 412 QA: BCM 318, BCM 490

352. Land Development Spring, 3(3-0)

P: BCM 126; BCM 325 or concurrently. R: Open only to Building Construction Management, Civil Engineering, History of Art, Landscape Architecture, and Urban Planning majors.

Methods and practices of land development for residential and commercial uses. Market research. Land use regulations. Legal documentation. Site analysis and design. Case studies.

QP: BCM 215, BCM 417 QA: BCM 418, BCM 490

422. Construction Contracts Fall, Spring, 3(3-0)

P: BCM 227, BCM 311, BCM 324. R: Open only to seniors and graduate students in Building Construction Management and Civil Engineering.

Construction contracts for commercial and residential projects. Contract procedures, bidding, changes, substitutions. Insurance, bonding, claims, disputes, and payments. Specifications. Responsibilities of owner and contractors.

QP: ATM 311, BCM 217, BCM 416

423. Construction Project Management Fall, Spring, 3(3-0)

P: BCM 311, BCM 324. R: Open only to seniors and graduate students in Building Construction Management and Civil Engineering.

Construction management principles and practices. Site and project management.

QP: BCM 416, ATM 311 QA: BCM 420

452. Commercial Utility Systems Spring, 3(3-0)

P: BCM 230. R: Open only to Building Construction Management, Mechanical Engineering, Civil Engineering, and Human Environment and Design majors.

Primary electrical, heating, ventilating, air conditioning, plumbing, elevator, and fire detection and suppression systems for commercial buildings.

QP: BCM 412

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.

QA: BCM 418

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 227 or BCM 311. 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.

QP: BCM 215, ATM 311, BCM 217 QA: BCM 490

823. Advanced Construction Project Management

Spring of odd-numbered years. 3(3-0)

P: BCM 422, BCM 423; or CE 373, CE 471. R: Open only to graduate students in Building Construction Management or Civil Engineering.

Project management issues, services, documentation, risk assessment. Bidding, cost accounting, scheduling. Dispute resolution and liability case studies.

QP: BCM 420, CE 372, CE 471

890. Special Problems

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 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.

QA: BCM 880

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.

QA: BCM 890

892. Construction Management Seminar

Fall, 1(1-0)

R: Open only to graduate students in College of Agriculture and Natural Resources or College of Engineering.

Current topics and issues in construction management. Construction methods and materials and building design.

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 graduate students in Building Construction Management. Approval of department.

QA: BCM 899

CHEMICAL ENGINEERING

CHE

Department of Chemical Engineering College of Engineering

201. Material and Energy Balances

Fall, Spring, 3(4-0)

P: MTH 133, CEM 142 or CEM 152, CPS 131 or CPS 130 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.

QP: CPS 112, MTH 214, CEM 142 QA: CHE 300

311. Fluid Flow and Heat Transfer

Spring, 4(5-0)

P: CHE 201 or concurrently, MTH 235 or concurrently. R: Open only to College of Engineering students. Not open to students with credit in ME 201 or MSM 351.

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.

QP: CHE 300, MTH 310 QA: CHE 340, CHE 341

312. Mass Transfer and Separations

Fall, 4(5-0)

P: CHE 201 or concurrently, MTH 235 or concurrently. R: Open only to College of Engineering students.

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

QP: CHE 300, MTH 310 QA: CHE 342, CHE 343

316. Unit Operations Laboratory

Spring, 3(1-6)

P: CHE 311 or concurrently; CHE 312; CHE 321 or concurrently. R: Open only to Chemical Engineering and Food Engineering majors.

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

QP: CHE 451, CHE 428 QA: CHE 423

321. Thermodynamics for Chemical Engineering

Spring, 4(5-0)

P: CHE 201, CEM 361. R: Open only to College of Engineering students.

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.

QP: CHE 300, CEM 361 QA: CHE 311, CHE 411

371. Chemical Engineering Materials

Fall, 3(3-0)

P: CEM 352; CEM 361 or concurrently. R: Open only to Chemical Engineering majors.

Structure, properties, and performance of classes of materials emphasizing polymeric materials.

QP: CEM 353 QA: CHE 443, CHE 442

422. Transport Phenomena

Spring, 3(3-0)

P: CHE 311, CHE 312; or FE 485. R: Open only to Chemical Engineering and Food Engineering majors.

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.

QP: MTH 310, CHE 343

431. Chemical Reaction Engineering

Spring, 3(3-0)

P: CHE 311 or concurrently; CHE 312; CHE 321 or concurrently. R: Open only to Chemical Engineering majors.

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.

QP: CHE 343, CHE 411 QA: CHE 428

432. Process Dynamics and Control

Fall, 3(3-0)

P: CHE 431. R: Open only to Chemical Engineering majors.

Mathematical modeling of process dynamics. Control theory. Design of control systems and specification of control hardware. Integration of control theory with modern practice.

QP: CHE 428 QA: CHE 451

433. Process Design and Optimization I

Fall, 3(4-0)

P: CHE 431, CHE 432 or concurrently. R: Open only to Chemical Engineering majors.

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.

QP: CHE 428, CHE 451 QA: CHE 461

434. Process Design and Optimization II

Spring, 3(4-0)

P: CHE 433. R: Open only to Chemical Engineering majors.

Integrated design of chemical engineering processes. Process and project engineering. Instrumentation and control systems. Flowsheet layout and optimization. Process simulation.

QP: CHE 461 QA: CHE 462