The minor in Environmental and Ecological Engineering consists of six courses (17 or 18 credits), and is available to any student at Purdue who has met the co- and/or pre-requisites for courses in the EEE course sequence. The minor includes three required courses (eight credits), one selective (three or four credits) and two courses proposed by the student (six credits). The student proposed courses must be relevant to some aspect of EEE. A list of suggested student proposed courses is available included in Appendix A, and will also be available on the DEEE web site. However, students are not limited to courses on this list.

Once a student has proposed a sequence of courses for the EEE minor, this will be submitted to a curriculum committee, which will approve the sequence. When the student has successfully completed the sequence of courses (earning at least a 2.0 grade point average over the entire sequence), that student will be granted a minor in EEE.

<table>
<thead>
<tr>
<th>Course title</th>
<th>Course number</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Environmental Engineering and Science</td>
<td>CE 350</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Environmental Sustainability OR Soil and Water Resource Engineering</td>
<td>CE 355</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>ABE 325</td>
<td>4</td>
</tr>
<tr>
<td>Life Cycle Assessment: Principles and Applications</td>
<td>ME 597Z</td>
<td>3</td>
</tr>
<tr>
<td>Introduction to Ecology and Evolution</td>
<td>BIOL 286</td>
<td>2</td>
</tr>
<tr>
<td>Student proposed course-1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Student proposed course-2</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Depending on the course requirements of the student’s major, the number of additional credits to earn an EEE minor may be less than 17 or 18. For example, a course that is required for the student’s major may be chosen as a student proposed course, as long as that course clearly is related to environmental and ecological engineering topics.

It is anticipated that after Fall 2008, CE350 and CE 355 will be cross-listed with EEE350 and EEE 355, and that ME 597Z will be cross-listed with EEE 455. ABE 325 or CE 355 may be student proposed courses if they are not chosen as the selective course.
Appendix A: List of potential student proposed courses

College of Engineering

Aeronautics and Astronautics Engineering

AAE 333 Fluid Mechanics

Kinematics of fluids and conservation equations for mass, momentum, and energy. Viscous and inviscid incompressible flow. Lift and drag in subsonic flow. Introduction to compressibility and boundary layers. Potential flow.

Agricultural and Biological Engineering

ABE 325 Soil And Water Resource Engineering

Interrelationships of the plant-water-air-soil system; hydrologic processes; protection of surface and ground water quality; GIS targeting of soil and water protection measures; and design of subsurface and overland drainage systems, irrigation systems, and soil erosion control practices.

ABE 526 Watershed Systems Design

Hydrologic design of upland water management systems for erosion control, water utilization, and run-off control; spatial analysis using Geographic Information Systems (GIS); examination of economic factors; analysis and design of composite systems for agricultural watersheds.

ABE 527 Computer Models in Environmental and Natural Resources.

This course offers students in environmental and natural resources and related design skills. Current computer models utilized in industry for decision support will be studied and used to further enhance the understanding of the hydrological processes. Labs will be design-oriented using software tools and will build on local case studies.

ABE 560/BME521 Biosensors: Fundamentals and Applications

The course is intended to provide a broad introduction to the field of biosensors as well as an in depth and quantitative view of device design and performance analysis. The student should leave the course with a solid understanding of the current state of the art as well as a basic skill set for continuation into advanced biosensor work and design. Topics are selected to emphasize biomedical, bio-processing, environmental, food safety, and bio-security applications.
Minor in Environmental and Ecological Engineering
Minor Code = 281

**ABE 580 Process Engineering Of Renewal Resources**
Physical and chemical structure of biomass. Reaction kinetics of hydrolysis of hemicellulose and cellulose to fermentable sugars. Fundamentals of ethanol production by fermentation. Separation of fermentation products into pure components.

**ABE 591K Biomass Feedstock Systems Engineering**
Biomass Feedstock Systems Engineering provides a thorough understanding of biomass feedstock resources, characteristics, and their utilization. Technologies, economics and life cycle assessments for the sustainable production/collection, handling, transport and storage of biomass feedstock for fuels, energy, power and bio-based products are core topics of this course. The course is targeted to senior and graduate level students in fields of engineering and sciences with an interest in renewable resources, power and energy systems.

**ABE 591S Ecohydrology**
Ecohydrology links hydrological and ecological processes at various spatiotemporal scales and is considered to be one of the most exciting frontiers of future. Movement and storage of water are integral parts of landscape and ecosystem functioning. Hydrological processes in individual ecosystems and the role of water in linking the myriad components of the landscape will be explored in this three-credit hour course. Interactions between hydrological and biological processes and factors that regulate and shape these interactions will be covered. The ecohydrology principles covered will include integration of water and biota at a catchment scale, evolutionarily established resilience and resistance of ecosystems to stress, and how ecosystem properties can be used as a management tool for biodiversity, water quality, and water quantity improvement.

**Civil Engineering**

**CE 352 Biological Principles Of Environmental Engineering**
Description: Introduction and application of environmental microbiological concepts to the solution of problems of water pollution and its control. Pre/Corequisites: CHM 257; Prerequisite: completion of freshman engineering requirements. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 353 Physico-Chemical Principles of Environmental Engineering**
This course presents basic physico-chemical aspects of air, water, and wastewater pollution, and pollution control methods. Topics covered in the course include acid/base chemistry, solubility, colloidal chemistry, sorption processes, and oxidation-reduction. Selected physico-chemical processes and analytical procedures are discussed, demonstrated, and applied in the laboratory. Pre/Corequisites: completion of freshman
Minor in Environmental and Ecological Engineering
Minor Code = 281

engineering requirements. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 355 Engineering Environmental Sustainability**
*(may count as student proposed course ONLY if ABE 325 is chosen as the selective)*

An introduction to the examination of global-scale resource utilization, food, energy and commodity production, population dynamics, and their ecosystem impacts.

**CE 456 or 597 Water and Wastewater Treatment**

Fundamental concepts and design procedures for the treatment of municipal and industrial wastewaters. Problem assessment; determination of effluent quality, preliminary treatment; biological, physical, and chemical treatment methods; and utilization and disposal of residues. Field trips required. Pre/Corequisites: C E 352, C E 353. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 457 Air Pollution Control And Design**

Fundamental concepts and design procedures for the removal of particulates, gases, and toxic air pollutants from waste gas streams. Problem assessment; characterization of exhaust gas streams; fan characteristics. Pre/Corequisites: C E 340. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 340 Hydraulics**

Fluid properties; hydrostatics; kinematics and dynamics of fluid flows; conservation of mass, energy, and momentum; flows in pipes and open channels. Formal laboratory experiments. Pre/Corequisites: CE 298. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 440 Urban Hydraulics**

Sources and distribution of water in urban environment, including surface reservoir requirements, utilization of groundwater, and distribution systems. Analysis of sewer systems and drainage courses for the disposal of both wastewater and storm water. Pumps and lift stations. Urban planning and storm drainage practice. Pre/Corequisites: CE 340. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**CE 443 Introductory Environmental Fluid Mechanics**

Differential equations for environmental fluid flows, including effects of variable density and rotation. Ideal fluid flow; boundary layer approximation; turbulence; water waves.
Minor in Environmental and Ecological Engineering
Minor Code = 281

Pre/Corequisites: C E 340, MA 262. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**Chemical Engineering**

**ChE 330 Principles of Molecular Engineering.**

Application of concepts of atomic and molecular bonding, solid microstructure, phase equilibria, and rate processes to the design of solid materials for specific engineering objectives. Pre/Corequisites: CHE 205, 211. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ChE 348 Chemical Reaction Engineering**

Application of kinetic rate equations, mass balances and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts and non-ideal mixing in continuous flow reactors. Pre/Corequisites: Prerequisite: CHE 211, MA 261. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ChE 377: Momentum Transfer**


**ChE 456 Process Dynamics and Control**

Dynamic response and control of chemical processing equipment, such as heat exchangers, chemical reactors, and absorption towers. Use is made of fundamental techniques of servomechanism theory, such as block diagrams, transfer functions, and frequency response. Introduction to advanced control techniques. Pre/Corequisites: CHE 377; Corequisite: CHE 348, CHE 378. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ChE 536 Particulate Systems**

A broad overview of the fundamental concepts in particulate systems including particle characterization, particle size measurement, sedimentation, fluidization, gas and liquid conveying, particle storage, fluid-particle separation, particle size enlargement and reduction, particle mixing and hazards associated with the handling of particulate solids.
Minor in Environmental and Ecological Engineering
Minor Code = 281

Practical applications are emphasized, with a focus on how particles behave differently than fluids. Pre-requisite: ChE 377.

**CHE 597F - Advanced Solar Energy Conversion**

The course will focus on: (1) the fundamentals of solar energy conversion, primarily with photovoltaics, (2) critical analysis of the state-of-the-art, and (3) the methods to develop the next generation of solar energy converters. Specific topics will include: Analysis of the solar spectrum, methods of solar energy utilization, thermodynamic analysis, electronic structure of materials, electronic transport, electron-hole generation, recombination, semiconductor junctions, device structure, minority carrier based devices, excitonic based devices, light management, economic analysis, experimental methods, state-of-the-art of silicon, thin film, and III-V technologies, next generation technologies.

**Industrial Engineering**

**IE 484: Integration of environmental considerations into facilities planning**

Extensions of topics on the design and operational control of integrated production systems. Includes production databases, facility layout, material handling, advanced control and scheduling, and physical distribution. Case studies, lab assignments, and projects. Pre/Corequisites: IE 383. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**Mechanical Engineering**

**ME 309: Fluid Mechanics**
Continuum, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Euler and Bernoulli equations, viscous flows, boundary layers, flow in channels and around submerged bodies, one-dimensional gas dynamics, turbomachinery. Prerequisite: ME 263.

**ME 413 Noise Control**

Psychoacoustics and theories of hearing. Environmental and building acoustics. Measurement methods and common instrumentation. Noise control methods. Machinery noise. Community reaction. Legal aspects. Design-oriented semester project. Course work in Physics, General; Course work in differential equations. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ME 418 Engineering Of Environmental Systems And Equipment**

Design and analysis of systems and equipment used in conditioning buildings. Review of fundamentals in thermodynamics, heat transfer, fluid mechanics, economics, non-linear equation solving, optimization. Analysis of building heating and cooling requirements for design and annual energy use. Design and selection of equipment. Pre/Corequisites: ME
Minor in Environmental and Ecological Engineering
Minor Code = 281

300, ME 315. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ME 525 Combustion**

Physical and chemical aspects of basic combustion phenomena. Chemical energetics and equilibrium. Basic chemical kinetics, chain reactions, and explosions. Chain and thermal ignition. Homogeneous combustion models. Detonations and deflagrations. Laminar flame speed and flame extinction. The Shvab-Zeldovich formulation of the multicomponent conservation equations. Diffusion flames and droplet combustion. Introduction to turbulent combustion. First Semester Senior Standing or higher. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**ME 597W Wind Energy and Turbines**


**Materials Engineering**

**MSE 597E (ECE595G) Materials and Devices for Solid-State Energy Conversion**

Principles of solid-state conversion of energy between electrical and light (photovoltaics, thermophotovoltaics and solid-state lighting based on light-emitting diodes), thermal and electrical (thermoelectric and solid-state thermionic), magnetic and acoustic (magnetostrictive) and electrical and acoustic (piezoelectric and electrostrictive); irreversible thermodynamics and efficiency limits, materials figures-of-merit, fundamentals of semiconductor device physics, device design issues; challenges in materials engineering (role of defects, dopants, contacts, bandgap engineering, and methods of materials synthesis); potential advantages of nanocomposites; prospects for technology replacement; societal impact assessment. Prerequisite: MSE 370 or EE 305.

**Nuclear Engineering**

**NE 300 Nuclear Structure And Radiation Interactions**

Review of atomic properties and introduction to nuclear models. Discussion of radioactive decay and the interaction of nuclear radiation and reaction products with matter. Energetics and cross-sections of nuclear reactions with applications to problems typical of nuclear engineering. Pre/Corequisites: Prerequisite: MA 261. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**NE 402 Engineering Of Nuclear Power Systems**
Minor in Environmental and Ecological Engineering
Minor Code = 281

Principles and practice of power plant systems with design applications; thermal cycles, heat transport, mechanical designs, control, safety analysis, shielding analysis, fuel cycles; resources, optimization, options, waste management. Fusion and alternate energy sources. Pre/Corequisites: Prerequisite: ME 315 or NUCL 351. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

NE 503 Radioactive Waste Management

Will familiarize students with the nature of the risks associated with radioactive waste and the history, regulations, and worldwide status for the safe storage of various types of radioactive waste. The sources, characteristics, and magnitudes of radioactive wastes are described, and the current and proposed engineered waste management systems are examined along with the analysis of their associated risks. Pre/Corequisites: Prerequisite: CHM 102; NUCL 200 or 211. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.
Minor in Environmental and Ecological Engineering  
Minor Code = 281

Agronomy

AGRY 540 Soil Chemistry

Emphasis on processes controlling the gaseous, solution, and solid phases in soils including precipitation, acid-base, oxidation-reduction, complexation, absorption, and ion exchange. Pre/Corequisites: Prerequisite: AGRY 365. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

AGRY 544 Environmental Organic Chemistry

The fundamental properties and processes responsible for the fate of organic chemicals in the environment, with emphasis on soil and water chemistry. Areas to be addressed will include both conceptual and theoretical aspects of processes relevant to environmental fate of contaminants; measurement, estimation, correlation, and application of the parameters most commonly used to assess various chemodynamic properties in soil-water systems. Prerequisite: AGRY 255, CHM 257. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

AGRY 545 Remote Sensing of Land Resources

Application of remote sensing and spatial databases for observing and managing land resources within the Earth System; analysis and interpretation of remotely sensed data in combination with field observations and other data sources; conceptualization and design of a global earth resources information system. Prerequisite: AGRY 270; or Prerequisite: AGRY 105, AGRY 255. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

AGRY 560 Physical Properties of Soils

Fundamentals of soil physics; transport of chemicals, heat, and gases; field spatial variability; principles and methods of physical analysis of soils; the influence of soil physical processes on environmental quality and agricultural production. Prerequisite: AGRY 255 or AGRY 270, introductory physics. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

AGRY 580 Soil Microbiology

The soil microbial population and its role in the soil ecosystem; microbial transformations of inorganic and organic compounds; decomposition of residues; and dynamics of soil organic matter. Prerequisite: AGRY 255, BCHM 307, BIOL 221. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.
Minor in Environmental and Ecological Engineering
Minor Code = 281

**AGRY 582 Environmental fate of Pesticides**

Emphasis is given to developing a fundamental understanding of the processes controlling the fate of organic chemicals, such as pesticides, in the environment. Processes considered include: volatilization, degradation, leaching, and sorption.

**Molecular Pharmacology**

**MCMP 560 Toxicology**

(HSCI 560) Introduction to general principles of toxicology, target organ toxicity, and safety evaluation. Covers toxicity of metals, solvents, pesticides, gases, dusts, and food additives. Prerequisite: BIOL 301, 302, CHM 333. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**Earth and Atmospheric Sciences**

**EAS 519 Applications of Environmental Geosciences**

This course provides practical project experience in the real-world applications side of environmental geology. Working as teams, students undertake environmental management and design projects that contribute to the solution of local-scale environmental problems. Projects will include engineering geology, hydrogeology, geophysics, and applied geomorphology. Prerequisite: EAS 313, EAS 385, 390, EAS 584. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**EAS 583 Geology of Landfills**

This course consists of the application of the geological sciences to the siting, exploration and site evaluation for solid waste disposal landfills, plus the evaluation of existing landfill facilities as they pertain to soils, bedrock, stratigraphy, landforms, geologic processes, and hydrogeology. Included are soil and rock exploration, laboratory testing, installation of ground water monitoring devices, and evaluation of contaminant transport. Both attenuation and confinement landfill systems are considered. Geological aspects of solid waste disposal regulations are reviewed and compared to those for hazardous waste disposal. Classroom discussions include evaluation of specific landfill examples and a semester project on a landfill evaluation. A one-day field investigation is required. Prerequisite: EAS 111 or EAS 381. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

**EAS 584 Hydrogeology**

Investigates the qualitative and quantitative aspects of ground water location, occurrence, movement, evaluation, and development, and the influence of man upon this resource.
Minor in Environmental and Ecological Engineering
Minor Code = 281

Geologic and engineering aspects of ground water systems are discussed. Classroom teaching is complemented by problem sets and field trips. Course work in Geological and Earth Sciences/Geosciences; Prerequisite: MA 262 or MA 266. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co- requisites.

EAS 585 Hydraulic Analysis of Ground-Water Systems

Investigates the general theory and application of hydraulic testing and analysis of aquifer and aquitard properties for such parameters as porosity, permeability, hydraulic conductivity, transmissivity, storativity, specific yield, dispersivity, and others. Theory of porous media flow is taught with applications to hydraulic testing. Confined, unconfined, semi-confined, transient, and steady-state flows are analyzed. Pump tests, slug tests, tracer tests, and regional analyses of flow nets are stressed. Classroom teaching is complemented with numerous problem sets. Offered in alternate years. Prerequisite: EAS 584, MA 262. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

EAS 586 Engineering Geology

Emphasis on application of geology to engineering works including dams, tunnels, shoreline protection, slope stability, building foundations, and urban planning. Related case histories of major projects emphasizing methods of investigation and interpretation. Consideration of collection and application of geological data required by designers for major engineering works; analysis of specific problems. Term paper and field investigation required. Prerequisite: EAS 385. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

EAS 587 Chemical Evolution of Groundwater

Examines the processes by which ground waters acquire their solutes during passage from recharge to discharge zones and the influence of rock types on aquifer chemistry. Topics covered are mineral dissolution, ion exchange, organic complexing, and membrane properties of clays. Prerequisite: CHM 116, EAS 244. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

EAS 588 Analytical Hydrogeochemistry

A "hands-on" course teaching the proper way to take field samples for chemical, isotopic, and head-gas analyses of ground waters. Sampled waters are then analyzed by a variety of techniques: gravimetry, titrimetry, colorimetry, and atomic absorption spectrometry, and ion chromatography. Prerequisite: EAS 587. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

EAS 589 Numerical Modeling of Ground Water Systems
Minor in Environmental and Ecological Engineering
Minor Code = 281

Investigates the general theory and application of numerical solutions of partial differential equations of flow through porous media and the simulation of ground water flow by computer methods, using both finite difference and finite element methods with a short introduction to boundary integral equation methods. Both transient and steady-state flow; confined, unconfined, and semi-confined flow are treated. Solute transport simulation methods include random walk, method of characteristics, and other methods. Classroom teaching and "hands on" computer experience is utilized. Offered in alternate years. Prerequisite: EAS 584, MA 262. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

Forestry

FNR 501 Limnology

Study of aquatic communities in relation to the chemical and physical features of inland waters; emphasis on management strategies for lake and stream habitats. One weekend field laboratory is required. Offered in alternate years. Prerequisite: BIOL 286; 6 credit hours in Chemistry. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

FNR 502 Watershed Hydrology, Ecology & Mgmt

An integrated approach to the study of streams and their watersheds, including physical, chemical, and biological interactions. Hydrologic and spatial (GIS) analysis methods are introduced, as well as practical monitoring and management techniques. Offered in even-numbered years.

FNR 540 Wetlands Ecology

Examination of the biotic and abiotic factors that influence wetlands, including the ecological, socioeconomic, and hydrological values of wetlands. Restoration and wildlife utilization also are examined. Laboratories involve examinations of various aspects of wetland ecology. Class trips are required. Students will pay individual lodging or meal expenses where necessary. Offered in odd-numbered years. Instructor approval is required. Prerequisite: FNR 548, BTNY 555 or ENTM 460. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

FNR 558 Digital Remote Sensing & GIS

Advanced course in the use of digital remote sensing techniques and geographic information systems (GIS) for renewable natural resources management. Emphasizes the physical principles behind the digital remote sensing of vegetative features, present-day instrument technology, spatial data processing and analysis algorithms, error analysis and accuracy assessment procedures, and multi-source data integration. Provides hands-on experience with forest canopy modeling, atmospheric modeling, image processing, and
Minor in Environmental and Ecological Engineering
Minor Code = 281

GIS software on microcomputer and workstation platforms. Prerequisite: FNR 357. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.