

## **Courses for the Nuclear Energy Minor**

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### ***Required Fuel Cycle Courses***

Three core courses are required for the nuclear minor:

#### **CH E 470. Introduction to Nuclear Energy 3 cr.**

Atomic and nuclear structure, nuclear stability and radioactivity, nuclear reactions, detection and measurement of radiation, interaction of radiation with matter, radiation doses and hazard assessment, principles of nuclear reactors, and applications of nuclear technology.

Prerequisite(s): CHEM 111, MATH 192.

#### **CH E 471. Health Physics 3 cr.**

Introduction to Radiation Protection, Radiation/Radioactivity, Radioactive Decay/Fission, Interaction of Radiation and Matter, Biological Effects of Radiation, Radiation Measurement/Statistics, Sampling for Radiation Protection Purposes, Radiation Dosimetry, Environmental Transport, Radiation Protection Guidance, External Radiation Protection, Internal Radiation Protection, Waste Management, and Hazards Analysis and Control.

Prerequisite(s): MATH 192, CH E 470. Crosslisted with: WERC 471

#### **CH E 476. Nuclear Fuel Cycles 3 cr.**

Physical and chemical processes in the conventional nuclear fuel cycle: uranium mining and milling, conversion, enrichment, fuel fabrication, reactor operations, interim storage, reprocessing and recycling, waste treatment and disposal. Alternative fuel cycles and future prospects. Prerequisite(s): CH E 470.

### ***Elective Fuel Cycle Courses***

Three elective courses are required for the nuclear minor. I propose that the following courses be accepted for the minor:

#### **CH E 439. Environmental Modeling 3 cr.**

Environmental transport processes in water, groundwater and the atmosphere; mathematical models to account for simultaneous chemical reaction and transport in the environment; models of chemical fate; aquatic chemistry; metals migration in soils; atmospheric deposition and global change; metals deposition. Prerequisite(s): MATH 392 or CH E 201.

**CH E 473. Nuclear Regulations and Compliance Practices 3 cr.**

Introduction, through the use of case studies, to the best technical compliance practices for regulations governing the siting, licensing, constructing, operating and decommissioning of nuclear fuel cycle facilities. Consent of instructor required. Prerequisite(s): MATH 191G and (CHEM 111G or CHEM 115). Crosslisted with: WERC 473

**CH E 474. Power Plant Design 3 cr.**

Principles of electric power generation. Review of combustion, heat transfer, and thermodynamic power cycles. Analysis of hydroelectric, fossil fuel, nuclear, and alternative power systems. Environmental and economic considerations. Prerequisite(s): MATH 191G, CHEM 111G.

**CH E 475. Nuclear Reactor Theory 3 cr.**

An overview of the properties of nuclei, nuclear structure, radioactivity, nuclear reactions, fission, resonance reactions, moderation of neutrons, will be followed by mathematical treatment of the neutronics behavior of fission reactors, primarily from a theoretical, one-speed perspective. Criticality, fission product poisoning, reactivity control, reactor stability and introductory concepts in fuel management, slowing down and one-speed diffusion theory. Corequisites: MATH 392. Prerequisites: CHEM 112G, PHYS 215G, MATH 291G.

**CHEM 4???. Nuclear Chemistry 3 cr. (2+3P) [New course—formerly CHEM 351]**

Laboratory course with lectures on principles of analytical techniques related to environmental monitoring of pollutants and waste management. Prerequisite: CHEM 371 or C E 462 or consent of instructor.

**CHEM 472. Analytical Methods for Toxic Organics & Metal Ions in the Environment 3 cr. (2+3P)**

Laboratory course with lectures on principles of analytical techniques related to environmental

**C E 470. Design of Municipal and Hazardous Waste Landfills 3 cr.**

Solid waste and application of geotechnical engineering principles and methods to the site selection and design of municipal and hazardous waste landfills. Prerequisite(s): C E 357 and C E 452, or consent of instructor.

**ENVE 455. Solid and Hazardous Waste Systems Design 3 cr.**

Design of processes and facilities used in the transport, storage, treatment, and disposal of solid and hazardous wastes. Prerequisite: C E 356 or consent of instructor.

**E S 452. Geohydrology 3 cr.**

Origin, occurrence, and movement of fluids in porous media and assessment of aquifer characteristics. Development and conservation of ground water resources, design of well fields. Prerequisite(s): C E 160 or GEOL 111G, and C E 231. Crosslisted with: GEOL 452 and C E 452

**E S 470. Environmental Impacts of Land Use and Contaminant Remediation 3 cr.**

Capstone course for the environmental science major. Case studies of environmental problems impacting land. Prerequisites: E S 256, E S 462, E S 370. [The instructor of these courses has expressed a willingness to relax prerequisite requirements for our students.]

**SOIL 424. Soil Chemistry 3 cr.**

Basic elements of soil chemistry including clay mineralogy, cation and anion exchange and the chemistry of problem (acid, saline and flooded) soils. Credit not given for both SOIL 424 and SOIL 479. Prerequisites: SOIL 252L or GEOL 360, or three semesters of chemistry. Same as CHEM 424, GEOL 424.

**SOIL 477. Environmental Soil Physics 3 cr.**

A description of the physical characteristics of porous media including soil. Examination of processes describing the transport of water, chemicals, heat and gases through porous media with application to environmental quality, waste management, and crop production.

**SOIL 477 L. Environmental Soil Physics Laboratory 1 cr.**

Concurrent enrollment with SOIL 477 recommended. Hands on experience with techniques for characterizing soil physical properties such as particle size distribution, bulk density, water retention, hydraulic conductivity and solute transport. Demonstrations of field and laboratory techniques for measuring moisture content, soil water potential, gas/air flow and thermal conductivity. Prerequisite: SOIL 252.

**SOIL 479. Environmental Soil Chemistry 3 cr.**

Basic elements of soil chemistry including discussion of clay mineralogy, cation and anion exchange and the chemistry of problem (acid, saline and flooded) soils. Credit not given for both SOIL 424 and SOIL 479. Prerequisites: SOIL 252L or GEOL 360, or three semesters of chemistry. Same as GEOL 479.

**E E 280. DC and AC Circuits 4 cr. (3+3P)**

Electric component descriptions and equations; Kirchhoff's voltage and current laws; formulation and solution of network equations for dc circuits; ideal op-amp circuits. Complete solutions of RLC circuits; steady-state analysis of ac circuits, ac power; introduction to frequency response techniques. Prerequisite(s): C or better in MATH 192 and PHYS 216.

**E E 391. Introduction to Electric Power Engineering 4 cr. (3+3P)**

Introduction to the principles, concepts, and analysis of the major components of an electric power system. Basic electromechanics, energy conversion and source conversion, transformers, transmission lines, rectifiers, regulators, and system analysis. Prerequisite(s): C or better in E E 280.

**E E 431. Power Systems II 3 cr.**

Analysis of a power system in the steady-state. Includes the development of models and

analysis procedures for major power system components and for power networks. Prerequisites: C or better in E E 391.

Note: Few students outside of the Electrical Engineering Department will take E E 431 (Power Systems II) because it requires as a prerequisite E E 391 (Introduction to Electric Power Engineering), which itself requires E E 280 (DC and AC Circuits). Thus far, no student has used E E 431 to satisfy the requirements of the Nuclear Energy minor. I propose that Electrical Engineering majors be allowed to count E E 391 or 431 toward the Nuclear Chemical Engineering minor, but not E E 280.

**ECON 571. Regulatory Policy and Industry Analysis: Electricity I 3 cr.**

Regulatory policy and economic analysis related to the Electric Industry. Topics include: characteristics of a utility and legal justification for regulation; characteristics and functions of a regulatory commission; history and structure of the industry; technology and network design; revenue requirements; cost allocation; and basic retail rate design. Prerequisite(s): ECON 252, FIN 306, or consent of instructor.

**PHYS 315. Modern Physics 3 cr.**

An introduction to relativity and quantum mechanics, with applications to atoms molecules, solids, nuclei, and elementary particles. Prerequisites: MATH 291G and PHYS 214 or PHYS 216G.

**PHYS 315 L. Experimental Modern Physics 3 cr. (1+6P)**

Elementary laboratory in modern physics which supports the subject matter in PHYS 315. Required for physics majors. Prerequisite(s): a C or better in PHYS 214L or 216GL. Pre/Corequisite(s): PHYS 315.

**PHYS 454. Intermediate Modern Physics I 3 cr.**

Introduction to quantum mechanics, focusing on the role of angular momentum and symmetries, with application to many atomic and subatomic systems. Specific topics include intrinsic spin, matrix representation of wave functions and observables, time evolution, and motion in one dimension. Prerequisite(s): PHYS 315. Pre/Corequisite(s): MATH 392 and PHYS 395.

**PHYS 455. Intermediate Modern Physics II 3 cr.**

Continuation of subject matter of PHYS 454. Specific topics include rotation and translation in three dimensions, solution of central potential problems, perturbation theory, physics of identical particles, scattering theory, and the interaction between photons and atoms. Prerequisite(s): PHYS 454.