

NUCLEAR ENGINEERING (UN)

UN 806 Selected Topics in Engineering Physics Units: 3.00

Offering Faculty: School of Graduate Studies

UN 860 Industrial Research Project Units: 3.00

UNENE course number = UN 0600 If they so elect, candidates for the M. Eng. (Nuclear Engineering) Degree may spend approximately four months in an industrial laboratory carrying out an industry-oriented project under the supervision of a suitably qualified staff scientist. Usually there is also a university co-supervisor. The Department will attempt to arrange an industrial project in consultation with the candidate and through negotiation with the candidate's employer. A satisfactory project topic and appropriate arrangements are required for the project to be approved by the Department and it is possible that in some cases this may not be feasible. Upon completion, the candidate will submit a substantial report on the project and make a presentation on it at the university. The industrial research project can only be undertaken after at least half the required courses have been taken. The industrial research project counts as two half courses. University of Western Ontario / Staff

Offering Faculty: Fac of Engineering Appl Sci

UN 861 Control Instr. Elec. Systems Units: 3.00

UNENE Course number = UN 0601 This course covers the basic control, instrumentation and electrical systems commonly found in CANDU based nuclear power plants. The course starts with an overall view of the dynamics associated with different parts of the plant, i.e. reactor, heat transport systems, moderator, steam generator, turbine, and electrical generator. Based on such knowledge, the control and regulation functions in the above systems are then defined. Different instrumentation and measurement techniques are examined, along with control strategies. The time and frequency domain performance characterizations of control loops are introduced with consideration of actuator and sensor limitations. Different controller design and tuning methods and instrumentation calibration procedures are discussed. Two modes of operation of CANDU plants will be analyzed, i.e. normal mode and alternate mode. Advanced control technologies, such as distributed control systems, Field bus communication protocols are introduced in view of their potential applications in the existing and newly constructed CANDU power plants. The electric systems in the CANDU plant will be examined. The modeling of the dynamics and control devices for the generator will be covered in details. The dynamic interaction between the CANDU power plants and the rest of the electric power grid with other generating facilities and various types of load will be studied. University of Western Ontario/J. Jiang.

Offering Faculty: Fac of Engineering Appl Sci

**UN 862 Nuclear Fuel Waste Management Units: 3.00**

UNENE Course Number = UN 0602 Presently, nuclear fuel waste management involves storage in water pools or dry storage containers at reactor sites. If the fuel is then defined as waste, permanent disposal at an appropriate deep geological site would be considered. This course will describe the physical and chemical properties of the fuel and these approaches to storage and disposal. Key features of the fuel include its chemical and physical structure and properties prior to, and after, in-reactor irradiation, the nature and distribution of radionuclides produced in-reactor, and the chemical and physical properties of the Zircaloy fuel cladding before and after in-reactor exposure. The principles behind pool and dry storage will be described including the design of storage containers and the chemical and corrosion processes that could influence their long-term integrity. The possible permanent disposal scenarios developed internationally will be discussed, with a primary emphasis on those potentially applicable in Canada. For this last topic, the design and fabrication of waste containers and the processes that could potentially lead to their failure, the properties of engineered barriers within the geological site, the essential geological features of the chosen site, and the computational modeling approaches used in site performance assessment calculations will be described. University of Western Ontario/ D. Shoemith

Offering Faculty: Fac of Engineering Appl Sci

UN 863 Project Manage. Nuclear Eng. Units: 3.00

UNENE Course number = UN 0603 Project Management is emerging as perhaps the key core competency in engineering in the 21st century industrial workplace. This course in Project Management will prepare nuclear engineers in the application of this discipline in their work. It is an intensive investigation into the major principles of Project Management slanted towards, but not exclusively about, the management of nuclear engineering projects. The course uses the Project Management Institute's PMBOK (Project Management Body of Knowledge) as a skeleton and expands that coverage with relevant examples from nuclear, software and general engineering. Special emphasis will be placed on Risk Management, particularly in the area of safety-critical projects. The graduate will be well-positioned both to apply the knowledge in their area of engineering and to sit the PMI's PMP examination. The course will be taught by a professional engineer holding the PMP certification, using many case studies from industry and engineering. University of Western Ontario/M. Bennett

Offering Faculty: Fac of Engineering Appl Sci

UN 870 Industrial Research Project Units: 3.00

UNENE course number = UN 0700 If they so elect, candidates for the M. Eng. (Nuclear Engineering) Degree may spend approximately four months in an industrial laboratory carrying out an industry-oriented project under the supervision of a suitably qualified staff scientist. Usually there is also a university co-supervisor. The Department will attempt to arrange an industrial project in consultation with the candidate and through negotiation with the candidate's employer. A satisfactory project topic and appropriate arrangements are required for the project to be approved by the Department and it is possible that in some cases this may not be feasible. Upon completion, the candidate will submit a substantial report on the project and make a presentation on it at the university. The industrial research project can only be undertaken after at least half the required courses have been taken. The industrial research project counts as two half courses. University of Waterloo/Staff.

Offering Faculty: Fac of Engineering Appl Sci

UN 871 Engineering Risk & Reliability Units: 3.00

UNENE course number = UN 0701 This course presents a broad treatment of the subject of engineering decision, risk, and reliability. Emphasis is on (1) the modelling of engineering problems and evaluation of systems performance under conditions of uncertainty; (2) risk-based approach to life-cycle management of engineering systems; (3) systematic development of design criteria, explicitly taking into account the significance of uncertainty; and (4) logical framework for risk assessment and risk-benefit tradeoffs in decision making. The necessary mathematical concepts are developed in the context of engineering problems. The main topics of discussion are: probability theory, statistical data analysis, component and system reliability concepts, time-dependent reliability analysis, computational methods, life-cycle optimization models and risk management in public policy. University of Waterloo/M. Pandey

Offering Faculty: Fac of Engineering Appl Sci

UN 872 Power Plant Thermodynamics Units: 3.00

UNENE course number = UN 0702 Theoretical and practical analysis of the following with particular reference to CANDU plants:- STEAM POWER CYCLES: Thermodynamic Processes; Thermodynamic Laws; Superheating and Reheating; Regenerative Feedwater Heating; Moisture Separation and Reheating; Turbine Expansion Lines- EXERGY AND HEAT TRANSFER: Available Energy Transfer; Exergy Flow Diagrams; Thermo-economic Analysis; Heat Conduction and Convection; Boiling and Condensing; Two Phase Flow- NUCLEAR HEAT REMOVAL: Reactor Heat Generation; Heat Transfer in Boilers and Condensers; Boiler Influence on Heat Transport System; Boiler Swelling and Shrinking; Boiler Level Control; Boiler Operations. University of Waterloo/ R. Chaplin

Offering Faculty: Fac of Engineering Appl Sci

UN 873 Nuclear Energy in Society: Regulation and Our Energy Future Units: 3.00

This course combines an in-depth study of regulation of nuclear power reactors with a module on the broad aspects of energy in society. It begins with an overall analysis of a regulated nuclear power industry, including why regulators are needed, their characteristics and qualities, and the impacts on industry of operating in a highly-regulated environment. Using practices from the USA, the UK, and Canada, it compares (through each stage of a plant life-cycle) prescriptive, goal-oriented, and risk informed regulation. Canadian regulatory requirements are explored in depth as a specific example. The final module examines the broader role of energy in society: how it is used, its characteristics, energy mixes, and the specific role of nuclear energy.

PREREQUISITE: permission of instructor

Offering Faculty: Fac of Engineering Appl Sci

UN 880 Industrial Research Project Units: 3.00

UNENE course number = UN 0800 If they so elect, candidates for the M. Eng. (Nuclear Engineering) Degree may spend approximately four months in an industrial laboratory carrying out an industry-oriented project under the supervision of a suitably qualified staff scientist. Usually there is also a university co-supervisor. The Department will attempt to arrange an industrial project in consultation with the candidate and through negotiation with the candidate's employer. A satisfactory project topic and appropriate arrangements are required for the project to be approved by the Department and it is possible that in some cases this may not be feasible. Upon completion, the candidate will submit a substantial report on the project and make a presentation on it at the university. The industrial research project can only be undertaken after at least half the required courses have been taken. The industrial research project counts as two half courses. McMaster University / Staff

Offering Faculty: Fac of Engineering Appl Sci

UN 881 Nuclear Plant Syst. Operations Units: 3.00

UNENE course number = UN 0801 System and overall unit operations relevant to nuclear power plants with emphasis on CANDU; includes all major reactor and process systems with nuclear plant simulator; self-study using interactive CD ROM. Two to three class one day meetings will be scheduled. McMaster University/G. Bereznoi

Offering Term: F

Offering Faculty: Fac of Engineering Appl Sci

UN 882 Reactor Physics Units: 3.00

UNENE course number = UN 0802 An introduction to nuclear energy and fission energy systems is presented. The energetics of nuclear reactions, interactions of radiation with matter, radioactivity, design and operating principles of fission are presented. Nuclear reactor physics including chain reactions, reactor statics and kinetics, multigroup analysis, core thermalhydraulics and the impact of these topics on reactor design are covered. Special topics such as xenon dynamics, burnup and reactor flux effects on safety are included. McMaster University/E. Nichita

Offering Faculty: Fac of Engineering Appl Sci

UN 883 Nuclear Reactor Safety Design Units: 3.00

UNENE course number = UN 0803 Technology and safety analysis underlying nuclear reactor safety. Topics include: Nature of the hazards; concepts of risk; probability tools and techniques; safety criteria; design basis accidents; case studies; safety analysis technology; human error; safety system design; and general safety design principles. McMaster University/V. Snell

Offering Faculty: Fac of Engineering Appl Sci

UN 884 Reactor Thermalhydraulics Units: 3.00

UNENE course number = UN 0804 Fundamentals of single-phase and two-phase flow, and heat and mass transfer. Nuclear power plant primary heat transport system design and calculations, including design description and characteristics of main components and systems. Simulation methodology and tools, including development and qualification of selected thermal-hydraulics computer codes. Course also covers experimental techniques, facilities and results that describe important thermal-hydraulics phenomena. Course topics include: development of conservation equations and relevant constitutive correlations, flow patterns and boiling heat transport regimes, critical heat flux and pressure drop calculations, description of most important computer codes, description of relevant experimental facilities and results, safety margins and operational safety issues and methodologies. McMaster University/N. Popov

Offering Faculty: Fac of Engineering Appl Sci

**UN 885 Radiation Health Risk/Benefits Units: 3.00**

UNENE course number = UN 0805 This course is designed to introduce graduate students to recent advances in radiation biology that have direct impact on our understanding of the health risks associated with ionizing radiation. The course will focus on radiation absorption in living tissue and physical and biological processes that influence the consequences of the exposure. Students will learn about the biological effects from different radiation qualities, doses, and dose rates. The course will address cellular radiation damage and repair mechanisms and introduce students to modern techniques in molecular biology used in accident and emergency biological dosimetry. The material will relate to radiation applications in medicine and industry. No prior knowledge of biology at an advanced level is required. McMaster University/D. Tucker

Offering Faculty: Fac of Engineering Appl Sci

UN 890 Industrial Research Project Units: 3.00

UNENE course number = UN 0900 If they so elect, candidates for the M. Eng. (Nuclear Engineering) Degree may spend approximately four months in an industrial laboratory carrying out an industry-oriented project under the supervision of a suitably qualified staff scientist. Usually there is also a university co-supervisor. The Department will attempt to arrange an industrial project in consultation with the candidate and through negotiation with the candidate's employer. A satisfactory project topic and appropriate arrangements are required for the project to be approved by the Department and it is possible that in some cases this may not be feasible. Upon completion, the candidate will submit a substantial report on the project and make a presentation on it at the university. The industrial research project can only be undertaken after at least half the required courses have been taken. The industrial research project counts as two half courses. Queen's University.

Offering Faculty: Fac of Engineering Appl Sci

UN 891 Nuclear Materials Units: 3.00

UNENE course number = UN 0901 A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures and stresses to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation which affect their performance, and often this dictates a requirement for a unique property (for example, a low cross section for thermal neutron absorption) that is not relevant in conventional applications. The effects of the radiation may be direct (e.g., the displacement of atoms from their normal positions by fast neutrons or fission fragments), or indirect (e.g., a more aggressive chemical environment caused by radiolytic decomposition). This course describes materials typically used in nuclear environments, the unique conditions to which they are subjected, the basic physical phenomena that affect their performance and the resulting design criteria for reactor components made from these materials. Queen's University/R. Holt

Offering Term: N

Offering Faculty: Fac of Engineering Appl Sci

UN 892 Fuel Management Units: 3.00

UNENE course number = UN 0902 Nuclear fuel cycles are studied from mining to ultimate disposal of the spent fuel, including the enrichment processes and the reprocessing techniques, from a point of view of the decision-making processes and the evaluation of the operational and economical consequences of these decisions. For the steps within the fuel cycles, the method of determining the associated costs, in particular those relevant to the disposal of nuclear waste, and the overall fuel cycle costs are described. Burn-up calculations are performed for the swelling time of the fuel within the reactor core. The objectives and merits of in-core and out-of-core fuel management for CANDU Pressurized Heavy Water Reactors (PHWR) and Light Water Reactors (LWR) are analyzed in detail, for the refueling equilibrium as well as for the approach to refueling equilibrium. The course also covers fuel management for thorium-fuelled CANDU reactors and other advanced fuels such as MOX containing plutonium from discarded nuclear warheads, and DUPIC (Direct Use of PWR fuel in CANDU reactors). The fuel management problem is treated as an optimization problem, with objective functions or performance indexes identified, as well as decision variables and appropriate constraints (active and non-active). The course also includes a review of the major work done in this area along with the most important computer codes. Queen's University/ H. Bonin

Offering Faculty: Fac of Engineering Appl Sci

UN 893 Industrial Research Project Units: 3.00

UNENE course number = UN 1000 If they so elect, candidates for the M. Eng. (Nuclear Engineering) Degree may spend approximately four months in an industrial laboratory carrying out an industry-oriented project under the supervision of a suitably qualified staff scientist. Usually there is also a university co-supervisor. The Department will attempt to arrange an industrial project in consultation with the candidate and through negotiation with the candidate's employer. A satisfactory project topic and appropriate arrangements are required for the project to be approved by the Department and it is possible that in some cases this may not be feasible. Upon completion, the candidate will submit a substantial report on the project and make a presentation on it at the university. The industrial research project can only be undertaken after at least half the required courses have been taken. The industrial research project counts as two half courses. University of Toronto

Offering Faculty: Fac of Engineering Appl Sci

UN 894 Reactor Chemistry & Corrosion Units: 3.00

UNENE course number = UN 1001 Corrosion and its costs, corrosion measurement, general materials and environment affects. Types of corrosion: uniform, galvanic, crevice, pitting, intergranular, selective leaching, erosion-corrosion, stress-corrosion, hydrogen effects. Corrosion testing: materials selection. Electrochemical principles: thermodynamics, electrode kinetics, mixed potentials, practical applications. High temperature corrosion. Nuclear plant corrosion, fossil plant corrosion, other industrial environments. University of Toronto/D. Lister

Offering Faculty: Fac of Engineering Appl Sci