GRADUATE DIPLOMAS IN NUCLEAR TECHNOLOGY

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Abstract

The University of Ontario Institute of Technology (UOIT) offers a graduate diploma program in nuclear technology that consists of a suite of six sub-specialties: Fuel, Materials and Chemistry; Reactor Systems; Operation and Maintenance; Safety, Licensing and Regulatory Affairs; Health Physics; and Radiological Applications. Four courses selected from a list that covers the knowledge and skill set of each sub-specialty have to be completed in order to gain a graduate diploma in the specific area. The program is designed to accommodate the needs of people working in the nuclear industry to upgrade their knowledge and skills, to promote career advancement and to provide a framework for lifelong learning.

1. Introduction

UOIT is Ontario's newest university. It officially came into being on June 27, 2002, with the legislature's passage of Bill 109, the University of Ontario Institute of Technology Act. UOIT welcomed its first class of 947 students in September 2003, including 110 students in the Nuclear Engineering and in the Radiation Science programs. Most of the initial cohort of students was hired into the nuclear industry, while some have continued their studies towards graduate degrees: the MASc and MEng degrees were approved in 2008, and some 30 graduate students enrolled in the first year of having the program offered. Application to commence a PhD program in Nuclear Engineering has been made, and subject to the approval of the Ontario Council of Graduate Studies (OCGS) the program is expected to start in September 2009. The masters and PhD programs offer two fields, namely Nuclear Power and Energy Applications, and Radiological and Health Physics.

Once the PhD programs is approved, the Faculty of Energy Systems and Nuclear Science of UOIT will be Canada's only university to offer the full range of BEng, MEng, MASc and PhD degrees in nuclear engineering. While these degree programs cover the normal scope of post-secondary education in nuclear engineering, the unique multidisciplinary nature of the nuclear industry has created opportunities for specialist graduate diploma programs, as presented in this paper.

2. Training versus education

The companies that make up the nuclear industry hire university graduates from a wide range of programs. However, in almost every case a recent graduate will have shortfalls in a number of knowledge areas that are important to the job he/she will be asked to perform. For this reason, many companies conduct orientation training, which includes not only information and tasks that are needed to find one's way around the office or plant, but courses that supplement the post-secondary education received by the new employee. To the extent that

the scope of the training ensures that the employee gains familiarity with the policies, practises, layouts, equipment, systems and processes that are unique to his assignment and to the work place, such orientation training is usually the most cost-effective way for the new employee to gain the knowledge and skills required to do his work.

In many cases there are knowledge gaps that require training that is similar to what is taught at colleges and universities, but which were not part of the program taken by many of the graduates. If the additional knowledge is not required for the initial work assignment, it does not need to be part of orientation training, and can often be acquired over periods of several months or a few years. In such cases, instead of intensive training sessions, courses offered by post-secondary institutions as part of their regular programs may be a preferred way for employees to acquire the desired knowledge and additional qualifications.

Constraints on university courses being able to meet industry knowledge and skill requirements have been identified in the past due to the differences between what universities produce and what industry needs [1]. In particular, Canadian universities strive to excel at research, because government funding is more focused on rewarding research excellence than teaching excellence. For this reason many undergraduate programs and individual professors concentrate on preparing undergraduates to go to graduate school rather than into industry. UOIT was specifically created to offer programs in areas where there is a strong market need for graduates. In particular, nuclear engineering was recognized by the Government of Ontario as a discipline where there was a major shortage of graduates. Given its location in Oshawa, approximately half way between the Pickering and Darlington nuclear power plants, UOIT is ideally situated to meet the needs of the industry for graduates with special knowledge in the nuclear area.

While the traditional graduate degree programs at the masters and doctorate levels meet a range of post-graduate education needs, these programs were originally designed for full-time studies. Recognizing the need for making this level of education more accessible to professionals already in the industry, AECL, Bruce Power and Ontario Power Generation funded the establishment of the University Network of Excellence in Nuclear Engineering (UNENE) in 2002 [2]. One of the significant results of UNENE has been to initiate and support a Master of Nuclear Engineering program that is delivered on weekends. Over 50 nuclear industry employees are participating in this program. However, the cost of the program ($25,000 per student), the time commitment to complete ten courses and the strict admission requirements specified by the graduate schools' of the participating universities, have limited enrolment levels.

3. Graduate Diplomas

The Ontario Council of Graduate Studies (OCGS) governs all graduate programs in Ontario. OCGS recognizes a number of different types of diploma programs, and in particular defines the "Type 4 graduate diploma: The sub-specialization within an existing program. These programs are stand-alone, direct-entry diplomas designed to suit the needs of a particular clientele or market (i.e., not additional to the master's or doctoral program, as Type 2) developed by a unit already offering a master's (and sometimes a doctoral) program." [3]

Such a program has been recognized earlier by McMaster University as being applicable to the nuclear industry, and has offered a Graduate Diploma in Nuclear Technology since 2002 [4].

Typically such graduate diploma programs are comprised of a subset of the graduate degree courses, for example the McMaster Graduate Diploma in Nuclear Technology requires only four courses instead of the ten needed for the Master of Engineering degree. Since the Ministry of Training, Colleges and Universities provides funding for the graduate diploma courses, the cost of tuition for each course is in the order of half of the UNENE course fees, and both the individual participants and the sponsoring company need to make a significantly smaller commitment in terms of time and money. In most cases a student who is successful in the diploma program has the choice to proceed to the MEng degree instead of using the courses towards the graduate diploma.

4. UOIT's Graduate Diploma in Nuclear Technology

The success of the nuclear programs at UOIT, with over 200 students in years one to four in the undergraduate programs, and 30 students in the first year of the masters programs, has resulted in a wide range of courses being available to form not one diploma program, but a suite of programs. A review of the needs of industry and the availability of courses in various specialties resulted in identifying the following six areas where specific diplomas are applicable:

1. Fuel, Materials and Chemistry
2. Reactor Engineering
3. Operation and Maintenance
4. Safety, Licensing and Regulatory Affairs
5. Health Physics
6. Radiological Applications

The admission requirements to the diploma program, in addition to proof of English language proficiency, include having a baccalaureate degree in the fields of engineering, science or mathematics with a grade point average of B- (70% or GPA = 2.7 on a 4.0/4.3 scale). In the case of mature students who do not meet the usual academic requirements for graduate studies, consideration is given to education, training and experience relevant to the chosen field of the diploma, as long as the applicant is deemed to have satisfactory preparation to succeed in the program.

To earn a diploma, students are required to complete four courses relevant to one of the six areas of sub-specialization. As listed below, each diploma has a set of defined courses relevant to the area of sub-specialization. In addition, there are number of non-specialist courses common to all the diploma programs.

1. Fuel, Materials and Chemistry

NUCL 5080G Advanced Topics in Environmental Degradation of Materials
NUCL 5220G Fuel Management in Nuclear Reactors
NUCL 5300G Advanced Topics in Radioactive Waste Management
NUCL 5310G Transmutation of Nuclear Waste
NUCL 5450G Advanced Material Analysis
ENGR 4510G Nuclear Plant Chemistry
ENGR 4610G Corrosion for Engineers
ENGR 4620G Radioactive Waste Management Design
ENGR 4680G Nuclear Materials
ENGR 4810G Nuclear Fuel Cycles

2. Reactor Engineering

NUCL 5030G Transport Theory
NUCL 5040G Monte Carlo Methods
NUCL 5200G Reactor Physics
NUCL 5210G Advanced Reactor Physics
NUCL 5215G Advanced Reactor Engineering
NUCL 5230G Advanced Nuclear Thermalhydraulics
NUCL 5240G Heat Transfer in Nuclear Reactor Applications
ENGR 5122G Computational Fluid Dynamics
ENGR 4700G Nuclear Plant Design and Simulation
ENGR 4730G Reactor Control
ENGR 4780G Nuclear Reactor Design

3. Operation and Maintenance

NUCL 5100G Nuclear Plant Systems and Operation
NUCL 5110G Reliability and Maintenance Engineering
NUCL 5250G Power Plant Thermodynamics
NUCL 5270G I&C and Electrical Systems
NUCL 5275G Safety Instrumented Systems
NUCL 5280G Advanced Reactor Control
ENGR 5121G Advanced Turbo Machinery
ENGR 5740G User Interface Design
ENGR 5910G Embedded Real-Time Control Systems
ENGR 5920G Analysis and Control of Nonlinear Systems
ENGR 5930G Adaptive Control
ENGR 5940G Intelligent Control Systems

ENGR 5960G Power System Operations, Analysis and Planning
ENGR 4670G Shielding Design

4. Safety, Licensing and Regulatory Affairs

NUCL 5050G Applied Risk Analysis
NUCL 5070G Environmental Modelling
NUCL 5090G Occupational Health and Safety
NUCL 5260G Reactor Containment Systems
NUCL 5350G Regulatory Affairs and Licensing Concepts
NUCL 5360G Emergency Response and Disaster Management
NUCL 5430G Advanced Dosimetry
NUCL 5440G Advanced Radiation Biophysics and Microdosimetry
ENGR 4520G Nuclear Plant Safety Design
ENGR 4660G Risk Analysis Methods
RADI 4220G Radiation Biophysics and Dosimetry
RADI 4550G Radiation Detection and Measurement

5. Health Physics

NUCL 5040G Monte Carlo Methods
NUCL 5070G Environmental Modelling
NUCL 5090G Occupational Health and Safety
NUCL 5300G Advanced Topics in Radioactive Waste Management
NUCL 5310G Transmutation of Nuclear Waste
NUCL 5430G Advanced Dosimetry
NUCL 5440G Advanced Radiation Biophysics and Microdosimetry
ENGR 4620G Radioactive Waste Management Design
ENGR 4670G Shielding Design
RADI 4220G Radiation Biophysics and Dosimetry
RADI 4550G Radiation Detection and Measurement

6. Radiological Applications

NUCL 5400G Advanced Radiation Science
NUCL 5410G Physics of Radiation Therapy
NUCL 5450G Advanced Material Analysis
NUCL 5460G Industrial Radiography
NUCL 5470G Nuclear Forensic Analysis
RADI 4430U Industrial Applications of Radiation Techniques
RADI 4440U Radioisotopes and Radiation Machines

NON-SPECIALIST COURSES COMMON TO ALL DIPLOMA PROGRAMS

NUCL 5010G Project Management for Nuclear Engineers
NUCL 5020G Mathematical Methods in Nuclear Applications
NUCL 5060U Nuclear Concepts for Engineers and Scientists
NUCL 5065U Thermalhydraulic Concepts for Engineers and Scientists
NUCL 5290G Advances in Nuclear Power Plant Systems
NUCL 5420G Aerosol Mechanics
ENGR 5010G Advanced Optimization
MCSC 6210G Advanced Topics in Mathematical Modelling
MCSC 6120G Numerical Methods for Ordinary Differential Equations
MCSC 6230G Advanced Topics in High-Performance Computing

To gain a diploma in a given specialty, a student must complete four courses not previously taken at UOIT or at another university with a comparable program, as follows:

a. Complete a minimum of two courses from the specialty, including at least one NUCL course.
b. Complete two other courses from either the Non-Specialist Common courses or from other specialties.
c. There must be a minimum of two NUCL courses completed.

Subject to the approval of the Graduate Program Director, one graduate course may be taken that is not listed for the Diploma in Nuclear Program, (i.e. from graduate a program offered by other UOIT faculties).

5. Course delivery

One of UOIT's unique features is being Ontario's only "laptop" university. Students lease the computers, which are loaded with course and/or program specific software consistent with the student's program of study. Every seat in every classroom has electric power and wired Internet connections, as well as the Campus having wireless connectivity. The hardware and software infrastructure facilitate learning both on and off campus, from any location and at any time in lecture halls, research laboratories, the library, and in public areas such as study halls, cafeterias and on-campus restaurants. The WebCT Vista learning management system is used extensively to communicate with students, including the posting of course objectives, laboratory exercises, tutorial schedules, assignment questions and sample solutions, chat rooms and class-specific e-mail. The main features of the UOIT web-centric learning environment are shown in Figure 1.

The possibility of being "on-line" during the lectures and being able to interact with the lecturer as if one was physically present in the classroom overcomes accessibility issues beyond the usual physical barriers, including the possibilities to study while at work, at home or any remote location with access to the Internet. The content of the lectures is also archived, permitting review and asynchronous access to the material being taught. The plans for delivering the courses that comprise the nuclear technology diploma program include classroom lectures,

directed studies and web-based synchronous and asynchronous delivery of the classroom experience. The implementation of what is usually referred to as distance education in parallel with the classroom lectures is designed to meet the needs of all students, whether or not they are able to attend classes on Campus. Recognizing the large number of people working in the nuclear industry within reasonable commuting distance of UOIT's Campus in Oshawa, most of the classes are scheduled as 3 hour sessions once a week, typically starting after 4 pm.

While the ubiquitous use of laptop computers and the Internet present a "high-tech" learning environment, the students expect and need a corresponding "high-touch" in terms of personal contact with their professors and teaching assistants. The nuclear graduate degree and diploma programs at UOIT are not designed for distance-only learning. It is expected that the majority of the students will attend classes at the Oshawa campus, and that no course can be completed without each student having been in face-to-face contact with the professor, or in exceptional cases with a member of the nuclear profession who is a recognized partner of UOIT.

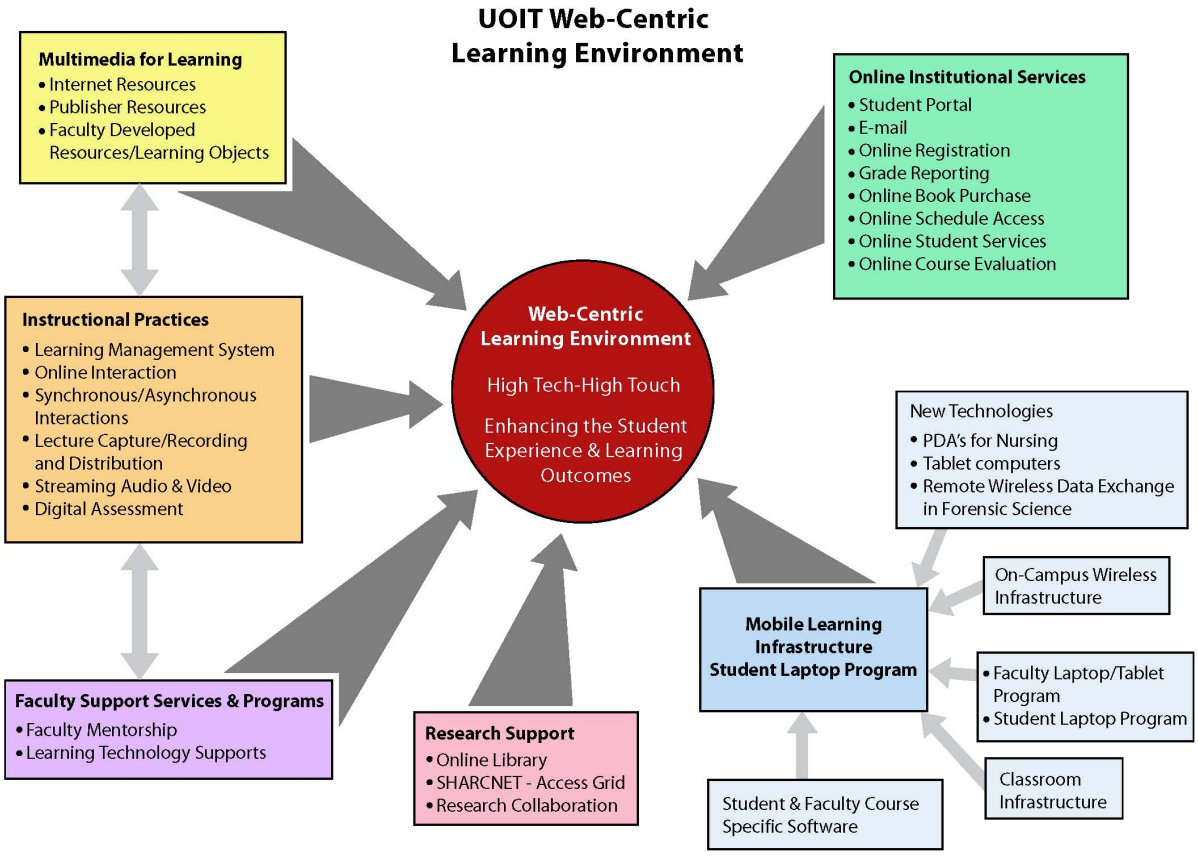

Figure 1 Web-centric learning environment

6. Conclusions

The Graduate Diploma in Nuclear Technology offered by UOIT consists of a suite of six subspecialties, and others may be added if there is sufficient demand from industry and potential students. The graduate diploma program was designed to provide education that complements industry training courses, to deliver courses for new hires that need knowledge specific to the nuclear industry, to promote life-long learning for professionals when they change jobs and need to update or upgrade their knowledge, and to provide graduate Canadian university credentials to people with foreign or other qualifications that are not normally recognized by Canadian graduate schools. The benefits of gaining a graduate diploma by completing four courses include the reduced commitment of time and money relative to the masters degrees, the potential to transfer diploma course credits to a masters degree program, and the opportunity to gain admission to a graduate program by recognition of experience, education and training outside the usual university degree granting system.

7. References

[1] W.J. Garland, "UNENE: Reinvigorating University-Based Education, Research and Development in Nuclear Engineering and Technology", The Nuclear Energy Working Group (NEWG) North American Security and Prosperity Partnership Initiative, Ottawa, Ontario, Canada, 2006 June 29.

[2] G.T. Bereznai and W.J. Garland, "New Postgraduate Programs in Nuclear Engineering to Meet the Needs of the Canadian Nuclear Industry", 16th Pacific Basin Nuclear Conference (16PBNC), Aomori, Japan, 2008 October 13-18.

[3] OCGS By-laws & Procedures Governing Appraisals; http://ocgs.cou.on.ca/_bin/home/byLaws.cfm

[4] McMaster University School of Graduate Studies Calendar 2008-2009 http://www.mcmaster.ca/graduate/grad_calendar.pdf