UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

Brief for the Appraisal of the MASc and MEng Programs in **Mechanical Engineering**

Submitted to the
Ontario Council on Graduate Studies
[date]

VOLUME I: The Program

THE PROGRAM

1 INTRODUCTION

1.1 Brief listing of programs

The master's programs lead to the degrees of Master of Applied Science (MASc) or Master of Engineering (MEng) in Mechanical Engineering. The MEng program will have two options: MEng-Project which will consist of a combination of courses and a project and MEng-Course which will consist only of courses.

The master's programs are new programs to be offered at the University of Ontario Institute of Technology (UOIT). The programs are planned to be launched in the January, 2006, or as soon as practical after all necessary approvals are obtained, by the Faculty of Engineering and Applied Science and its affiliated School of Energy Systems and Nuclear Science.

1.2 Background

The University of Ontario Institute of Technology is Canada's newest university. UOIT took in its first undergraduate engineering students in the fall of 2003. Undergraduate engineering degrees at UOIT are offered by both the Faculty of Engineering and Applied Science and its affiliated School of Energy Systems and Nuclear Science.

The Faculty of Engineering and Applied Science first offered an undergraduate program in Manufacturing Engineering in the fall of 2003. In the fall of 2004, the Faculty of Engineering and Applied Science added an undergraduate program in Mechanical Engineering with three options: Mechanical Engineering Comprehensive, Energy Engineering, and Mechatronics Engineering. In the Fall of 2005, the Faculty of Engineering and Applied Science will add undergraduate programs in Automotive, Electrical, and Software Engineering.

The School of Energy Systems and Nuclear Science first offered an undergraduate program in Nuclear Engineering in the fall of 2003. In the fall of 2004, the School of Energy Systems and Nuclear Science added an undergraduate program in Energy Systems Engineering.

With the rapid growth and success of the undergraduate engineering programs at UOIT, the Faculty of Engineering and Applied Science and the School of Energy Systems and Nuclear Science are ready and able to expand into graduate programs by offering MASc and MEng programs in Mechanical Engineering in the fall of 2005. A PhD program in Mechanical Engineering is also envisioned. The plan is to seek approval from the Ontario Council on Graduate Studies once the master's programs are up and running.

1.2.1 Other programs

As of 2004, in Ontario there were 13 universities offering graduate programs in engineering. Table 1-1 lists the universities offering graduate programs in engineering and indicates which programs are offered by each institution.

Table 1-1: Graduate Engineering Programs in Ontario as of 2004

University	Faculty	Programs	Degrees
Carleton University	Faculty of Engineering and Design	Civil Engineering[1] Electrical Engineering[1] Environmental Engineering[1] Mechanical & Aerospace Engineering[1] Software Engineering ConGESE[2] Telecommunications Technology Management	MASc/MEng/PhD MASc/MEng/PhD MASc/MEng/PhD MASc/MEng/PhD MEng MEng
University of Guelph	School of Engineering	Engineering	MEng/MSc/PhD
Lakehead University	Faculty of Engineering	Environmental Engineering Engineering (Control)	MSc MSc
Laurentian University	School of Engineering	Mineral Resources Engineering	MASc/MEng
McMaster University	Faculty of Engineering	Chemical Engineering Civil Engineering Design & Manufacturing[3] Electrical & Computer Engineering Engineering Physics Materials Science & Engineering Mechanical Engineering Software Engineering	MASc/MEng/PhD MASc/MEng/PhD MEng MASc/MEng/PhD MEng/PhD MASc/MSc/PhD MASc/MEng/PhD MASc/MEng/PhD
University of Ottawa	Faculty of Engineering	Chemical Engineering Civil Engineering[1] Electrical Engineering[1] Engineering Management Environmental Engineering[1] Mechanical & Aerospace Engineering[1] Software Engineering ConGESE[2]	MASc/MEng/PhD MASc/MEng/PhD MASc/MEng/PhD MEng MASc/MEng/PhD MASc/MEng/PhD MEng
Queen's University	Faculty of Applied Science	Chemical Engineering Civil Engineering Design & Manufacturing[3] Electrical & Computer Engineering Geoengineering[4] Materials & Metallurgical Engineering Mechanical Engineering Mining Engineering	MEng/MSc/PhD MEng/MSc/MSc(Eng)/PhD MEng MEng/MSc/MSc(Eng)/PhD MSc/MScE/PhD MEng/MSc/MSc(Eng)/PhD MEng/MSc/MSc(Eng)/PhD MEng/MSc/MSc(Eng)/PhD
Royal Military College of Canada	Engineering Division	Chemistry & Chemical Engineering Civil Engineering Defence Engineering & Management Electrical & Computer Engineering Geoengineering[4] Mechanical Engineering	MSc/MEng/PhD MEng/PhD MDEM MEng/PhD MSc/MScE/PhD MASc/MEng/PhD

Ryerson University	Faculty of Engineering and Applied Science	Chemical Engineering	MASc/MEng
		Civil Engineering	MASc/MEng/PhD
		Electrical & Computer Engineering	MASc/MEng/PhD
		Elect. & Comp. Eng. – Computer Networks	MASc/MEng
		Environmental Applied Science & Management	MASc
		Mechanical Engineering	MASc/MEng/PhD
University of Toronto	Faculty of Applied Science and Engineering	Aerospace Science & Engineering	MASc/MEng/PhD
		Biomedical Engineering	MASc/PhD
		Chemical Engineering & Applied Chemistry	MASc/MEng/PhD
		Civil Engineering	MASc/MEng/PhD
		Clinical Biomedical Engineering	MHSc
		Design & Manufacturing[3]	MEngDM
		Electrical & Computer Engineering	MASc/MEng/PhD
		Engineering & Management	BASc/MBA
		Environmental Engineering[5]	MASc/MEng/PhD
		Environmental Studies[5]	MASc/MEng/PhD
		Integrated Manufacturing[5]	MEng
		Knowledge Media Design[5]	MASc/PhD
		Materials Science & Engineering	MASc/MEng/PhD
		Mechanical & Industrial Engineering	MASc/MEng/PhD
		Software Engineering ConGESE[2]	MEng
		Telecommunications	MEng
		Wood Engineering[5]	MASc
University of Waterloo	Faculty of Engineering	Chemical Engineering	MASc/PhD
		Civil Engineering	MASc/MEng/PhD
		Design & Manufacturing[3]	MEng
		Electrical & Computer Engineering	MASc/MEng/PhD
		Management of Technology	MASc
		Management Sciences	MASc/MMSc/PhD
		Mechanical Engineering	MASc/MEng/PhD
		Software Engineering ConGESE[2]	MASc
		Systems Design Engineering	MASc/MEng/PhD
University of Western Ontario	School of Engineering	Biomedical Engineering	MESc/PhD
		Design & Manufacturing[3]	MEng
		Engineering Science	MESc/MEng/PhD
University of Windsor	Faculty of Engineering	Civil Engineering	MASc/MEng/PhD
		Electrical Engineering	MASc/MEng/PhD
		Engineering Materials	MASc/MEng/PhD
		Environmental Engineering	MASc/MEng/PhD
		Industrial Engineering	MASc/MEng
		Manufacturing Systems	PhD
		Mechanical Engineering	MASc/MEng/PhD

Sources: Advanced Design and Manufacturing Institute (ADMI), Canadian Council of Professional Engineers (CCPE), Consortium for Graduate Education in Software Engineering (ConGESE), and Ontario Council on Graduate Studies (OCGS).

[1] *Joint program between Carleton University and the University of Ottawa.*

[2] ConGESE: Consortium for Graduate Education in Software Engineering – Joint program between Carleton University, University of Ottawa, Queen's University, University of Toronto, University of Waterloo, University of Western Ontario, and York University. Note that only schools that offer ConGESE master's degrees through engineering departments are noted in the table.
[3] ADMI: Advanced Design and Manufacturing Institute - Joint program between McMaster University, Queen's University, University of Toronto, University of Waterloo, and University of Western Ontario.
[4] Joint program between Queen's University and Royal Military College of Canada.
[5] Collaborative program between two or more graduate units at the University of Toronto.

Referring to Table 1-1, the universities in Ontario that currently offer graduate programs specifically in Mechanical Engineering are Carleton University/University of Ottawa[*], McMaster University, Queen's University, Royal Military College of Canada, Ryerson University, University of Toronto[†], University of Waterloo, and University of Windsor. The University of Western Ontario also offers graduate studies in Mechanical Engineering, but its program is listed under the general title of Engineering Science. Counting the program offered by Carleton University/University of Ottawa as one and also counting the program at the University of Western Ontario, there are a total of nine institutions offering graduate programs in Mechanical Engineering in Ontario.

In addition to the above programs, a number of other programs are offered at Ontario universities that could be thought of as complementary to Mechanical Engineering including: Lakehead University – Engineering (Controls); Laurentian University – Mineral Resources Engineering; McMaster University – Materials Science & Engineering; Queen's University – Materials & Metallurgical Engineering and Mining Engineering; University of Toronto - Aerospace Science & Engineering, Biomedical Engineering, Integrated Manufacturing, Materials Science & Engineering, and Wood Engineering; University of Western Ontario – Biomedical Engineering; and University of Windsor – Industrial Engineering and Manufacturing Systems. McMaster University, Queen's University, University of Toronto, University of Waterloo, and University of Western Ontario offer a joint program in Design & Manufacturing through the Advanced Design and Manufacturing Institute (ADMI).

Figure 1-1 indicates the cities offering graduate engineering programs in Southern Ontario. Note that Kingston, Toronto, and Ottawa each have two universities offering graduate engineering programs. Figure 1-1 marks the location of all cities in Ontario offering graduate engineering programs with the exception of one, Lakehead University in Thunder Bay.

* Carleton University and University of Ottawa have a joint graduate program in Mechanical & Aerospace Engineering administered through the Ottawa-Carleton Institute for Mechanical and Aerospace Engineering (OCIMAE).
† University of Toronto offers a program in Mechanical & Industrial Engineering.

Figure 1-1: Cities Offering Graduate Engineering Programs in Southern Ontario (Large Circles ●) and the Location of the University of Ontario Institute of Technology in Oshawa
Source: Yahoo! Maps (http://maps.yahoo.com/)

1.2.2 Graduate program demand

The demand for Mechanical Engineering graduate studies is evident based on the increasing student enrolment in Mechanical Engineering graduate programs across Ontario. Table 1-2 shows the total enrolment for all Mechanical Engineering programs in Ontario in terms of the number of full-time and part-time PhD and master's students. The table shows that since the academic year 1998/1999, enrolments in PhD programs have increased 42% for full-time students and 40% for part-time students. Over the same period, full-time master's student enrolments have increased by 79%, while part-time student enrolments have increased by 66%. These numbers show that there is a major demand for graduate studies in Mechanical Engineering in Ontario.

Table 1-2: Graduate Enrolment in Mechanical Engineering Programs in Ontario: 1998/1999 to 2002/2003

Program	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	Growth (%) 1998 to 2003
PhD Full-Time	176	168	170	202	250	42
PhD Part-Time	20	22	26	30	28	40
Master's Full-Time	286	313	335	458	512	79
Master's Part-Time	112	134	135	181	186	66

Source: Ontario Council on Graduate Studies (OCGS) Macroindicator Data 2002-2003

Due to recent events in the United States, there has been a shift in international graduate student enrolments from the United States to Canada. In addition, new immigrants to Canada are interested in upgrading their skills in order to obtain employment. These two trends are adding to the demand for increased graduate student spaces in Ontario.

Government policies are also increasing the demand for graduate programs in Mechanical Engineering. The Government of Canada has outlined a number of goals and targets in its Innovation Strategy‡, including:

GOALS - ADDRESSING THE KNOWLEDGE PERFORMANCE CHALLENGE
• Vastly increase public and private investments in knowledge infrastructure to improve Canada's R&D performance.

TARGETS
• By 2010, rank among the top five countries in the world in terms of R&D performance.
• By 2010, at least double the Government of Canada's current investments in R&D.

GOALS - ADDRESSING THE SKILLS CHALLENGE
• Develop the most skilled and talented labour force in the world.

TARGETS
• Through to 2010, increase the admission of master's and PhD students at Canadian universities by an average of 5 percent per year.
• By 2004, significantly improve Canada's performance in the recruitment of foreign talent, including foreign students, by means of both the permanent immigrant and the temporary foreign workers programs.
• Over the next five years, increase the number of adults pursuing learning opportunities by 1 million.

GOALS - ADDRESSING THE INNOVATION ENVIRONMENT CHALLENGE

‡ Source: Industry Canada, 2002, *Achieving Excellence: Investing in People, Knowledge and Opportunity*.

• Governments at all levels work together to stimulate the creation of more clusters of innovation at the community level.
• Federal, provincial/territorial and municipal governments cooperate and supplement their current efforts to unleash the full innovation potential of communities across Canada, guided by community-based assessments of local strengths, weaknesses and opportunities.

TARGETS
• By 2010, develop at least 10 internationally recognized technology clusters.
• By 2010, significantly improve the innovation performance of communities across Canada.

The proposed graduate programs in Mechanical Engineering at UOIT are poised to help meet the above goals and targets.

The Council of Ontario Universities (COU) formed a Task Force on Future Requirements for Graduate Education in Ontario. The Task Force determined that the Government of Ontario should establish a 10-year goal of doubling graduate enrolment in Ontario's universities to meet the demand for increased graduates[§]. The programs proposed by UOIT and the location of the university make it a logical choice for expanding Mechanical Engineering graduate school capacity in Ontario.

Within the Greater Toronto Area (GTA) there are currently only two universities offering graduate programs in Mechanical Engineering: Ryerson University and the University of Toronto (see Figure 1-2).

§ Source: COU Task Force on Future Requirements for Graduate Education in Ontario, 2003, *Advancing Ontario's Future Through Advanced Degrees.*

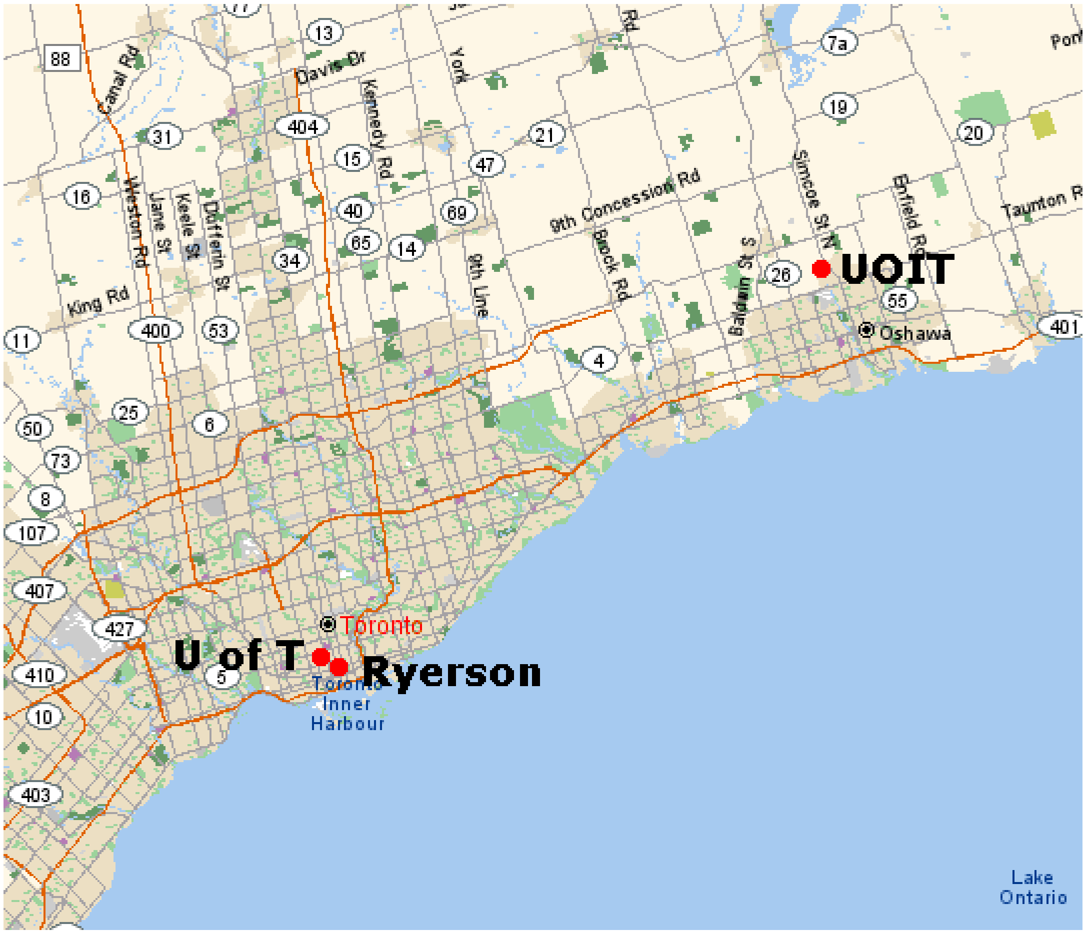

Figure 1-2: Map of the Central and Eastern Portions of the Greater Toronto Area (GTA) Showing the Locations of Ryerson University, the University of Toronto (U of T), and the University of Ontario Institute of Technology (UOIT)
Source: Yahoo! Maps (http://maps.yahoo.com/)

The population of the GTA as of the 2001 census was 4,682,897**. Montréal, with a 2001 census population of 3,426,350††, has four universities that offer graduate programs in Mechanical Engineering: Concordia University, École de Technologie Supérieure, École Polytechnique, and McGill University. Comparing the GTA to Montréal on the basis of population, the GTA lacks Mechanical Engineering graduate school capacity. The addition of a graduate program in Mechanical Engineering at UOIT will help increase the graduate school capacity in Mechanical Engineering within the GTA.

The location of UOIT within the GTA is also ideal. Figure 1-3 shows the location of graduate engineering programs in the GTA and neighbouring cities. Figure 1-3 shows that there are no engineering graduate schools in the eastern half of the GTA or in any neighbouring cities east of the GTA. All of the graduate schools in the region are located in the centre of the GTA or in neighbouring cities west of the GTA. The location of UOIT makes it an excellent choice for bringing

** Source: Statistics Canada (http://www.statcan.ca/)
†† Source: Statistics Canada (http://www.statcan.ca/)

increased engineering graduate school capacity to the eastern half of the GTA and neighbouring cities.

Figure 1-3: Universities Offering Graduate Engineering Programs within the Greater Toronto Area (GTA) and Neighbouring Cities and the Location of the University of Ontario Institute of Technology (Note that the University of Guelph Does Not Offer a Graduate Program in Mechanical Engineering)
Source: Yahoo! Maps (http://maps.yahoo.com/)

In addition to being in a strategic location based on the population of the GTA, the location of UOIT is also ideal for taking advantage of a number of major industrial companies in the eastern half of the GTA whose areas are very relevant to the Mechanical Engineering programs being proposed by UOIT. These companies include General Motors Canada, Ontario Power Generation, Siemens, Messier-Dowty, and many others.

1.3 Mission

The mission of the Faculty of Engineering and Applied Science is to contribute to society through excellence in education, scholarship, and service. We will provide for our graduate students a rigorous education and endeavour to instil in them the attitudes, values, and vision that will prepare them for a lifetime of continued learning and leadership in their chosen careers. We engage in scholarship of discovery, application, and integration.

1.4 Program objectives

There are four objectives common to the graduate programs:

- Depth. To provide students with an understanding of the fundamental knowledge prerequisites for the practice of, or for advanced study in, the fields of energy and thermo-fluids engineering and mechatronics and manufacturing engineering, including their scientific principles, analysis techniques, and design methodologies.

- Breadth. To provide students with the broad and advanced education necessary for productive careers in the public or private sectors and in academia.

- Professionalism. To develop skills necessary for clear communication and responsible teamwork, and to inspire professional attitudes and ethics, so that students are prepared for modern work environments and for lifelong learning.

- Learning Environment. To provide an environment that will enable students to pursue their goals through innovative graduate programs that are rigorous, challenging, and supportive.

The main objective of the MASc program is to prepare students for a career as a R&D engineer. Graduates of the program will be able to work as R&D engineers in advanced technology companies or government agencies or continue on in their education and pursue a doctorate degree.

The objectives of the MASc program are achieved through a combination of course work, supervised research, a research seminar, and a research thesis.

The main objective of the MEng program is to provide the opportunity for engineers in industry to upgrade and expand their skills. Graduates of the program will be able to apply what they have learned in a variety of applications in industry.

The objectives of the MEng program are achieved through either a combination of course work and a project, or solely course work depending on which option the student selects.

1.5 Method used for the self-study as well as the preparation of the brief, including faculty and student input and involvement

This appraisal was prepared by the Graduate Committee of the Faculty of Engineering and Applied Science in collaboration with its affiliated School of Energy Systems and Nuclear Science. Input from industry professionals and academics at other institutions have been sought. The appraisal has gone through thorough reviews by the Curriculum Committee and the Faculty Council of the Faculty of Engineering and Applied Science and School of Energy Systems and Nuclear Science as while as by the Associate Provost, Research and Graduate Studies, the Curriculum and Program Review Committee, and the Academic Council of UOIT.

1.6 Fields in the programs

The master's programs comprise the following fields:

- Energy and Thermofluids Engineering
- Mechatronics and Manufacturing Engineering

1.7 Review concerns expressed in previous appraisal and actions taken

As this is an application for a new program, this section is not applicable.

1.8 Special matters and innovative features

The University of Ontario Institute of Technology provides each of its students access to its Mobile Learning Environment. Every graduate student at UOIT will have wireless and wired access to library resources, email, and the internet, in addition to other online services.

Students enrolled in the programs will have access to three state-of-the-art facilities that are unique to Canada: the Borehole Thermal Energy Storage System (BTESS), the Integrated Manufacturing Centre (IMC), and the Automotive Centre of Excellence (ACE). The BTESS, IMC, and ACE will provide an opportunity for graduate students in the program to conduct innovative research in either of the proposed fields of the program.

The BTESS is one of the largest geothermal well fields in North America. Three hundred and eighty-four holes, each 213 metres (700 feet) deep, provide the basis for a highly efficient and environmentally friendly heating and cooling system, capable of regulating eight of UOIT's buildings. The geothermal site provides a unique facility within Canada to conduct research into thermal energy storage.

The IMC is a fully automated, industrial-grade, flexible manufacturing facility capable of fabricating and assembling a wide range of products from raw materials, with limited human intervention. The IMC provides a facility to conduct research in advanced manufacturing and mechatronics engineering.

The ACE will be a state-of-the-art automotive R&D facility on UOIT's campus. ACE will provide graduate students conducting research related to the automotive industry access to world class facilities that will be unique to Canada.

Details about the BTESS, IMC, and ACE are provided in Section 3.2.

2 THE FACULTY

2.1 List of faculty by field

Table 2-1 lists the faculty members involved in the graduate program and identifies their research field, gender, home unit, and supervisory privileges. Expected retirements within the next seven years are also noted in Table 2-1.

Currently there are 20 core faculty members involved in the programs. There are 14 Category #1 core faculty, five Category 3 core faculty, and one Category 5 core faculty. For the Category 1 faculty, eleven are from the Faculty of Engineering and Applied Science and three are from the School of Energy Systems and Nuclear Science. For the Category 3 faculty, three members hold joint appointments with the Faculty of Engineering and Applied Science and Faculty of Business and Information Technology, one member is from the School of Energy Systems and Nuclear

Science, and one member is from the Faculty of Science. For the Category 5 faculty, the one member is with the Faculty of Engineering and Applied Science.

It must be noted that since UOIT is a new university, the number of professors involved in the programs will increase rapidly over the coming years. Table 2-2 shows the plan for new faculty hires in both the Faculty of Engineering and Applied Science and the School of Energy Systems and Nuclear Science.

Table 2-1: Faculty Members by Field

					Fields[3]	
Faculty Name & Rank[1]	**M/F**	**Ret. Date**	**Home Unit[2]**	**Supervisory Privileges**	**1**	**2**
Category 1						
Bereznai - Professor	M	2007	SESNS	Full	x	
Dincer - Professor	M		FEAS	Full	x	
Esmailzadeh - Professor	M		FEAS	Full		x
Gabriel - Professor	M		FEAS	Full	x	
Gulshani - Associate	M		SESNS	Full	x	
Lin - Assistant	F		FEAS	Full		x
Marceau - Professor	M		FEAS	Full	x	
Naterer - Professor	M		FEAS	Full	x	
Nichita - Assistant	M		SESNS	Full	x	
Nokleby - Assistant	M		FEAS	Full		x
Pop-Iliev - Associate	M		FEAS	Full		x
Rizvi - Assistant	M		FEAS	Full		x
Rosen - Professor	M		FEAS	Full	x	
Zhang - Assistant	M		FEAS	Full		x
Category 2						
N/A						
Category 3						
Berg - Assistant	M		FS	Full	x	
Grami - Associate	M		FEAS/FBIT	Full		x

Martin - Assistant	M		FEAS/FBIT	Full		x
Vargas Martin - Assistant	M		FEAS/FBIT	Full		x
Waller - Associate	M		SESNS	Full	x	
***Category* 4**						
N/A						
***Category* 5**						
Gorantla – Adjunct Associate	M		FEAS	Full		x
***Category* 6**						
N/A						

[1] *Category 1: Tenured or tenure-track core faculty members whose graduate involvement is exclusively in the graduate program under review.*
Category 2: Non-tenure-track core faculty members whose graduate involvement is exclusively in the graduate program under review.
Category 3: Tenured or tenure-track core faculty members who are involved in teaching and/or supervision in other graduate program(s) in addition to being a core member of the graduate program under review.
Category 4: Non-tenured or tenure-track core faculty members who are involved in teaching and/or supervision in other graduate program(s) in addition to being a core member of the graduate program under review.
Category 5: Other core faculty including emeritus and adjunct professors.
Category 6: Non-core faculty who participate in the teaching of graduate courses.
[2] *FBIT: Faculty of Business and Information Technology*
FEAS: Faculty of Engineering and Applied Science
FS: Faculty of Science
SESNS: School of Energy Systems and Nuclear Science
[3] *Field 1: Energy and Thermofluids Engineering*
Field 2: Mechatronics and Manufacturing Engineering

Table 2-2: Planned Faculty Hiring for the Years 2005 to 2008

			Number in Each Field[3]	
Home Unit[1]	**Year**	**Total Number[2]**	**1**	**2**
FEAS	2005/2006	1.5	0	1.5
SESNS	2005/2006	4	4	0
FEAS	2006/2007	14	2	7
SESNS	2006/2007	6	6	0
FEAS	2007/2008	13	3	7
SESNS	2007/2008	4	4	0
FEAS	2008/2009	11	2	6

SESNS	2008/2009	-	-	-

[1] *FEAS: Faculty of Engineering and Applied Science*
SESNS: School of Energy Systems and Nuclear Science
[2] *Includes total number of faculty hires in all FEAS programs (Automotive, Electrical, Manufacturing, Software, and Electrical).*
[3] *Field 1: Energy and Thermofluids Engineering*
Field 2: Mechatronics and Manufacturing Engineering

2.2 External operating research funding

Table 2-3 presents the external research funding that faculty members have received to date since 1998. Note that the funding listed represents only confirmed funding and shall increase as the faculty successfully secure additional funding. Since the first faculty started at UOIT in 2003, the funding in Table 2-3 for the years 1998 to 2002 represents funding secured by UOIT faculty while at other institutions.

Table 2-3: Operating Research Funding by Source and Year

	Source			
Year[1]	**Granting Councils [2]**	**Other Peer Adjudicated [3]**	**Contracts**	**Others [4]**
1998	$58,373.50	$153,584.19	$50,928.00	$83,310.00
1999	$999,667.50	$111,633.00	$44,000.00	$109,041.00
2000	$667,902.50	$116,179.00	$111,860.50	$2,675.00
2001	$264,307.50	$61,375.00	$33,750.00	$0.00
2002	$93,000.00	$389,360.00	$33,750.00	$0.00
2003	$83,000.00	$150,505.00	$61,250.00	$128,210.00
2004	$312,397.00	$57,975.00	$162,190.00	$283,210.00
2005[5]	$134,870.00	$30,000.00	$105,050.00	$170,000.00
Totals	$2,613,518.00	$1,070,611.19	$602,778.50	$781,446.00

[1] *Calendar year.*
[2] *NSERC; CFI (including partner contributions: Manitoba Innovations Fund (MIF), Northern Ontario Heritage Fund (NOHF), Ontario Research and Development Challenge Fund (ORDCF), Westland Helicopters, Manitoba Hydro).*
[3] *Canadian International Development Agency (CIDA); Canadian Space Agency (CSA); Environment Canada; Natural Resources Canada; Mathematics of Information Technology and Complex Systems (MITACS), Premier's Research Excellence Awards (PREA), Ontario Ministry of Community and Social Services, Business and Technology Integration Branch; Alberta Innovation Fund; Western Economic Diversification; International Federation for the Promotion of Mechanism and Machine Science (IFToMM), King Fahd University of Petroleum and Minerals (KFUPM); Sharif University of Technology; Government of Brunei; Government of Iran.*
[4] *University start-up grants and other miscellaneous research funding.*
[5] *Confirmed to date. Note that all new faculty have applied for NSERC Discovery Grants. In addition, faculty have applied for NSERC Research Tools and Instruments Grants and CFI New Opportunities Grants.*

Table 2-4 presents the total external research funding by field for 2003 to 2005. As with Table 2-3, the amounts in Table 2-4 represent only the confirmed funding and shall increase as the faculty successfully secure funding from the various source listed above and from industry.

Table 2-4: Total External Operating Funding by Field – 2003 to 2005

	Granting Councils	Other peer adjudicated	Contracts	Others
Field 1	$306,650.00	$155,380.00	$328,490.00	$256,420.00
Field 2	$223,617.00	$83,100.00	$0.00	$325,000.00

Faculty members are actively applying for funding from the Natural Sciences and Engineering Research Council (NSERC) of Canada, the Canadian Foundation for Innovation (CFI), AUTO21, Materials and Manufacturing Ontario (MMO), the Premier's Research Excellence Awards (PREA), among others. In addition, the faculty are active in securing research funding through industry contracts. As the number of faculty increases over the next few years, it is fully expected that the funding presented in Tables 2-3 and 2-4 will increase substantially.

2.3 Graduate supervision

Table 2-5 lists the completed and current numbers of thesis supervisions by faculty member. The Table shows that there is a good balance of senior professors, who have successfully graduated students, and new professors, who have not yet graduated students. Table 2-5 also shows that although UOIT does not yet have a graduate program in engineering, that members of the faculty are active in co-supervising students with professors at other institutions within Ontario and Canada. A number of the faculty involved in the proposed program currently hold adjunct appointments at other universities. Table 2-6 outlines these adjunct appointments.

Table 2-5: Completed and Current Numbers of Thesis Supervisions by Faculty Member

	Completed			Current		
Member	**Master's**	**PhD**	**PDF**	**Master's**	**PhD**	**PDF**
Category 1						
Bereznai	2	0	0	0	0	0
Dincer	7	4	5	2	3	4
Esmailzadeh	31	8	7	4	4	3
Gabriel	16	1	7	3	1	0
Gulshani	0	0	0	0	0	0
Lin	0	0	0	6	1	1

Marceau						
Naterer	5	1	0	1	8	0
Nichita	0	0	0	0	0	0
Nokleby	0	0	0	1	0	0
Pop-Iliev	4	0	0	0	1	0
Rizvi	3	0	0	0	2	1
Rosen	10	1	2	4	0	2
Zhang	2	0	0	0	0	0
Category 3						
Berg	0	0	0	0	0	0
Grami	0	0	0	0	0	0
Martin	11	0	0	0	0	0
Vargas Martin	0	0	0	0	0	0
Waller	2	0	0	1	0	0
Category 5						
Gorantla	2	0	0	0	0	0

Table 2-6: Adjunct Appointments

Member	**University – Department**
Category 1	
Bereznai	
Dincer	Carleton University – Department of Mechanical Engineering University of Waterloo – Department of Mechanical Engineering
Esmailzadeh	Concordia University – Department of Mechanical and Industrial Engineering Sharif University of Technology, Iran – Department of Mechanical Engineering University of Toronto – Department of Mechanical and Industrial Engineering
Gabriel	
Gulshani	
Lin	
Marceau	

Naterer	University of Manitoba – Department of Mechanical and Manufacturing Engineering (pending) University of Toronto – Department of Mechanical and Industrial Engineering (pending)
Nichita	
Nokleby	University of Victoria – Department of Mechanical Engineering (pending)
Pop-Iliev	
Rizvi	
Rosen	Ryerson University – Department of Mechanical and Industrial Engineering University of Western Ontario – Department of Mechanical Engineering
Zhang	University of Saskatchewan – Department of Mechanical Engineering
Category 3	
Berg	University of Waterloo – Department of Mechanical Engineering
Grami	Ryerson University – Department of Electrical and Computer Engineering
Martin	
Vargas Martin	Universidad Autonoma de Aguascalientes, Mexico– Department of Electronic Systems
Waller	Royal Military College of Canada – Department of Chemistry and Chemical Engineering University of New Brunswick – Department of Mechanical Engineering
Category 5	
Gorantla	

2.4 Current teaching assignments

Table 2-7 shows the planned teaching loads for the 2005/2006, academic year. Table 2-8 shows the teaching assignments for the 2004/2005 academic year and Table 2-9 shows the teaching assignments for the 2003/2004. Note that UOIT took in its first undergraduate students in the 2003/2004 academic year.

Table 2-7: Teaching Assignments for 2005/2006 at UOIT

Faculty Member	Rank	Undergraduate[1]	Graduate	Comments
Category 1				
Bereznai	Professor	ENGR3860 (3/0/1) ENGR4640 (3/0/1)		Dean, School of Energy Systems and Nuclear Science

Dincer	Professor	ENGR 2320U (3/1/1) ENGR 2860U (3/1/1) (2 Sections)		
Esmailzadeh	Professor	ENGR 2020U (4/0/2) (2 Sections)		Programs Director, Faculty of Engineering and Applied Science
Gabriel	Professor			Associate Provost, Research and Graduate Programs, UOIT
Gulshani	Associate			
Lin	Assistant	ENGR 3200U (3/1.5/1.5) ENGR 3460U (3/1.5/1.5)		
Marceau	Professor			Provost, UOIT
Naterer	Professor	ENGR 2640U (3/1/1)		
Nichita	Assistant			
Nokleby	Assistant	ENGR 3200U (3/1.5/1.5) ENGR 3270U (3/1/1) ENGR 3390U (3/1/1)		
Pop-Iliev	Associate	ENGR 2310U (3/2/0) ENGR 3030U (4/2/0) ENGR 3300U (3/0/1)		
Rizvi	Assistant	ENGR 2220U (3/0/0) ENGR 2420U (3/1/1) ENGR 3190U (3/1.5/0)		
Rosen	Professor			Dean, Faculty of Engineering and Applied Science
Zhang	Assistant	ENGR 2220U (3/0/0) ENGR 2420U (3/1/1) ENGR 3350U (3/1/1)		
Category 3				
Berg	Assistant			
Grami	Associate	ENGR XXXXU		
Martin	Assistant	ENGR 1200U (3/0/2)		
Vargas Martin	Assistant	ENGR 1200U (3/0/2)		
Waller	Associate			
Category 5				

Gorantla	Adjunct Associate			

[1] *The numbers in the brackets following the course number correspond to weekly Lecture/Laboratory/Tutorial hours, respectively.*
[2] *Team teaching with another professor.*
[3] *MITS courses are part of the Faculty of Business and Information Technology's Master of Information Technology Security Program.*

Table 2-8: Teaching Assignments for 2004/2005 at UOIT

Faculty Member	Rank	Undergraduate[1]	Graduate	Comments
Category 1				
Bereznai	Professor			Dean, School of Energy Systems and Nuclear Science
Dincer	Professor	ENGR 2640U (3/1/1) ENGR 2860U (3/1/1)		
Esmailzadeh	Professor	ENGR 2020U (4/0/2)		Programs Director, Faculty of Engineering and Applied Science
Gabriel	Professor			Associate Provost, Research and Graduate Programs, UOIT
Gulshani	Associate	ENGR 2010U (3/1/1) ENGR 2860U (3/1/1)		
Marceau	Professor			Provost, UOIT
Nichita	Assistant	ENGR 2500U (3/0/0) ENGR 3820U (3/0/0)		
Nokleby	Assistant	ENGR 3200U (3/1.5/1.5)		
Pop-Iliev	Associate	ENGR 2310U (3/2/0) ENGR 3200U (3/1.5/1.5)		
Rizvi	Assistant	ENGR 2220U (3/0/0) (2 Sections)		
Rosen	Professor			Dean, Faculty of Engineering and Applied Science
Zhang	Assistant	ENGR 2420U (3/1/1)		
Category 3				
Berg	Assistant	PHY 1010U (3/1.5/1)[2] (2 Sections) PHY 1020U (3/1.5/1)[2] (2 Sections)		

Grami	Associate	BUSI 1900U (3/0/0) ENGR 2790U (3/2/1)	MITS 5200G[2, 3] MITS 5500G[2, 3]	
Martin	Assistant		MITS 5200G[2, 3] MITS 5300G[3]	
Vargas Martin	Assistant	BUSI 1830U (3/0/2) ENGR 1200U (3/0/2) (2 Sections)		
Waller	Associate	ENGR 2140 (3/0/2) ENGR 2950 (3/2/0)		
Category 5				
Gorantla	Adjunct Associate	ENGR 2790U (3/2/1) (Lab Instructor)		

[1] *The numbers in the brackets following the course number correspond to weekly Lecture/Laboratory/Tutorial hours, respectively.*
[2] *Team teaching with another professor.*
[3] *MITS courses are part of the Faculty of Business and Information Technology's Master of Information Technology Security Program.*

Table 2-9: Teaching Assignments for 2003/2004 at UOIT

Faculty Member	Rank	Undergraduate[1]	Graduate	Comments
Category 1				
Bereznai	Professor		ENG PHY 6P03[3]	Dean, School of Energy Systems and Nuclear Science
Dincer	Professor			
Esmailzadeh	Professor	ENGR 3200U (3/1.5/1.5)[2]		Programs Director, Faculty of Engineering and Applied Science
Pop-Iliev	Assistant	ENGR 3200U (3/1.5/1.5)[2]		
Rosen	Professor			Dean, Faculty of Engineering and Applied Science
Category 3				
Grami	Associate	BUSI 1520U (3/0/0) BUSI 1900U (3/0/0)		
Martin	Assistant	BUSI 1500U (3/0/0) BUSI 1830U (3/0/2) ENGR 1200U (3/0/2)		
Waller	Associate			

[1] The numbers in the brackets following the course number correspond to weekly Lecture/Laboratory/Tutorial hours, respectively.
[2] Team teaching with another professor.
[3] Taught at McMaster University (course title: ENG PHY 6P0 – Nuclear Power Plant Systems and Operation).

When the graduate program starts in the Fall of 2005, a normal teaching load will consist of three to four semester-length courses per year.

2.5 Commitment of faculty members from other graduate programs and/or from other institutions

Professors Grami, Martin, and Vargas Martin hold cross appointments between the Faculty of Engineering and Applied Science and the Faculty of Business and Information Technology, and are involved in teaching courses in the Faculty of Business and Information Technology's Master of Information Technology program. As cross-appointed faculty, all three faculty members will divide their time accordingly between the two faculties.

Professor Waller of the School of Energy Systems and Nuclear Science is involved in teaching one course in the Faculty of Business and Information Technology's Master of Information Technology program.

Professor Berg of the Faculty of Science is involved in proposed graduate programs within the Faculty of Science, in addition to being involved in the proposed graduate program of the Faculty of Engineering and Applied Science. It is expected that as UOIT expands, additional members from the Faculty of Science whose expertise compliment the fields listed will become involved in the proposed programs.

3 PHYSICAL AND FINANCIAL RESOURCES

3.1 Library resources

The goal of the University of Ontario Institute of Technology library is to enrich the research, teaching, study, and conversation of the University by providing exceptional library and information services and facilities to support all academic programs.

The construction of a new, state-of-the-art library for the University of Ontario Institute of Technology was completed in the fall of 2004. Designed by internationally renowned Diamond and Schmitt Architects Incorporated, the 73,000-square-foot library serves students, faculty, and staff. The four-storey, $20.7-million library houses individual and collaborative learning spaces, research workstations, electronic classrooms, a round pavilion with a reading room and periodicals collection, and other facilities. It offers a variety of learning spaces to suit individual learning styles and user needs. Its design also allows for future enlargement, up to double the original size.

The University's Mobile Learning environment provides students with access to library resources using their wireless laptop anytime, from anywhere. Students are able to work individually or collaboratively anywhere in the building. Digital resources and complementary print collections are provided for students in both a physical and virtual environment. Librarians are available to provide students with the skills to navigate effectively through the information environment.

In addition to interlibrary loans, students will also have access to the resources available at the largest academic library in Canada, the University of Toronto Libraries, through a partnership program.

To keep faculty and students informed of the library's continued growth and to provide easy access to resources, the UOIT Library staff have been constructing and revising its web site: www.uoit.ca/library on an ongoing basis.

A more detailed presentation on the library resources is listed in Appendix A: Library Submission.

3.2 Laboratory facilities

Students in the MASc and MEng programs will have access to the following major equipment and common facilities:

- **Borehole Thermal Energy Storage System (BTESS)** - The BTESS is one of the largest geothermal well fields in the world. Three hundred and eighty-four holes, each 213 metres (700 feet) deep, provide the basis for a highly efficient and environmentally friendly heating and cooling system, capable of regulating eight of UOIT's buildings. The facility contains a large monitoring station for thermal/energy data monitoring and recording. This data will be an excellent source of material for graduate theses in the area for system analysis, design, optimization, and performance improvement. The geothermal site provides a unique facility within Canada to conduct research into thermal energy storage.

- **Integrated Manufacturing Centre (IMC)** - The IMC is a 925 m^2, fully automated, industrial-grade, flexible manufacturing facility capable of fabricating and assembling a wide range of products from raw materials, with limited human intervention. The IMC provides a facility to conduct research in advanced manufacturing and mechatronics engineering. The main components of the IMC are divided into two areas: the manufacturing zone and the assembly zone.

  Manufacturing Zone:
    - Inverted, Rail-Mounted, 6-Axis Robot
    - Parts Washer
    - CNC Electrical Discharge Machine (EDM)
    - CNC Milling Machine
    - CNC Lathe
    - Injection Moulding Machine
    - CNC Coordinate Measuring Machine (CMM)
    - 3-D Printer

  Assembly Zone:
    - Automatic Storage and Retrieval System (ASRS)
    - Conveyor System
    - Eight 6-Axis Robots (Two with Welding Capabilities)

- **Automotive Centre of Excellence (ACE)** - UOIT in conjunction with General Motors Canada, the Province of Ontario, and the Government of Canada, have agreed to develop a $58-million state-of-the-art automotive R&D facility on UOIT's campus. The Automotive Centre of Excellence, will provide graduate students conducting research related to the automotive industry access to world class facilities that will be unique to Canada. Facilities in the Automotive Centre of Excellence will include:
    - Wind Tunnel
    - Four Engine Test Rigs
    - Three Dynamometers
    - Three Horiba Emission Analysers
    - Rapid Prototyping Facility
    - Machine Shop
    - Materials Testing Facility

The Faculty of Engineering and Applied Science and School of Energy Systems currently have the following research labs:

- Active Vibration Control Laboratory – UA1540 (65 m^2 – Shared)
- Advanced Materials Engineering Laboratory – UA1440 (70 m^2 – Shared)
- Centre for Engineering Design, Automation, and Robotics (CEDAR) – UA1460 (65 m^2 – Shared)
- Intelligent Robotics and Manufacturing Laboratory – UA1460 (65 m^2 – Shared)
- Laboratory for Applied Research on Design and Engineering of Composite Materials – UA1440 (70 m^2 – Shared)
- Mechatronic and Robotic Systems Laboratory – UA1460 (65 m^2 – Shared)
- Nuclear Engineering Laboratory – UA4150 (78 m^2)
- Radiation Engineering Laboratory – UAB408 (45 m^2)
- SHARCNET – UA4280 (70 m^2)
- Sustainable Energy Systems Laboratory – UA1620 (55 m^2)
- Thermal Engineering and Microfluidics Laboratory – UA1520 (60 m^2)
- Two-Phase Flow Laboratory – UA1420 (78 m^2)

Active Vibration Control Laboratory: This lab is primary used for research into the areas of adaptive, active and passive vibration control, and dynamic modeling and vibrations of nonlinear machines and flexible structures. The experimental work to be carried out is aimed to verify the vibration suppression of time-varying and parametrically excited dynamic structures through adapting a two-tier alternative: a) system identification to determine the deviations in the structural parameters, and b) a semi-active optimal re-tuning of the absorber elements. In order to show the vibration suppression improvement, initially the primary will be excited by a simple harmonic excitation. Then by changing the frequency of excitation the effectiveness of the re-tuning procedure is obtained. In addition to the above experiment, the use of servo-valve controlled pneumatic isolators will be considered. For this study, feedback and feedforward signals using displacement and velocity transducers (LVDT) will be fed to the control systems to excite the spool valve and in turn adjust the air trapped in the pneumatic below. The aim is to have zero level motion for a sprung mass subjected to a harmonically excited base support.

Advanced Materials Engineering Laboratory: The Advanced Materials Engineering Laboratory researches wood plastic composites and polymer bonding, along with other areas.

Wood Plastic Composites
Wood is one of the most versatile of natural materials with many desirable properties and therefore, its wide spread usage as building material is placing strain on world's forestry resources. The research involves development and production of Wood Plastic Composites (WPC) with improved properties so that these composites can replace wood in many applications, thereby, helping reduce deforestation rates. The currently produced WPC, due to their inferior properties, are not suitable for many wood replacement applications. This research focuses on improving the properties of WPC by using stronger reinforcing fibres, in conjunction with incorporating a fine cellular structure so that the new composite not only looks and feels like real wood but will have mechanical properties similar to it too. The WPC will be produced on extrusion processing system capable of using both chemical and physical blowing agents.

Polymer Bonding
This research involves improvement of mechanical properties of plastic parts produced by rapid prototyping systems, with the ultimate goal of manufacturing functional parts instead of just 3D models. The parts are produced by fusing particles or filaments of plastics, at elevated temperatures, which are formed layer by layer to build up a 3D part. It entails studying the bond formation due to sintering and diffusion phenomena in polymers and developing predictive models so that new materials and compositions can be evaluated expeditiously with minimum experimentations.

Other Research Areas
Other research interests at the lab are development of production processes and the characterization of new composites, nano-materials, bio-based materials, and foamed materials.

Centre for Engineering Design, Automation, and Robotics (CEDAR): A group of faculty members from the Faculty of Engineering and Applied Science has been awarded a New Opportunities Grant from the Canada Foundation for Innovation (CFI) to purchase infrastructure for the Centre for Engineering Design, Automation, and Robotics (CEDAR). The initial infrastructure for CEDAR will comprise a reconfigurable manipulator system, a mobile-manipulator system, and a machine vision system. The facilities will be used to conduct research into robotics, mechatronics, and manufacturing. The CEDAR facilities will also be used in conjunction with the IMC to increase the IMC's ability to conduct research into flexible manufacturing. CEDAR currently has two affiliated laboratories: the Intelligent Robotics and Manufacturing Laboratory and the Mechatronic and Robotic Systems Laboratory.

Intelligent Robotics and Manufacturing Laboratory: The Intelligent Robotics and Manufacturing Lab within the Centre for Engineering Design, Automation, and Robotics (CEDAR) at UOIT has two core research directions: Reconfigurable Manufacturing and Distributed Control. The two core research areas of the lab focus on developing complementary new technologies for flexible manufacturing systems. The objectives of the Distributed Control research are to develop new Internet/Web based distributed intelligent systems to monitor, manage and control production systems. The systems developed will allow manufacturers to reorganise production and process plans dynamically within a shop floor or within a group of shop floors. The objectives of the

Reconfigurable Manufacturing direction are to develop new production systems that can be reconfigured to optimize utilization of resources. Three themes within the Reconfigurable Manufacturing research are the design of new modular reconfigurable machine systems (Reconfigurable Parallel Kinematic Machines), virtual reconfigurable manufacturing systems and modular reconfigurable control.

Laboratory for Applied Research on Design and Engineering of Composite Materials: Cellular and reinforced polymeric and metallic composite materials offer a balance of properties unavailable from other material types. Therefore, their typical applications include satisfying conflicting requirements within the aerospace, automotive, and various other high-performance industrial sectors such as: (i) the need for minimum material usage due to high material costs and weight constraints, and (ii) the need for safe and predictable performance within severe service environments. This research laboratory, led by Dr. Remon Pop-Iliev, focuses on addressing these conflicting requirements through exploring: (i) the design and development of novel composite materials capable of satisfying demanding combined mechanical, chemical, thermal and environmental factors, as well as (ii) the development of innovative processing strategies for their fabrication. In this context, the laboratory is intended to provide the scientific and engineering foundations for a variety of optimized engineering solutions such as: material selection development, materials qualification and evaluation, materials processing, product design and manufacture, product evaluation, life prediction failure analysis, and disposal recycle reuse analysis.

Mechatronic and Robotic Systems Laboratory: The Mechatronic and Robotic Systems Laboratory conducts research into advanced robotic and mechatronic systems. The laboratory is led by Dr. Scott Nokleby and is affiliated with UOIT's Centre for Engineering, Design, Automation, and Robotics (CEDAR). The lab conducts research into the kinematics and control of complex systems such as joint-redundant manipulators, mobile-manipulator systems, and redundantly-actuated parallel manipulators. Redundant manipulators and mobile-manipulator systems offer numerous advantages over traditional non-redundant systems. Effective utilization of the redundancy inherent in these systems is instrumental in moving the systems from the laboratory and applying them to real-world applications. Research will be conducted using the facilities of CEDAR. In addition, the laboratory has applied for funding from the Natural Sciences and Engineering Research Council (NSERC) of Canada to acquire a track-mounted 6-joint manipulator.

Nuclear Engineering Laboratory: Extensive use of equipment, process and systems simulation is made in support of courses and research. The University has access to several codes used in the design of CANDU type nuclear power plants, as well real-time simulations that demonstrate operational behaviours under both normal and accident conditions for nuclear power plants that use pressurized and boiling light water reactors, and pressurized heavy water reactors. A variety of virtual operator/machine interfaces are used to conduct plant operations by an individual or a team of operators.

In addition, the Nuclear Engineering Laboratory conducts research into thermohydraulics modeling, reactor physics modeling, and radiation transport modeling. Equipment planned for the laboratory includes computer racks with a multi-node processing system.

Radiation Engineering Laboratory: The Radiation Engineering Laboratory conducts research into aerosol particle characterization for health physics applications and coded aperture imaging of visually obscured objects. The equipment currently available in the laboratory includes: Malvern Spraytech particle sizer; NIM bins (2) and radiation counting electronics; portable field survey instruments. Equipment to be acquired includes: SAIC RTR-4 Portable x-ray imaging system and electronics; neutron source; and other gamma radiation sources.

SHARCNET: See Section 3.3.

Sustainable Energy Systems Laboratory: Advanced energy systems, ranging from fuel cells to energy storage systems, are now widely used in various sectors, and the key issues are analysis, design, modeling, performance improvement, and economic and environmental considerations. Research activities in the area of energy at this lab are concentrated in advanced energy systems and applications as well as alternative energy sources and technologies. The paramount objective is to make such advanced energy systems more efficient, more cost-effective, more environmentally benign and more sustainable. Some research projects are:

- Energy and exergy analysis of PEM and SO fuel cells
- Transport phenomena in PEM and SO fuel cells
- Life cycle assessment of fuel cell vehicles
- Hybrid energy systems for hydrogen production
- Energy and exergy analysis of thermal energy storage systems
- Energy and exergy analysis of crude oil distillation systems
- Energy and exergy analysis of cogeneration and district heating systems
- Energy and exergy analysis of wind energy systems
- Energy and exergy analysis of power plants
- Energy and exergy analysis of solar thermal systems (e.g., solar ponds)
- Hybrid energy systems for snow melting and freeze protection for highways and bridges
- Performance assessment of integrated energy systems

Thermal Engineering and Microfluidics Laboratory: This laboratory investigates fundamental and applied problems involving heat transfer and microfluidic energy conversion. Detailed understanding of heat transfer has importance in various applications, such as manufacturing and materials solidification problems in extrusion, welding, casting and injection molding. Experimental studies of convective heat transfer with phase change are performed in a closed test cell. Thermocouples and interferometric / pulsed laser measurements provide new temperature and velocity data involving convective irreversibilities within the fluid. Also, predictive design tools are developed with CFD (Computational Fluid Dynamics). In this laboratory, the research infrastructure includes test cells for forced and free convection, computer workstations, microchannel experiments, fluid and heat transfer instrumentation (including laser based measurements) and temperature control systems.

Additional research includes micro-scale heat transfer. Advanced miniaturization involving microfluidic systems has considerable potential in the development of ultra small power sources (micro heat engines), sensors, waste heat recovery, fluid control and advanced insulation materials. For example, micro heat engines could replace batteries in some portable electronic devices, as batteries can be problematic in terms of their bulk, cost and power generation capabilities. This laboratory investigates microfluidic transport processes in energy conversion and flow control problems. Embedded microchannels, micro-engines or micro-tabs within a surface are used to delay boundary layer separation or reduce wall friction. It is known that micro-scale heat and fluid flow become appreciably different from large-scale systems, due to surface, electromagnetic and thermocapillary effects. Experimental and theoretical studies of these effects are conducted. The micro heat engine experiment involves a suspended droplet within a microchannel and a thermal bridge providing a cyclic heat source to the microchannel. Also, it includes sensors responsive to a pressure change within the microchannel to induce a voltage drop.

Two-Phase Flow Laboratory: The Two-Phase Flow Laboratory comprises two major apparatuses: the terrestrial two-phase flow experimental facility and the Flight qualified two-phase flow experimental facility. The ground based two-phase flow experimental apparatus is used to study the behaviour of two-phase flow under different orientations and flow conditions. It is a fully automated, closed loop system with vertical upward and vertical downward observation sections, heated test sections, and a 180 degree bend. This facility allows for the study of heat transfer, film thickness, void fraction, pressure drop, and phase distribution properties of terrestrial two-phase flows. A NAC HSV-1000 high speed video camera capable of recording at 500 or 1000 frames per second in colour or black & white is used to record flow regimes and their transitions.

The flight qualified two-phase flow experimental apparatus is used to study the behaviour of two-phase flow in a simulated space environment (microgravity). It is a closed loop system with three main subsystems: 1) Fluid Management: includes the test section, pump/separator, air blower, flow meter, valves, etc.; 2) Thermal Management: includes heat sources, radiator, temperature measurement devices, etc.; and 3) Data Acquisition and Control. This facility is flight qualified for the NASA KC-135 microgravity platform. It can be used to study microgravity heat transfer, film thickness, void fraction, pressure drop, and phase distribution in various geometries. These flows can be studied over a 1.7m development length.

Additional equipment planned for the laboratory includes: circumferentially and volumetrically heated channels; concentric heaters piping; condensers and/or heat exchangers; manifolds; low-flow meters; pressure and differential transducers; void-fraction meters; thermocouples; and other instruments. The equipment will be used to conduct research on natural circulation phenomena under single-phase and two-phase flow conditions in simple pipes and interconnected piping, manifolds, and heat exchangers.

Additional Facilities: Construction of a 3,835 m^2 Engineering Laboratory Building on the UOIT campus will commence in the Spring of 2005, with completion expected in the Fall of 2006. Upon completion, graduate students will have access to the following shared laboratories:

- Combustion/HVAC Laboratory
- Component Design Laboratory
- Computer Aided Design (CAD) Laboratory
- Control Systems Laboratory
- Electronics Laboratory
- Emerging Energy Laboratory

- Fluid Mechanics/Heat Transfer Laboratories
- Manufacturing Laboratory with CNC and Plastics Processing Equipment
- Mechatronics Laboratory
- Microprocessors/Digital Systems Laboratory
- Radiation Laboratories
- Solid Mechanics Laboratory

Future Research Laboratories and Facilities: As the Faculty of Engineering and Applied Science and the School of Energy Systems and Nuclear Science expand, additional research labs will be added. Labs and facilities envisioned that are directly related to the proposed programs include:

- Biomechanical Laboratory
- Controls Laboratory
- Materials Laboratory
- Micro-Electrical-Mechanical Systems (MEMS) and Nano-Engineering Laboratory
- Thermodynamics Laboratory

With the launch of the Electrical and Software Engineering undergraduate programs in the Fall of 2005, the Faculty of Engineering and Applied Science plans to launch a graduate program in Electrical Engineering. The Electrical Engineering program will compliment the Mechatronics portion of this application. Envisioned research labs and facilities for this program include:

- Biomedical Engineering Laboratory
- Clean Room
- Digital Signal Processing (DSP) Laboratory
- Digital Systems Laboratory
- Electronics Laboratory
- Microwave and Radio-Frequency (RF) Laboratory
- Optics Laboratory
- Power Systems Laboratory
- Software Laboratory
- Wireless Communications Laboratory

3.3 Computer facilities

As mentioned previously, all students will have wireless and wired access to library resources, email, and the internet through UOIT's Mobile Learning Environment. Individual supervisors will provide computer facilities for their MASc students and some MEng-Project students. MEng students will have the option to subscribe to UOIT's laptop program. UOIT's laptop program provides students with a current model IBM laptop that is equipped with a suite of program specific software. In addition, UOIT has 240 pc's available to students in the Learning Commons and library.

UOIT is a member of the Shared Hierarchical Academic Research Computing Network (SHARCNET). SHARCNET[‡‡] is a High Performance Computing (HPC) institute involving 11

‡‡ Source: SHARCNET web site: http://www.sharcnet.ca/

academic institutions in southern Ontario. The purpose of SHARCNET is to provide support for support leading-edge research. Where required, students enrolled in the proposed programs will have access to this facility for their research.

In 2005/2006 UOIT will be joining the PACE Program – Partners for the Advancement of Collaborative Engineering Education§§. PACE is a program between General Motors, Sun Microsystems, and UGS, that provides state-of-the-art hardware and software for engineering schools. The value of the PACE contribution to UOIT will be $35 million. Both MASc and MEng graduate students will have full access to the PACE hardware and software for their studies.

3.4 Space

The Faculty of Engineering and Applied Science and the School of Energy Systems and Nuclear Science are located in UOIT's Engineering and Science Building. This is a brand new building that features office space for faculty and graduate students in addition to research lab space. The current total research space allocated to engineering is 1,496 m^2. An additional 273 m^2 has been allocated for faculty and graduate student offices.

Faculty members have private offices with telephone lines. Graduate students will have access to shared office facilities and/or research labs. All offices and research spaces are wired for access to UOIT's network. In addition, wireless and wired access is available throughout the Engineering and Science Building as well as the library and other spaces on campus.

Office space totalling 62 m^2 is currently allocated exclusively to graduate students. The amount of space allocated to graduate students will increase as the programs come online. It is expected that the majority of graduate students will have their office space within the research laboratory of their respective supervisors. Faculty office space averages 13 m^2 and faculty research space averages ~25 m^2.

3.5 Financial support of graduate students

3.5.1 MASc Students

Every MASc student offered admission to a graduate program at the Faculty of Engineering and Applied Science and its affiliate School of Energy Systems and Nuclear Science at the University of Ontario Institute of Technology should be able to complete their program regardless of their financial status.

It is expected that the average support for MASc students will be approximately $16,000 per year with funding coming from a variety of sources, including:

- UOIT Scholarships/Bursaries*** – ten Engineering Research Excellence Awards of $7,500 per year and five Engineering Research Awards of $5,000 per year will be available once the program is running full scale. These two sets of awards will be merit

§§ Source: PACE web site: http://www.pacepartners.org/

*** Note that the exact amounts of the proposed awards may change depending on University policies and market demands.

based. Another $41,000 in funding per year will be distributed on a needs basis.
- External Awards – These include NSERC postgraduate awards and provincial awards.
- Teaching Assistantships – MASc students will be eligible to earn up to approximately $8,000 per year through teaching assistantships.
- Research Assistantships – Additional support from individual supervisors will be available to students.
- Work-Study and Other Forms of Employment-Based Learning
- Provincial Loan Programs

Normally, funding will not be provided to part-time students.

3.5.2 MEng Students

MEng students will have access to financial support through provincial loan programs, teaching assistantships, and work-study placements. Normally, additional funding will not be provided to MEng students.

3.5.3 Financial Counselling

The University and its student support services shall make financial counselling available to students.

3.5.4 Annual Reporting

The Office of Graduate Programs, with the assistance of Student Services, shall issue an annual report on Student Financial Support to include the following:
- levels of student financial need;
- student financial assistance provided, broken down by category and source (external/Faculty) of assistance; and
- the debt levels carried by students upon graduation.

This report shall be submitted for information to the Academic Council.

4. PROGRAM REGULATIONS AND COURSES

4.1 The intellectual development and the educational experience of the student

There are four objectives common to the graduate programs in engineering:

- Depth: To provide students with an understanding of the fundamental knowledge prerequisites for the practice of, or for advanced study in, the fields of energy and thermo-fluids engineering and mechatronics and manufacturing engineering, including their scientific principles, analysis techniques, and design methodologies.

- Breadth: To provide students with the broad and advanced education necessary for productive careers in the public or private sectors or in academia.

- Professionalism: To develop skills necessary for clear communication and responsible teamwork, and to inspire professional attitudes and ethics, so that students are prepared for modern work environments and for lifelong learning.

- Learning Environment: To provide an environment that will enable students to pursue their goals through innovative graduate programs that are rigorous, challenging, and supportive.

The mission and values of the university provide the foundation for all activities and are reflected in the plans for the intellectual development and educational experience of graduate students in the Faculty of Engineering and Applied Science:

University Vision, Mission and Values

VISION

The University of Ontario Institute of Technology is an innovative and market-oriented institution, pursuing inquiry, discovery and application through excellence in teaching and learning, value-added research and vibrant student life.

MISSION

- Provide career-oriented undergraduate and graduate university programs with a primary focus on those programs that are innovative and responsive to the needs of students and employers.
- Advance the highest quality of research.
- Advance the highest quality of learning, teaching, and professional practice in a technologically enabled environment.
- Contribute to the advancement of Ontario and Canada in the global context with particular focus on Durham Region and Northumberland County
- Foster a fulfilling student experience and a rewarding educational (work) environment.
- Offer programs with a view to creating opportunities for college graduates to complete a university degree.

VALUES

Integrity and Respect
We will treat each other with dignity, including those with challenges.

Honesty and Accountability
Our actions reflect our values, and we are accountable for both.

Intellectual Rigour
We strive for excellence and challenge convention.

The Academic Unit

In keeping with this part of its mission to *Foster a fulfilling student experience and a rewarding educational (work) environment* UOIT has developed operational and support processes and services to enhance the learning environment for students. UOIT will continue to provide a fulfilling experience and a rewarding educational environment for graduate students.

The mission of the Faculty of Engineering and Applied Science is to contribute to society through excellence in education, scholarship, and service. We will provide for our graduate students a rigorous education and endeavour to instil in them the attitudes, values, and vision that will prepare them for a lifetime of continued learning and leadership in their chosen careers. We engage in scholarship of discovery, application, and integration.

In order for our students and faculty engage to in scholarship of discovery, application, and integration UOIT has made every effort to provide state- of- the- art learning resources, including the library, learning technologies, and laboratories. For example students in the MASc and MEng programs will have access to major equipment and common facilities such as: BTESS, IMC, and ACE. Details about these facilities are described in Section 3.2.

As can be seen in Section 2 a team of well qualified faculty is available for the development of the students and for the ongoing monitoring of program quality and student progress.

In addition, academic support staff, and student support services, also contribute to the operation of the department and provide service, guidance and support for graduate students.

The Curriculum and Program Requirements

Program Learning Outcomes

Graduates of the engineering graduate programs shall be able to:

1. Demonstrate specialized knowledge and understanding of essential facts, concepts, principles, and theories in a specific area of advanced study.

2. Recognize and be guided by social, professional, and ethical expectations and concerns involved in advanced education and research.

3. Effectively use advanced tools for research.

4. Apply the principles of effective data management, information organization, and information-retrieval skills to data of various types.

5. Utilize analytical, methodological, interpretive and expository skills in conducting projects and research

6. Expand and enhance the application of specific and well-concentrated research to engineering problems and practice

7. Critically evaluate advanced information and knowledge and examine their application in engineering practice.

8. Identify problems and opportunities for system analysis, design, improvement, and optimization.

9. Understand, explain, and solve problems using quantitative and qualitative methods.

10. Appreciate the importance of, and develop the strategies for, further education and lifelong learning.

11. Design and conduct experiments, and analyze and interpret experimental data and computational results.

12. Demonstrate effective oral and written communication skills.

The learning outcomes for the MASc program are achieved through a combination of course work, supervised research, a research seminar, and a research thesis.

The objectives for the MEng program are achieved through either a combination of course work and a project, or solely course work depending on which option the student selects.

The combination of courses and/or projects or research, will be designed collaboratively between the student and an assigned faculty advisor/mentor. Each learner will have the opportunity to develop the prerequisites for specialized practice of, or for advanced study in, the fields of energy and thermo-fluids engineering or mechatronics and manufacturing engineering, including their scientific principles, analysis techniques, and design methodologies. Learning activities and materials in graduate courses will be carefully designed to ensure that learners are deliberately exposed to study, the majority of which is at, or informed by, the forefront of engineering theory and practice.

The courses have been designed to give students in depth learning in a specialized area of engineering, opportunity for advanced development of generic skills such as communication and teamwork, as well as participation in the scholarly activities of research, seminars, and presentations.

Throughout the curriculum, learning activities are planned, and student progress will be monitored to ensure that safety, professional guidelines, and ethical responsibilities relevant to engineering and for specific areas of advanced study are modelled developed, and evaluated.

Learning Community

UOIT is committed to providing innovative programs through excellence in teaching and learning, value-added research and “vibrant student life.” The MASc and the MEng exemplify this commitment. The physical design of the university environment provides many places and spaces for groups to meet and interact, for academic and social purposes. The technological links available to students ensure that a network of communication and support among students and between students and university resources is established and strengthened during their years at UOIT. Facilities and personnel are available to support learning and development in all areas – academic, physical, social and emotional.

The student-centred philosophy of UOIT is designed to develop and continually enhance a strong sense of academic community, in which students, faculty, support staff and administrators share ideas and experiences.

Students in the MASc and MEng will benefit from the relationship with faculty in a learning partnership.

Regularly scheduled scientific presentations, guest speakers, and research colloquia which are open to the university community, are already a part of academic life at UOIT. With the development of the graduate programs this will be increased. In addition, the faculty of Engineering and Applied Science will plan to invite recognized experts and leading-edge researchers to present seminars and advise on student and faculty research. UOIT's rich network of industry and academic contacts, as exemplified by the ACE project will provide access to exceptional researchers and professionals.

Scholarly Activities

As can be seen in the basic outlines provided in Section 4.5 many courses, as well as the projects and thesis activities, require students to undertake significant independent work, and to organize and provide reports and seminars. This provides for development of leadership, organization, communication, and professional presentation skills. These sessions will be conducted in an environment which supports intellectual debate, allows for critique and constructive feedback, and encourages reflective practice.

All students in the engineering graduate programs will be encouraged to attend professional conferences and educational sessions which may take place at UOIT or outside the university. MASc students will be encouraged to attend and participate in conferences and workshops relevant for their specialized area of interest. Financial support will be made available by their faculty supervisor. Students will be encouraged and mentored to present their thesis and project work at professional conferences and to other audiences through industry and academic networks.

The learning activities and academic culture of UOIT is guided by its mission and values. The graduate programs being developed by the Faculty of Engineering and Applied Science will be a model of our university values.

Intellectual Rigour

We strive for excellence and challenge convention

4.2 Program regulations

4.2.1 Part-time studies

To facilitate access to all potential students, part-time studies will be permitted. This is especially true to allow engineers in industry access to the MEng program. The MASc program has a minimum residence requirement where the student must be enrolled full-time and attending the University of Ontario Institute of Technology. For the MASc program, students must spend a minimum of one year of full-time study in residence at UOIT.

4.2.2 Admission

The minimum admission requirements for the MEng and MASc programs is completion of an undergraduate engineering degree from an accredited engineering program at a Canadian university, or its equivalent, with a minimum of a B (75%) average in the last two years, although a B+ is preferred for MASc applicants. Applicants must possess maturity and self-motivation. Since close technical contact with a faculty member is an essential part of graduate education in engineering, MASc students must find a professor, who specializes in the applicant's desired area of research, willing to act as a supervisor, prior to being accepted into the program. MEng students who wish to do the MEng-Project option must find a professor who is willing to act as a project supervisor. In the event the MEng student cannot find a project supervisor, the student must transfer into the MEng-Course option.

4.2.3 Degree requirements

Table 4-1 summarizes the degree requirements for the MASc, MEng-Project, and MEng-Course programs.

Table 4-1: Degree Requirements

Program	**Required - Credits**	**Options - Credits**	**Total Credits**
MASc	Thesis plus ENGR 5003G – Seminar - 15 Credits	5 Courses - 15 Credits	30
MEng-Project	Project - 9 Credits	7 courses - 21 Credits	30
MEng-Course		10 courses - 30 Credits	30

For the MASc program, a student must complete five courses worth a total of 15 credits and a thesis worth 15 credits. In addition to the five courses, the student must successfully complete ENGR 5003G – Seminar. MASc students must spend a minimum of one year of full-time study in residence at the University of Ontario Institute of Technology. The maximum time for completion of a MASc degree is three years, five years for students who switch to part-time status, measured from the date the student entered the program. No financial support will be available from the Faculty after two years).

For the MEng-Project option, a student must complete seven courses worth a total of 21 credits and a project worth nine credits. For the MEng-Course option, a student must complete 10 courses worth a total of 30 credits. The maximum time for completion of a MEng degree is four years measured from the date the student entered the program.

Section 4.4 provides a list of available courses and Section 4.5 provides detailed course descriptions and outlines.

4.2.4 Progress reports

After completing the first year of their program and in each year thereafter, MASc students must complete a progress report that outlines what they have done in the previous year and what are their objectives for the following year. This progress report must be submitted to the student's supervisory committee (see Section 4.2.5). Permission to continue in the program will be based on a satisfactory report as determined by the student's supervisory committee.

4.2.5 Thesis evaluation procedures

Within six months of starting a MASc program, a supervisory committee for the student must be formed. The supervisory committee for a MASc student will consist of the student's supervisor or supervisors plus two faculty members from UOIT. The Faculty Graduate Programs Director will be an ex officio member of all supervisory committees.

The supervisory committee is chaired by a member of the committee other than the student's supervisor. The supervisory committee is responsible for monitoring and evaluating the student's progress through their program.

All MASc students must successfully defend their thesis in front of an examination committee. The examination committee for a MASc student will be comprised of the student's supervisory committee plus an external examiner who may or may not be a faculty member of UOIT. All external examiners must be approved by the Associate Provost, Research and Graduate Programs.

4.2.6 Language requirements

All applicants are required to give evidence of their oral and written proficiency in English. This requirement can be satisfied with one of the following criteria:

i) The student's mother tongue or first language is English

ii) The student has studied full-time for at least three years (or equivalent in part-time studies) in a secondary school or university where the language of instruction and examination was English; or

iii) The student has achieved the required proficiency on one of the tests in English language acceptable to the University of Ontario Institute of Technology (see below)

Recommended Scores - English Language Proficiency Tests
(higher scores may be required)

TOEFL (computer based) 220
TOEFL (paper based) 560
IELTS 7
MELAB 85
CAEL 60

4.2.7 Distance delivery

The programs will not be delivered in a distance delivery manner at the present time. In the future, it is expected that distance/hybrid delivery of parts of the programs will be used where the subject matter permits.

4.3 Part-time studies

Part-time studies are primarily offered for the MEng program. To facilitate engineers from industry taking the MEng program, graduate courses are planned to be offered in the late afternoon or early evening. In general, all courses will be taught by regular faculty members.

The MASc program has a minimum residence requirement where the student must be enrolled full-time and attending the University of Ontario Institute of Technology. For the MASc program, students must spend a minimum of one year of full-time study in residence at UOIT.

4.4 Total graduate courses listed and level

Table 4-2 lists the proposed graduate courses to be offered. Courses related to the Energy and Thermofluids Engineering field are numbered as ENGR 51xxG. Courses related to the Mechatronics and Manufacturing Engineering field are numbered as ENGR 52xxG. Courses numbered ENGR 50xxG are common to both fields.

MASc and MEng-Project students may take one ENGR 4xxxU level undergraduate course in lieu of a graduate level course, provided they have not already taken a similar course during their undergraduate degree and the course is approved by both the student's supervisor and the Faculty Graduate Programs Director. MEng-Course students may take up to two ENGR 4xxxU level undergraduate courses in lieu of up to two graduate level courses, again, provided they have not taken similar courses during their undergraduate degree and the courses are approved by the Faculty Graduate Programs Director.

Students will be allowed to take graduate courses offered by other faculties, provided they are approved by the Faculty Graduate Programs Director.

Courses will be offered on the basis of demand with the expectation that courses will be offered at a minimum of once every two years.

Table 4-2: Proposed Courses

Course	Title
ENGR 5001G	**MASc Thesis**
ENGR 5002G	**MEng Project**
ENGR 5003G	**Seminar**
ENGR 5004G	**Directed Studies**
ENGR 5005G	**Special Topics**

ENGR 5010G	**Advanced Optimization**
ENGR 5011G	**Advanced Engineering Design**
ENGR 5012G	**Advanced and Smart Materials**
ENGR 5100G	**Advanced Energy Systems**
ENGR 5101G	**Thermal Energy Storage**
ENGR 5102G	**Fuel Cells and Hydrogen Systems**
ENGR 5120G	**Advanced Fluid Mechanics**
ENGR 5121G	**Advanced Turbo Machinery**
ENGR 5122G	**Computational Fluid Dynamics**
ENGR 5140G	**Advanced Heat Transfer**
ENGR 5141G	**Heat Exchanger Design and Analysis**
ENGR 5160G	**Advanced Thermodynamics**
ENGR 5161G	**HVAC and Refrigeration Systems Design and Analysis**
ENGR 5180G	**Advanced Nuclear Engineering**
ENGR 5181G	**Advanced Radiation Engineering**
ENGR 5221G	**Computer-Integrated Manufacturing**
ENGR 5222G	**Polymers and Composite Processing**
ENGR 5223G	**Advanced Manufacturing Processes and Methodologies**
ENGR 5240G	**Advanced Dynamics**
ENGR 5241G	**Advanced Mechanics of Materials**
ENGR 5242G	**Advanced Vibrations**
ENGR 5260G	**Advanced Robotics and Automation**
ENGR 5261G	**Advanced Mechatronics: MEMS and Nanotechnology**
ENGR 5262G	**Manipulator and Mechanism Design**
ENGR 5263G	**Advanced Control**

4.5 Graduate course descriptions and outlines

Course Title: ENGR 5001G – MASc Thesis
Year and Semester: N/A
• **Course Description and Content Outline:** The thesis is the major component of the MASc program and is carried out under the direction of the student's supervisor. The thesis may involve an investigation which is fundamental in nature, or may be applied, incorporating creative design. Through the thesis, candidates are expected to give evidence of competence in research and a sound understanding of the area of specialization involved. • **Delivery Mode and Teaching Method(s):** N/A • **Student Evaluation:** The student is required to write a research thesis. Upon completion, the student must defend the thesis in front of an examination committee comprised of his or her supervisory committee plus an external examiner. • **Resources to be purchased by students:** None • **Textbook requirements:** None • **Learning Outcomes.** Students who successfully complete the MASc thesis have reliably demonstrated the ability to: Outcome 1: understand and explain the essential facts, concepts, principles, and theories relating to their research topic. Outcome 2: effectively use advanced tools for research. Outcome 3: apply the principles of effective data management, information organization, and information-retrieval skills to data of various types. Outcome 4: critically evaluate advanced information and knowledge and their implementation. Outcome 5: understand, explain, and solve problems using quantitative and qualitative methods. Outcome 6: design and conduct experiments, analyze and interpret experimental data, and/or computational results. Outcome 7: prepare and present, orally and in writing, to peers and experts, a systematic report on a significant research topic.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": All Faculty Members
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: None
Equipment requirements: Dependent on the Topic

Course Title: ENGR 5002G – M.Eng. Project
Year and Semester: N/A
• **Course Description and Content Outline:** The MEng Project provides students with the opportunity, under the supervision of a faculty member, to integrate and synthesize knowledge gained throughout their program of study. The chosen topic will be dependent on the area of specialization of the student. • **Delivery Mode and Teaching Method(s):** N/A • **Student Evaluation:** Students are required to write a report and give a presentation on their completed project. Upon completion, the student must defend the project in front of an examination committee. • **Resources to be purchased by students:** None • **Textbook requirements:** None • **Learning Outcomes.** Students who successfully complete the MEng project have reliably demonstrated the ability to: Outcome 1: understand and explain the essential facts, concepts, principles, and theories relating to their research topic. Outcome 2: identify problems and opportunities for system analysis, design, improvement, and optimization Outcome 3: understand, explain, and solve problems using quantitative and qualitative methods. Outcome 4. organize and complete a significant project in a timely manner Outcome 5: synthesize significant information from the project and prepare well organized and complete technical reports. Outcome 6. prepare and present, orally and in writing, to peers and experts, a final report on a significant project.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": All Faculty Members
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: None
Equipment requirements: Dependent on the Topic

Course Title: ENGR 5003G – Seminar
Year and Semester: N/A
• **Course Description and Content Outline:** Participation in a program of seminars by internal and external speakers on current research topics. All MASc students will be required to give a seminar on their thesis research during the second year of their program. • **Delivery Mode and Teaching Method(s):** Mandatory attendance in a series of seminars by internal and external speakers. • **Student Evaluation:** Pass/Fail • **Resources to be purchased by students:** None • **Textbook requirements:** None • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: comply with the social, professional, and ethical requirements involved in advanced education and research. Outcome 2: examine and reflect on contemporary issues and professional and ethical responsibilities which impact both engineering, and their specific area of interest. Outcome 3: appreciate the need, and have the knowledge and skills required to further their education through lifelong learning. Outcome 4: prepare and present a research seminar on a significant topic, to an audience of peers and experts Outcome 5. receive and respond to questions, critique and other feedback from peers and experts
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": N/A
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: N/A
Classroom requirements: Seminars will require the use of a classroom/meeting with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5004G – Directed Studies
Year and Semester: N/A
• **Course Description and Content Outline:** Faculty permission may be given for supervised research projects, individual study, or directed readings. Students wishing to pursue a course of directed studies must, with a faculty member who is willing to supervise such a course, formulate a proposal accurately describing the course content, the learning goals, the intended method and extent of supervision, and the method by which work will be evaluated. This course may only be taken once. • **Delivery Mode and Teaching Method(s):** Dependent on the Topic • **Student Evaluation:** Dependent on the Topic • **Resources to be purchased by students:** Dependent on the Topic • **Textbook requirements:** Dependent on the Topic • **Learning Outcomes:** Dependent on the Topic
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": All Faculty Members
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: None
Equipment requirements: Dependent on the Topic

Course Title: ENGR 5005G – Special Topics
Year and Semester: N/A
• **Course Description and Content Outline:** Presents material in an emerging field or one not covered in regular offerings. May be taken more than once, provided the subject matter is substantially different. • **Delivery Mode and Teaching Method(s):** Dependent on the Topic • **Student Evaluation:** Dependent on the Topic • **Resources to be purchased by students:** Dependent on the Topic • **Textbook requirements:** Dependent on the Topic • **Learning Outcomes:** Dependent on the Topic
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": All Faculty Members
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Dependent on the Topic
Equipment requirements: Dependent on the Topic

Course Title: ENGR 5010G – Advanced Optimization

Year and Semester: N/A

- **Course Description and Content Outline:** The objective of this course is to understand the principles of optimization and its application to engineering problems. Topics covered include: the steepest descent and Newton methods for unconstrained optimization; golden section, quadratic, cubic and inexact line searches; conjugate and quasi-Newton methods; the Fletcher-Reeves algorithm; fundamentals of constrained optimization theory; simplex methods for linear programming; modern interior-point methods; active-set methods and primal-dual interior-point methods for quadratic and convex programming; semidefinite programming algorithms; sequential quadratic programming and interior-point methods for nonconvex optimization. In addition, implementation issues and current software packages/algorithms for optimization will be covered. Global optimization, including genetic algorithms and simulated annealing, will be introduced.
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** The principal form of assessment will be two major projects, one counting for 30% and the other counting for 50% of the course mark. Assignments will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of lectures.
- **Resources to be purchased by students:** N/A
- **Textbook requirements (sample):**
  Antoniou, A. and Lu, W.-S., (In-Press), *Optimization: Methods, Algorithms, and Applications*, Kluwer Academic.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to:
  Outcome 1: formulate and solve unconstrained and constrained optimization problems.
  Outcome 2: understand how the major unconstrained, constrained, and global optimization techniques work.
  Outcome 3: use optimization as a tool for solving engineering design problems.

Information About Course Designer/Developer:
Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science

Identify faculty to teach the course and/or statement "faculty to be hired":
S. Nokleby and D. Zhang

If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A

Faculty qualifications required to teach/supervise the course:
PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: Software requirements include MATLAB with both the Optimization Toolbox and the Genetic Algorithm and Direct Search Toolbox.

Course Title: ENGR 5011G – Advanced Engineering Design
Year and Semester: N/A

- **Course Description and Content Outline:** This course covers the basics of design philosophy, methodology, principles, and theory as a foundation for surveying current research areas in the product development process. A brief introduction to concurrent design and life cycle design is followed by addressing the application of the design process to problem solving. The relationship between creativity and the design process is explored by using tools for solving engineering system design and synthesis problems. Computer, mathematical, and/or physical modeling of the problem and solution, the axiomatic design approach, Taguchi robust design, design of experiments, and prototyping are strongly emphasized topics.
  - **Content outline by topic:**
    1. Introduction to Concurrent Design
    2. Introduction to Life Cycle Design
        - Design for X
    3. Axiomatic Design
        - The independence axiom
        - The information axiom
        - Design matrix
        - Design hierarchy
        - Mapping from functional to physical to process domains
    4. Functional Decomposition
    5. Modeling
    6. Taguchi Robust Design
    7. Design of Experiments
    8. Prototyping
    9. Analysis of Engineering Experiments
- **Delivery Mode and Teaching Method(s):** Classroom presentation, laboratories, and tutorials. Guest lectures by engineers from industry on selected topics. Lectures: 3 hours/week and Tutorials/Laboratory: 2 hours/week
- **Student Evaluation:** Teamwork and communication skills are strongly encouraged and developed through group assignments. Students will be actively involved in hands-on design and execution of original individual and group projects under faculty supervision. Student project teams will prepare a demanding final group project involving both analytical techniques and some computational techniques that will be supported with a detailed report and an oral presentation.
- **Resources to be purchased by students:** To be Determined by Professor
- **Textbook requirements:**
  None.
- **References:**
  Suh, N. P., 1990, *The Principles of Design*, Oxford Series on Advanced Manufacturing.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to:
  Outcome 1: synthesise solutions to open-ended design problems
  Outcome 2: define a problem, review current research, generate multiple solutions to a defined problem, analyze possible solutions, and develop the best possible solution to the defined problem.
  Outcome 3: demonstrate the ability to model the problem, generate a computer model of the problem/solution or create a physical model of the solution and develop a presentation on the model.
  Outcome 4: develop criteria for testing, analyze how well the model fits the defined solution, optimize the solution, document the solution, and demonstrate the ability of the design to meet the

original problem statement, and make a technical presentation on the overall solution. Outcome 5: identify the principles of good teamwork and effective communication and demonstrate those skills during a series of interactive exercises.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: R. Pop-Iliev, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": R. Pop-Iliev
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Stationary desktop PC units (or laptops) having a specific suite of software installed and wireless and wired internet access will be preferred.

Course Title: ENGR 5012G – Advanced and Smart Materials
Year and Semester: N/A
• **Course Description and Content Outline:** The core material will consist of: basic features of physical transducer behavior, mathematical constitutive models and material properties, characterization methods and experimental data, sensor and actuator devices, translation of material behavior to device behaviour, solid state devices, non-solid state devices (motors and pumps), mesoscale and MEMS devices, adaptive structures. However, due to the rapid evolutions in the field, the syllabus will be dynamic to respond to the new developments in materials and their applications. The topics will be continually reviewed and monitored for currency. Some of the topics from the following list will be also be included, covering fundamental principles, mechanisms and applications: a) Piezoelectric materials, b) 'Negative' materials, c) Conductive polymers, d) Advanced composites, e) Shape-memory materials, f) Magneto-rheological fluids, and g) Intelligent textiles. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** Reports 35%, presentations 35% exam 30% • **Resources to be purchased by students:** N/A • **Textbook requirements:** None • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: understand the issues relating to a range of advanced and smart materials, and the fundamental principles and mechanisms responsible for their characteristic behaviours. Outcome 2: discuss the role and critical importance of the underlying mechanisms responsible for advanced and smart behaviour. Outcome 3: critically assess a given scenario and produce a scientific report that is effective in terms of content and structure. Outcome 4: select and use materials based upon the properties and characteristics of materials and their influences on the design of solutions to technological challenges. Outcome 5: undertake case studies into the area of advanced and smart materials and identify and retrieve relevant information from various sources with minimal assistance.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: G. Rizvi, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": R. Pop-Iliev and G. Rizvi
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5100G – Advanced Energy Systems
Year and Semester: N/A
• **Course Description and Content Outline:** Advanced power and refrigeration cycles. Advanced gas turbine systems. Combustion systems and applications. Energy storage. Nuclear reactor technology. Fuel cells. Solar power. Wind power. Hydro power. Co- and tri-generation. Geothermal district heating systems. Energy and exergy analysis of advanced energy systems. • **Content outline by topic:** o Advanced power and refrigeration cycles. o Advanced gas turbine systems. o Combustion systems and applications. o Energy storage. o Nuclear reactor technology. o Fuel cells. o Solar power. o Wind power. o Hydro power. o Co- and tri-generation. o Geothermal district heating systems. o Energy and exergy analysis of advanced energy systems. • **Delivery Mode and Teaching Method(s):** One-term , 3 hours of lectures per week. • **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). • **Resources to be purchased by students:** None • **Textbook requirements:** Kharchenko, N. V., 1999, *Advanced Energy Systems*, New York, NY. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to Outcome 1. utilize theoretical and practical information required to design, analyze, rate and evaluate advanced energy systems, Outcome 2. examine and utilize practical applications of currently available advanced energy systems Outcome 3. understand and apply necessary practical solution methodologies and tools.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course : I. Dincer and M. Rosen
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: EES and MATLAB will be provided to the students.

Course Title: ENGR 5101G – Thermal Energy Storage

Year and Semester: N/A

- **Course Description and Content Outline:** General Introductory Aspects for Thermal Engineering. Energy Storage Systems. Thermal Energy Storage Methods. Thermal Energy Storage and Environmental Impact. Energy Storage and Energy Savings. Solar Energy and Thermal Energy Storage. Heat Transfer and Stratification in Sensible Heat Storage Systems. Latent Heat Storage Systems. Heat Storage with Phase Change. Thermodynamic Optimization of Thermal Energy Storage Systems. Energy and Exergy Analyses of Thermal Energy Storage Systems. Thermal Energy Storage Case Studies.
  - **Content outline by topic:**
    - General Introductory Aspects for Thermal Engineering.
    - Energy Storage Systems.
    - Thermal Energy Storage Methods.
    - Thermal Energy Storage and Environmental Impact.
    - Energy Storage and Energy Savings.
    - Solar Energy and Thermal Energy Storage.
    - Heat Transfer and Stratification in Sensible Heat Storage Systems.
    - Latent Heat Storage Systems.
    - Heat Transfer with Phase Change.
    - Thermodynamic Optimization of Thermal Energy Storage Systems.
    - Energy and Exergy Analyses of Thermal Energy Storage Systems.
    - Thermal Energy Storage Case Studies.
- **Delivery Mode and Teaching Method(s):** One-term, 3 hours of lectures per week.
- **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%).
- **Resources to be purchased by students:** None
- **Textbook requirements:** Dincer, I. and Rosen, M. A., 2002, *Thermal Energy Storage Systems and Applications*, Wiley: New York, NY.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to

Outcome 1.utilize theoretical and practical background on thermal energy storage systems and applications

Outcome 2.apply the solution methodologies and tools for practical thermal energy storage systems design, analysis and performance evaluation.

Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science

Identify faculty to teach the course : I. Dincer and M. Rosen

If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.

Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: Engineering Equation Solver (EES).

Course Title: ENGR 5102G – Fuel Cells and Hydrogen Systems
Year and Semester: N/A

- **Course Description and Content Outline:** Introduction to hydrogen and hydrogen fuel cells. Efficiency and open circuit voltage. Operational fuel cell voltages. Proton exchange membrane fuel cells. Alkaline electrolyte fuel cells. Direct methanol fuel cells. Medium and high-temperature fuel cells. Fuelling fuel cells. Components of fuel cell power systems. Delivering fuel cell power. Analysis of Fuel cell systems. Fuel cell calculations. Tests.
  - **Content outline by topic:**
    - Introduction to hydrogen and hydrogen fuel cells.
    - Efficiency and open circuit voltage.
    - Operational fuel cell voltages.
    - Proton exchange membrane fuel cells.
    - Alkaline electrolyte fuel cells.
    - Direct methanol fuel cells.
    - Medium and high-temperature fuel cells.
    - Fuelling fuel cells.
    - Components of fuel cell power systems , system design.
    - Delivering fuel cell power.
    - Analysis of Fuel cell systems.
    - Fuel cell modeling and calculations.
    - Tests and industry standards.
    - Reliability, durability, and engineering challenges.
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%).
- **Resources to be purchased by students:** None
- **Textbook requirements:** Larminie, J. and Dicks, A., 2003, *Fuel Cell Systems Explained – 2nd Edition*, Wiley: New York, NY.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to

  Outcome 1: apply fundamentals of electrochemistry, thermodynamics, fluid dynamics, and heat and mass transfer, as appropriate, to examine various issues of interest to mechanical engineers including electrode flooding (water management), temperature, and species distribution.

  Outcome 2: articulate the basic fundamentals of electrochemistry in terms of electrode processes, electrochemical potential, thermodynamics and kinetics of electrode reactions applicable to electrochemical systems.

  Outcome 3: describe, explain, and model the various types of electrochemical overpotential occurring within the electrochemical system including ohmic, concentration, and activation overpotentials.

  Outcome 4: describe, explain, and model the effects of mass transfer in electrochemical systems by migration, diffusion, and convection.

  Outcome 5: describe and use Nernst equation to model cell EMF as a function of product and reactant activities.

  Outcome 6: understand the meaning, use, and experimental derivation of the Tafel slope for determination of the transfer coefficient and the exchange current density.

  Outcome 7: understand the concepts and fundamentals behind basic experimental electrochemical methods used to determine various key parameters including, mass and ionic transport coefficients, exchange current density, and internal resistances.

Outcome 8: Identify the main components, advantages, and limitations of gas-fed PEM, direct inject PEM, molten carbonate, alkaline, phosphoric acid, and solid oxide fuel cell systems. Outcome 9: visualize current, temperature and species distributions in an operating fuel cell under various operating conditions. Outcome 10: apply basic software tools to the analysis of experimental data and mathematical models.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": P. Berg, I. Dincer, and M. Rosen
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Engineering Equation Solver (EES) and MATLAB will be provided to the students.

Course Title: ENGR 5120G – Advanced Fluid Mechanics

Year and Semester: N/A

- **Course Description and Content Outline:** Derivation of three-dimensional conservation equations of mass, momentum and energy for compressible viscous fluids. General properties of Navier-Stokes equations. Examples of exact solutions of the Navier-Stokes equations. Approximate solutions for creeping motions. Laminar boundary layer equations and methods of solution: derivation of boundary layer equations, boundary layer separation, general properties of boundary layer equations; Von Karman momentum-integral equations; finite-difference solutions. Stability of laminar flows: theory of small disturbances; Orr-Summerfield equation, transition. Introduction to turbulence. Applications.
  - **Content outline by topic:**
    - Derivation of three-dimensional conservation equations of mass, momentum and energy for compressible viscous fluids.
    - General properties of Navier-Stokes equations.
    - Examples of exact solutions of the Navier-Stokes equations.
    - Approximate solutions for creeping motions.
    - Laminar boundary layer equations and methods of solution: derivation of boundary layer equations, boundary layer separation, general properties of boundary layer equations; Von Karman momentum-integral equations; finite-difference solutions.
    - Stability of laminar flows: theory of small disturbances; Orr-Summerfield equation, transition.
    - Introduction to turbulence.
    - Applications.
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). A term project will be assigned to the students to tackle a problem, write its governing equations, use numerical techniques to approximate the governing equations and write and run his own program to obtain results.
- **Resources to be purchased by students:** None
- **Textbook requirements:**
  Schlichting, H., 1989, *Boundary Layer Theory – 8th Edition*, McGraw-Hill: New York, NY.
  White, F. M., 1991, *Viscous Fluid Flow*, McGraw-Hill, New York, NY.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to

Outcome 1. explain the phenomena of viscous fluid flow

Outcome 2. derive the governing equations for practical cases

Outcome 3.explain how the boundary layer theory can make flows involving fluids of small viscosity amenable to successful theoretical analyses.

Information About Course Designer/Developer:

Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science

Identify faculty to teach the course and/or statement "faculty to be hired": K. Gabriel, P. Gulshani, and G. Naterer
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Computer-based simulations will be conducted.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Simulation software.

Course Title: ENGR 5121G – Advanced Turbo Machinery

Year and Semester: N/A

- **Course Description and Content Outline:** Basic Thermodynamics and Fluid Mechanics equations and definitions of efficiencies in turbomachines. Two-dimensional cascades (cascade analysis, performance of cascades and cascade correlations). Axial flow turbines. Radial flow turbines. Axial flow compressors. Centrifugal compressors and fans. Applications of turbomachinery to engineering problems. Design, analysis and performance analyses of turbomachines. Transport phenomena aspects. Software use and tests.
  - **Content outline by topic:**
    - Basic Thermodynamics and Fluid Mechanics equations and definitions of efficiencies in turbomachines.
    - Two-dimensional cascades (cascade analysis, performance of cascades and cascade correlations).
    - Axial flow turbines.
    - Radial flow turbines.
    - Axial flow compressors.
    - Centrifugal compressors and fans.
    - Applications of turbomachinery to engineering problems.
    - Design, analysis and performance analyses of turbomachines.
    - Transport phenomena aspects.
    - Software use and tests.
- **Delivery Mode and Teaching Method(s):** One-term , 3 hours of lectures per week.
- **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%).
- **Resources to be purchased by students:** None
- **Textbook requirements:** Wilson, G. and Korakianitis, T., 2002, *The Design of High-Efficiency Turbomachinery and Gas Turbines – 2nd Edition*, Pearson: New York, NY.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to

Outcome 1.apply the principles used in analyzing/designing compressors and turbines.

Outcome 2.design a gas turbine to meet specific mission requirements.

Outcome 3.understand the design systems and techniques used in the aeropropulsion and gas turbine industries.

Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science

Identify faculty to teach the course : M. Rosen

If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.

Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: EES and MATLAB will be provided to the students.

Course Title: ENGR 5122G – Computational Fluid Dynamics
Year and Semester: N/A
• **Course Description and Content Outline:** Introduction to CFD modelling and mesh generation software. Basic equations of fluid flow and commonly used approximations. Turbulence modelling (one and two equation models, and higher order models). Iterative solution methods and convergence criteria. Practical analysis of turbulent pipe flow / mixing elbow and turbomachinery blade problems. Software use and tests. • **Content outline by topic:** o Introduction to CFD modelling and mesh generation software. o Basic equations of fluid flow and commonly used approximations. o Turbulence modelling (one and two equation models, and higher order models). o Iterative solution methods and convergence criteria. o Practical analysis of turbulent pipe flow / mixing elbow and turbomachinery blade problems. o Software use and tests. • **Delivery Mode and Teaching Method(s):** One-term, 3 hours of lectures per week. • **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). • **Resources to be purchased by students:** None • **Textbook requirements:** Chung, T. J., 2002, *Computational Fluid Dynamics*, Cambridge University Press: Oxford, UK., Ferziger, J. H., and Peric, M., 2003, *Computational Methods for Fluid Dynamics*, Springer: New York, NY. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to Outcome 1.apply practical skills in Computational Fluid Dynamics including the use of FLUENT, the most widely used commercial CFD code available. Outcome 2.apply these skills to relevant Engineering applications and gain an appreciation of the limitations and advantages of CFD modelling. Outcome 3. (i) Set up a numerical model (including mesh generation) using FLUENT. (ii) Identify and define the correct boundary conditions and most appropriate turbulence model. (iii) Interpret the results and validate them using experimental and theoretical data.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course : P. Gulshani and G. Naterer
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Special CFD software (e.g., FLUENT) will be provided.

Course Title: ENGR 5140G – Advanced Heat Transfer
Year and Semester: N/A
• **Course Description and Content Outline:** Introduction and conservation equations. Conservation equations and gas kinetics. Unidirectional Steady Conduction. Multidirectional Steady Conduction. Time-Dependent Conduction. External Forced Convection. Internal Forced Convection. Natural Convection. Convection with Change of Phase. Heat Exchangers. Radiation. Mass Transfer Principles. • **Content outline by topic:** o Introduction and conservation equations. o Conservation equations and gas kinetics. o Unidirectional Steady Conduction. o Multidirectional Steady Conduction. o Time-Dependent Conduction. o External Forced Convection. o Internal Forced Convection. o Natural Convection. o Convection with Change of Phase. o Radiation. o Mass Transfer Principles. • **Delivery Mode and Teaching Method(s):** One-term 3 hours of lectures per week. • **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). • **Resources to be purchased by students:** None • **Textbook requirements:** Bejan, A., 1998, *Heat Transfer – 2nd Edition*, Wiley: New York, NY.Bejan, A. and Kraus, A. D., 2003, *Heat Transfer Handbook*, Wiley: New York, NY. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to Outcome 1. utilize insights and theory into the phenomena of advanced heat transfer topics in conduction, convection and radiation, phase change heat transfer and mass transfer Outcome 2.utilize the theory and skills needed to solve advanced heat transfer problems both analytically and numerically.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course I. Dincer, K. Gabriel, P. Gulshani, G. Naterer, and M. Rosen
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Engineering Equation Solver (EES) will be provided.

Course Title: ENGR 5141G – Heat Exchanger Design and Analysis

Year and Semester: N/A

- **Course Description and Content Outline:** Basic mechanisms of heat transfer, such as conduction, convection, boiling, condensation and radiation. Classification of heat exchangers according to flow. Heat exchanger analysis using LMTD, 2–NTUc–R–P–F and ε-NTU methods. Selection criteria of heat exchangers. Thermal-hydraulic and mechanical design of shell-and-tube heat exchangers. Design and analysis of double-pipe heat exchangers. Design and performance evaluation of finned-tube heat exchangers. Energy and exergy analyses of heat exchangers. Performance evaluation of plate-fin heat exchangers. Design considerations in boilers and condensers. Fouling growth models and its impact on heat exchanger performance and life-cycle analysis. Flow-induced vibration. Software Use/Tests.
  - **Content outline by topic:**
    - Basic mechanisms of heat transfer, such as conduction, convection, boiling, condensation and radiation.
    - Classification of heat exchangers according to flow.
    - Heat exchanger analysis using LMTD, 2–NTUc–R–P–F and -NTU methods.
    - Selection criteria of heat exchangers.
    - Thermal-hydraulic and mechanical design of shell-and-tube heat exchangers.
    - Design and analysis of double-pipe heat exchangers.
    - Design and performance evaluation of finned-tube heat exchangers.
    - Energy and exergy analyses of heat exchangers.
    - Performance evaluation of plate-fin heat exchangers.
    - Design considerations in boilers and condensers.
    - Fouling growth models and its impact on heat exchanger performance and life-cycle analysis.
    - Flow-induced vibration.
    - Software Use/Tests.
- **Delivery Mode and Teaching Method(s):** One-term 3 hours of lectures per week.
- **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%).
- **Resources to be purchased by students:** None
- **Textbook requirements:** Hewitt, G. F., 2002, *Heat Exchanger Design Handbook*, Begell House: New York, NY.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to

Outcome 1. apply the theoretical and practical background on how to design, analyze, rate and evaluate heat exchangers, particularly for thermal applications

Outcome 2.utilize solution methodologies and tools for practical applications.

Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science

Identify faculty to teach the course: I. Dincer, K. Gabriel, P. Gulshani, G. Naterer, and M. Rosen

If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.

Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: Engineering Equation Solver (EES) and MATLAB will be provided to the students.

Course Title: ENGR 5160G – Advanced Thermodynamics
Year and Semester: N/A
• **Course Description and Content Outline:** Axiomatic representation of fundamentals of classical thermodynamics. First law of thermodynamics. Equilibrium. Euler and Gibbs-Duhem relations. Second law of thermodynamics. Entropy production. Exergy and Irreversibility. Energy and exergy analysis of advanced power and refrigeration cycles. Legendre transformations and Extremum principle. Maxwell relations and thermodynamics derivatives. Stability. Phase transformations. Nernst postulate. Chemical reactions and equilibrium. Case study problems. • **Content outline by topic:** o Axiomatic representation of fundamentals of classical thermodynamics. o First law of thermodynamics. o Equilibrium. o Euler and Gibbs-Duhem relations. o Second law of thermodynamics. o Entropy production. o Exergy and irreversibility. o Energy and exergy analysis of advanced power and refrigeration cycles. o Legendre transformations and extremum principle. o Maxwell relations and thermodynamics derivatives. o Stability. o Phase transformations. o Nernst postulate. o Chemical reactions and equilibrium. o Case study problems. • **Delivery Mode and Teaching Method(s):** One-term , 3 hours of lectures per week. • **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). • **Resources to be purchased by students:** None • **Textbook requirements:** Bejan, A., 1997, *Advanced Engineering Thermodynamics – 2nd Edition*, Wiley: New York, NY., Winterbone, D. E., 1997, *Advanced Thermodynamics for Engineers*, Elsevier: London, UK. Wark, K., 1994, *Advanced Thermodynamics for Engineers*, McGraw-Hill: New York, NY. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to Outcome 1.apply knowledge of selected advanced subjects in thermodynamics. Outcome 2.explain the main laws and concepts of thermodynamics and apply these over the whole range of conventional and new systems and technologies covered by engineering thermodynamics.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course: I. Dincer, G. Naterer, and M. Rosen
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5161G – HVAC and Refrigeration Systems Design and Analysis
Year and Semester: N/A
• **Course Description and Content Outline:** Basic Concepts. Elements of Heat Transfer for Buildings. Thermodynamic Processes in Buildings. Energy use and Environmental Impact. Human Thermal Comfort and Indoor Air Quality. Fluid Mechanics in Building Systems. Solar Radiation. Heating and Cooling Loads. Annual Energy Consumption. Heat Transfer Equipment. Cooling Equipment. Thermal Energy Storage. Software Use/Tests. • **Content outline by topic:** o Basic Concepts o Elements of Heat Transfer for Buildings o Thermodynamic Processes in Buildings o Energy use and Environmental Impact o Human Thermal Comfort and Indoor Air Quality o Fluid Mechanics in Building Systems o Solar Radiation o Heating and Cooling Loads o Annual Energy Consumption o Heat Transfer Equipment o Cooling Equipment o Thermal Energy Storage o Software Use/Tests. • **Delivery Mode and Teaching Method(s):** One-term 3 hours of lectures per week. • **Student Evaluation:** Mid-term exam (20%), project and presentation (25%), weekly homework assignments (15%), and final exam (40%). • **Resources to be purchased by students:** None • **Textbook requirements:** Dincer, I., 2003, *Refrigeration Systems and Applications*, Wiley, New York, NY.Kreider, J. F. and Rabl, A., 2002, *Heating and Cooling of Buildings*, McGraw-Hill, New York, NY.**,**ASHRAE, 1999, *Handbook of Fundamentals*, Atlanta, GA. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to Outcome 1.apply theoretical and practical background on HVAC and refrigeration systems, particularly for building applications Outcome 2.utilize the solution methodologies and tools for practical HVAC and refrigeration systems design, analysis and performance evaluation.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: I. Dincer, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course I. Dincer and M. Rosen
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? Course materials and details will be available on WebCT. Numerical and analytical methods will be used.
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Engineering Equation Solver (EES) will be provided to the students. The second software will be provided with the book.

Course Title: ENGR 5180G – Advanced Nuclear Engineering
Year and Semester: N/A

- **Course Description and Content Outline:** The course is an introduction to advanced topics in nuclear engineering, with emphasis on reactor physics. Covered topics include neutron slowing down, resonance absorption, multigroup transport and diffusion equations, reactor kinetics, and homogenization methods. Lattice and full-core numerical methods are also covered. Pre-requisites: Courses in linear algebra, differential equations, vector calculus.
  - **Topics include:**
    - Neutronic Nuclear Reactions
    - Multigroup Neutron Diffusion
    - Numerical Methods for the Steady-State Multigroup Diffusion Equation
    - Neutron Transport Equation
    - Numerical Methods for the Steady-State Multigroup Transport Equation
    - Reactor Kinetics
    - Numerical Methods for the Space-Time-Dependent Multigroup Diffusion Equation
    - Generation of Multigroup Cross Sections
    - Homogenization (Equivalence Theory)
    - Perturbation Theory
    - Variational Methods
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** Assignments, Exams, Oral Presentations, Projects
- **Resources to be purchased by students:** N/A
- **Textbook requirements:**
  Stacey, W. M., 2001, *Nuclear Reactor Physics*, Wiley-Interscience.
- **Literature:**
  Stacey, W. M., 2001, *Nuclear Reactor Physics*, Wiley-Interscience.
  Duddwrstadt, J. J. and Hamilton, L. J., 1976, *Nuclear Reactor Analysis*, John Wiley & Sons.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to:
  Outcome 1: write the Boltzmann equation and explain its main terms.
  Outcome 2: solve the Boltzmann equation analytically for simple configurations.
  Outcome 3: differentiate between fixed-source and eigenvalue transport problems.
  Outcome 4: derive the diffusion equation as a first-order angular approximation to the transport equation.
  Outcome 5: solve the diffusion equation analytically for simple configurations.
  Outcome 6: understand the application of the finite-difference, finite element and nodal methods to the solution of the multigroup diffusion equation.
  Outcome 7: understand the use of the discrete-ordinate and collision-probability methods to the solution of the multigroup transport equation
  Outcome 8: apply equivalence theory to find multigroup homogenized cross sections.
  Outcome 9: derive the point-kinetics equations with six delayed neutron groups.
  Outcome 10: apply approximate solution methods to the point-kinetics equations.
  Outcome 11: understand the application of finite-difference and modal methods to the solution of space-time kinetics problems.
  Outcome 12: understand the basis of applying perturbation and/or variational methods to reactor physics problems.

Information About Course Designer/Developer:
Course designed by faculty eligible to teach this course: E. Nichita, PhD, Nuclear Engineering ,

School of Energy Systems and Nuclear Science
Identify faculty to teach the course and/or statement "faculty to be hired": E. Nichita and E. Waller
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? A WebCT course website will play a role in the delivery of resources for this course: syllabus, schedule, assignments, solutions to homework and exams, handouts, supplementary notes, etc.
Faculty qualifications required to teach/supervise the course: PhD in Science or Engineering, with adequate background in reactor/radiation physics and numerical methods.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5181G – Advanced Radiation Engineering
Year and Semester: N/A

- **Course Description and Content Outline:** This course introduces advanced concepts in radiation engineering, with an emphasis on how ionizing radiation interactions with matter may be modelled. The course reviews fundamental particle interaction mechanics, measurement and detection of radiation, evaluation of nuclear cross sections and various solutions to the Boltzmann transport equation. Pre-requisites: Undergraduate courses in nuclear physics, differential equations, and statistics.
  - **Topics include:**
    - Charged and neutral particle interaction mechanics
    - Elastic scattering kinematics
    - Laboratory and Centre-of Mass co-ordinate system considerations
    - Wave function operators and the Schroedinger equation
    - Expectation values and the Hamiltonian
    - Nuclear shell, optical and compound nucleus models for cross sections
    - Asymptotic approximation to nuclear scattering cross sections
    - Energy averaged cross sections and cross section libraries
    - Boltzmann transport equation
    - Spherical harmonics approximations to solve the transport equation
    - Generation of the diffusion equation
    - Discrete ordinates method to solve the transport equation
    - Monte Carlo methods to solve the transport equation
    - Basic nuclear radiation detection principles
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** Assignments, Exams, Oral Presentations, Projects
- **Resources to be purchased by students:** N/A
- **Textbook requirements:** Lewis, E. and Miller, W., 1993, *Computational Methods of Neutron Transport*, ANS Publications: Illinois.
  Custom Handouts
- **Literature:**
  Lux, I. and Koblinger, L., 1990, *Monte Carlo Particle Transport Methods: Neutron and Photon Calculations*, CRC Press: Boston.
  Lewis, E. and Miller, W., 1993, *Computational Methods of Neutron Transport*, ANS Publications: Illinois.
  Duderstadt, J. and Martin, W., 1979, *Transport Theory*, Wiley-Interscience: New York.
  Schaeffer, N., 1974, *Reactor Shielding for Nuclear Engineers*, USAEC: Virginia.
  Knoll, G., 1989, *Radiation Detection and Measurement – 3rd Edition*, Wiley: Toronto.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to:
  Outcome 1: understand how charged and neutral particles interact with materials.
  Outcome 2: understand how radiation may be used to determine material properties.
  Outcome 3: solve particle scattering problems in both the laboratory and centre-of-mass frames of reference.
  Outcome 4: derive cross sections from the Schroedinger equation.
  Outcome 5: understand the various models for nuclear cross sections.

  Outcome 6: understand how continuous and multi-group cross sections and generated and used in

particle transport computations. Outcome 7: solve the Boltzmann transport equation using: a. Spherical harmonics; b. Discrete ordinates; and c. Monte Carlo analysis Outcome 8: understand the basic concepts of ionizing radiation detection.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: E. Waller, PhD, PEng, School of Energy Systems and Nuclear Science
Identify faculty to teach the course and/or statement "faculty to be hired": E. Nichita, E. Waller, and Faculty to be Hired
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? A WebCT course website will play a role in the delivery of resources for this course: syllabus, schedule, assignments, solutions to homework and exams, handouts, supplementary notes, etc.
Faculty qualifications required to teach/supervise the course: PhD degree in Physics, Mathematics or Engineering with experience in Radiation Transport.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5221G – Computer-Integrated Manufacturing

Year and Semester: N/A

- **Course Description and Content Outline:** This course is about Computer-Integrated Manufacturing (CIM) with a particular focus on automated manufacturing process planning. It provides advanced instruction in design and implementation of integrated CAD/CAM, robotics, and flexible manufacturing systems. It also provides emphasis on concurrent engineering principles, manufacturing process engineering, computer-aided process planning, NC programming, and CAD/CAM integration. The course provides experience with CAD/CAM software and NC machines.
  - **Content outline by topic:**
    1. Computer evolution
       - Computer architecture
       - Boolean algebra
       - Logic design
    2. Concurrent engineering principles
    3. Analysis of product definition processes
    4. Manufacturing process engineering
    5. Communication in manufacturing environments
    6. Technological and organizational requisites for CIM
    7. Manufacturing requirements planning
    8. CAD/CAM integration
       - NC programming
    9. Just-in-time manufacturing
    10. Future directions for factory automation
- **Delivery Mode and Teaching Method(s):** Classroom presentation, laboratories, and tutorials. Guest lectures by engineers from industry on selected topics. Lectures: 3 hours/week and Tutorials/Laboratory: 2 hours/week.
- **Student Evaluation:** Students will be actively involved in hands-on design and execution of original individual and group projects under faculty supervision. Student project teams will prepare a demanding final group project involving a detailed report and an oral presentation.
- **Resources to be purchased by students:** To be Determined by Professor
- **Textbook requirements:** None
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to
  Outcome 1: explain the issues relating to automation in a manufacturing setup and the abilities and limitation of computerized systems in dealing with them.
  Outcome 2: explain the function of software commonly used in manufacturing and demonstrate their ability to use that software to design a flexible manufacturing process.
  Outcome 3: access and use a variety of resources (human, equipment, tools, plans, vendors and materials) to plan and complete CIM projects according to process and time requirements.
  Outcome 4: analyze and execute a flexible manufacturing process, identify problems in the process, and redesign the process for improvement during a simulated manufacturing line.
  Outcome 5: be proficient in these skills through a variety of shop projects and in a final exercise that uses a combination of these skills.

Information About Course Designer/Developer:
Course designed by faculty eligible to teach this course: R. Pop-Iliev, PhD, PEng, Faculty of Engineering and Applied Science and G. Rizvi, PhD, Faculty of Engineering and Applied Science

Identify faculty to teach the course and/or statement "faculty to be hired":
R. Pop-Iliev and G. Rizvi

If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Stationary desktop PC units (or laptops) having a specific suite of software installed and wireless and wired internet access will be preferred.

Course Title: ENGR 5222G – Polymers and Composite Processing
Year and Semester: N/A
• **Course Description and Content Outline:** Polymer structure-property relations, linear and nonlinear viscoelasticity, dynamic mechanical analysis, time temperature superposition, creep and stress relaxation, mechanical models for prediction of polymer deformation, rubber elasticity, experimental methods for viscosity-temperature-shear rate measurements, application to melts, filled systems and suspensions. Processes for polymers; injection, extrusion, thermoforming, blow molding, rotational molding, compression and transfer molding, calendaring and post-manufacturing operations. Fibre types and properties, fibre forms, polymeric matrix and interfaces, typical composite properties. Processes for long fibre/thermoset composites, pre-pregging, resin transfer moulding, filament winding, pultrusion, autoclave cure. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** Assignments 15%, Midterm 35% Final 50% • **Resources to be purchased by students:** N/A **Textbook requirements:** None • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: relate the significance of polymer structures to their physical, mechanical and thermal properties. Outcome 2: use linear and nonlinear viscoelasticity, dynamic mechanical analysis, time temperature superposition and creep and stress relaxation principles to predict polymer behaviour due to applications of stress and strain. Outcome 3: apply mechanical models for prediction of polymer deformation and rubber elasticity. Outcome 4: explain the experimental methods for viscosity-temperature-shear rate measurements. Outcome 5: describe the basic processes for polymers; i.e. injection, extrusion, thermoforming, blow molding, rotational molding, compression and transfer molding, calendaring and post-manufacturing operations. Outcome 6: assess and recommend fibre types and properties, fibre forms, polymeric matrix and interfaces, typical composite properties for applications. Outcome 7: describe the processes for long fibre/thermoset composites, pre-pregging, resin transfer moulding, filament winding, pultrusion, autoclave cure.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: G. Rizvi, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course : R. Pop-Ileiv and G. Rizvi
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

Course Title: ENGR 5223G – Advanced Manufacturing Processes and Methodologies
Year and Semester: N/A

- **Course Description and Content Outline:** This course is about implementing advanced manufacturing processes and methodologies into production operations as the strategy for achieving reductions in inventory costs, faster manufacturing turnaround times, fewer faulty products, and using less floor space for production. It addresses the next generation manufacturing and production techniques that take advantage of the opportunities offered by selective use of new materials and emerging technologies for high efficient machining, coating, forming, assembly operations, etc. Virtual manufacturing methodologies and multi-objective optimization in terms of design, performance, safety, cost, and environment as well as advanced manufacturing methodologies such as lean manufacturing are also addressed. Prerequisite: Computer-Integrated Manufacturing (ENGR 5221G) and Polymer and Composite Processing (ENGR 5222G).
  - **Content outline by topic:**
    1. Overview of emerging materials and technologies
       - Materials
         - Ceramics and intermetallics for high temperature
         - Advanced aluminium, magnesium and cast iron alloys
         - Aluminium and polyurethane foams for crash energy absorption
         - Powder metallurgy
         - Metal and ceramic matrix composites
    2. Machining
       - High speed and dry
       - Materials and coatings for high efficiency tools
       - Machining centers
    3. Forming
       - Sheet metals and plastics
       - Low investment metal forming
       - Innovative casting
       - Rapid prototyping and tooling
    4. Assembly
       - Laser welding of steels
       - Laser welding of thermoplastics
       - Laser processes monitoring
       - Adhesive and mechanical joining
    5. Surface treatments and coatings
       - Laser treatments
       - Eco-compatible and sustainable
       - Wear prevention coatings
    6. Virtual manufacturing
       - Metal forming and machining (e.g., sheet metal stamping, advanced forming technologies such as double-sheet hydroforming, high speed, and dry machining)
       - Plastic molding
       - Casting and forging (e.g., semi-solid casting and local forging)
    7. Lean Manufacturing
    8. Kanban
       - Demand driven, pull-based flow manufacturing
       - Demand Flow Technology (DFT)
    9. Relationship between Lean manufacturing and Six Sigma

- **Delivery Mode and Teaching Method(s):** Classroom presentation, laboratories, and tutorials. Guest lectures by engineers from industry on selected topics. Lectures: 3 hours/week and Tutorials/Laboratory: 2 hours/week
- **Student Evaluation:** Teamwork and communication skills are strongly encouraged and developed through group assignments. Students will be actively involved in hands-on execution of original individual and group assignments under faculty supervision. Student project teams will prepare a demanding final group project involving a detailed report and an oral presentation.
- **Resources to be purchased by students:** To be Determined by Professor
- **Textbook requirements:**
  None
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to
  Outcome 1: master the main concepts of the major advanced manufacturing processes and display competence in a range of advanced manufacturing methodologies.
  Outcome 2: apply a broad-based knowledge of the various areas of advanced manufacturing processes to both simulated and real world manufacturing processes.
  Outcome 3: apply advanced improvement methodologies and techniques to both simulated and real world manufacturing processes.
  Outcome 4: critically evaluate and communicate both orally and in writing primary literature articles in the area of advanced manufacturing processes and methodologies.
  Outcome 5: identify the principles of good teamwork and effective communication in a manufacturing environment and demonstrate those skills during a series of interactive exercises.

Information About Course Designer/Developer:
Course designed by faculty eligible to teach this course: R. Pop-Iliev, PhD, PEng, Faculty of Engineering and Applied Science

Identify faculty to teach the course and/or statement "faculty to be hired":
R. Pop-Iliev and G. Rizvi

If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A

Faculty qualifications required to teach/supervise the course:
PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: Stationary desktop PC units (or laptops) having a specific suite of software installed and wireless and wired internet access will be preferred.

Course Title: ENGR 5240G Advanced Dynamics
Year and Semester: N/A
• **Course Description and Content Outline:** This course builds upon the knowledge students have gained in a first dynamics course to cover more advanced dynamical systems. Topics covered will include: 3-D kinematics and kinetics of particles and systems of particles using Newton's method; equations of motion in normal and tangential, cylindrical, and spherical coordinates; two body central force motion with applications in orbital dynamics, and particle on a rotating earth. 3-D kinematics and kinetics of rigid bodies, Euler angles, single and multiple rotating reference frames, Coriolis acceleration, inertial reference frames, equations of translational motion, angular momentum, rotational motion, body axes and rotation relative to a coordinate system, Euler's and modified Euler's equations of motion with applications in dynamics of gyroscopes, robots, and vehicles. Variational mechanics, constraints, generalized coordinates, principles of virtual work, D'Alembert, and Hamilton's principle, concept of Hamiltonian, Hamilton's canonical equations. Lagrange's equation for system of particles and rigid bodies, generalized force and moment, calculus of variations, concepts of Lagrangian and Lagrange multiplier, Lagrange's equations for holonomic and non-holonomic systems, stability analysis of autonomous and non-autonomous dynamical systems. Numerical solutions of dynamic systems, explicit methods include finite difference and Rung-Kutta, and implicit methods are Houbolt, Wilson-theta, Park stuffy stable, and Newark-beta. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 20% of the course mark. Assignments will count for 10% and a mid-term exam will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of the lectures. • **Resources to be purchased by students:** None • **Textbook requirements (sample):** Ginsberg, J. H., 1995, Advanced Engineering Dynamics – 2nd Edition, Cambridge University Press: New York, NY. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: model and analyze systems of rigid bodies in three dimensions. Outcome 2: use Lagrange's equations to solve complex dynamical problems. Outcome 3: understand the applications of Hamiltonian and Hamilton's canonical. Outcome 4: determine the stability of 3-D motions of many dynamical systems. Outcome 5: apply numerical methods to obtain solutions of dynamical systems.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: E. Esmailzadeh, Ph.D., Faculty of Engineering and Applied Science
Identify faculty to teach the course E. Esmailzadeh, P. Gulshani, S. Nokleby, and D. Zhang
If the method of instruction includes on-line deliverywhat percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: To Be Determined by Professor

Course Title: ENGR 5241G – Advanced Mechanics of Materials
Year and Semester: N/A
• **Course Description and Content Outline:** This course builds upon the knowledge students have gained in the first solid mechanics course to cover more advanced mechanics of materials. Topics covered will include: The general state of stress and strain in three dimensions; formulation of general equilibrium equations; compatibility conditions; constitutive relationships; elasto-plastic relationships; Airy stress function; analytical solutions of special problems including thick-walled cylinders, rotating disks, bucking of columns, stress concentration, and curved beams; energy methods in elasticity; torsion problem; bending of beams; contact stresses; analysis of flat plates; creep and relaxation; introduction to fracture mechanics; fatigue and failure theories. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 20% of the course mark. Assignments will count for 10% and a mid-term exam will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of lectures. • **Resources to be purchased by students:** None • **Textbook requirements (sample):** Boresi, A. P. and Schmidt, R. J., 2003, *Advanced Mechanics of Materials – 6th Edition*, John Wiley & Sons, Inc. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: understand and apply transformation of stress and strains in three dimensions and failure theories for isotropic materials. Outcome 2: apply energy methods to determine the values of load and deflection of indeterminate structures. Outcome 3: design flexible structures based on the principles of fracture mechanics and predict the critical load and crack length. Outcome 4: estimate fatigue life of the structures subjected to cyclic loadings. Outcome 5: understand and apply the principles of shear and torsion of beams, shafts, and thin-walled structures. Outcome 6: analyze the stress distribution in curved beams, rotating disks, thick-walled cylinders, and flat plates.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: E. Esmailzadeh, PhD, Faculty of Engineering and Applied Science
Identify faculty to teach the course E. Esmailzadeh and D. Zhang
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: To Be Determined by Professor

Course Title: ENGR 5242G - Advanced Vibrations
Year and Semester: N/A
• **Course Description and Content Outline:** This course builds upon the knowledge students have gained in a first vibration course to cover more advanced vibrating systems. Topics covered will include: Lagrange's equations of motion, generalized coordinates and force, virtual work, linearization of equations for small oscillations, multi-degree of freedom linear systems, mass matrix, flexibility and stiffness matrix, natural frequencies and mode shapes, orthogonality of the mode shapes, modal matrix and decoupling procedure, harmonic force, and series solution for arbitrary excitation. Linear continuous systems, free vibration of strings, rods and shafts, lateral vibration of Euler-Bernoulli beams, effect of rotary inertia and shear on the vibration of beams, orthogonality of the mode shapes, harmonic excitation of beams, mode summation method in the case of arbitrary excitation. Approximate methods for free vibration analysis: Rayleigh, Dunkerly, Rayleigh-Ritz, Holzer, Myklestud, and matrix iteration methods. Vibration of plates, free vibration analysis using analytical methods, Rayleigh and Rayleigh-Ritz methods, harmonic excitation, and Galerkin's method in forced vibration analysis of plates. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 20% of the course mark. Assignments will count for 10% and a mid-term exam will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of the lectures. • **Resources to be purchased by students:** None • **Textbook requirements (sample):** Ginsberg, J. H., 2001, *Mechanical and Structural Vibrations: Theory and Applications*, John Wiley & Sons: Toronto, ON. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: model and analyze discrete vibrating systems. Outcome 2: obtain the transient and steady-state response of m-DOF systems. Outcome 3: obtain the eigenvalues and eigenvectors using different techniques. Outcome 4: model and analyze continuous systems. Outcome 5: solve partial differential equations for flexible structures.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: E. Esmailzadeh, Ph.D., Faculty of Engineering and Applied Science
Identify faculty to teach the course : E. Esmailzadeh and D. Zhang
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: To Be Determined by Professor

Course Title: ENGR 5260G – Advanced Robotics and Automation
Year and Semester: N/A
• **Course Description and Content Outline:** This course builds upon the knowledge students have gained in a first robotics course to cover more advanced kinematics topics and their application to more complex robotic systems such as redundant manipulators and parallel mechanisms. Topics covered will include: point, direction, line, and screw motion descriptions; homogeneous transformations; line and screw coordinates; quaternion representations; inverse displacement solutions by analytic, root finding, hybrid, and numerical methods; appropriate frames of reference; screw systems and transforms; local and globally optimum solutions of redundant rates; overdetermined and near degenerate solutions; singularity analysis; and parallel manipulator kinematics. Prerequisite: Robotics and Automation (ENGR 4280U) or equivalent. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 30% of the course mark. Assignments will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of lectures. • **Resources to be purchased by students:** N/A • **Textbook requirements (sample):** Davidson, J. K. and Hunt, K. H., 2004, *Robots and Screw Theory: Applications of Kinematics and Statics to Robotics*, Oxford University, Press: Toronto.Angeles, J., 2002, *Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms – Second Edition*, Springer, New York, New York. Tsai, L.-W., 1999, Robot Analysis: *The Mechanics of Parallel and Serial Manipulators*, John Wiley & Sons, Inc.: Toronto. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: understand advanced serial manipulator kinematics and its applications. Outcome 2: understand parallel manipulator kinematics and its applications. Outcome 3: apply advanced kinematic geometry methods, such as screw theory, to various problems in robotics.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course: S. Nokleby and D. Zhang
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: Robot manipulators available in UOIT's Integrated Manufacturing Centre. Software requirements include MATLAB and MAPLE.

Course Title: ENGR 5261G – Advanced Mechatronics: MEMS and Nanotechnology
Year and Semester: N/A
Course Description and Content Outline: This course is designed to be an introduction to MEMS (micro-electro-mechanical systems) and nanotechnology and their applications. Topics covered will include: introduction to MEMS and nanotechnology; working principles of MEMS and nanotechnology; design and fabrication of MEMS and nano-systems; microfabrication and micromachining; materials for MEMS and nanotechnology; and applications of MEMS and nanotechnology. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 30% of the course mark. Assignments will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of lectures. • **Resources to be purchased by students:** To Be Determined by Professor • **Textbook requirements (sample):** Senturia, S. D., 2001, Microsystem Design, Kluwer Academic Publishers. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: understand the basic principles of how MEMS and nano-systems work. Outcome 2: design and analyze MEMS and nano-systems. Outcome 3: understand the processes for fabricating MEMS and nano-systems. Outcome 4: understand applications of MEMS and nanotechnology.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: D. Zhang, PhD, PEng, Faculty of Engineering and Applied Science and S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science
Identify faculty to teach the course and/or statement "faculty to be hired": S. Nokleby, D. Zhang, and Faculty to be Hired
If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: To Be Determined by Professor

Course Title: ENGR 5262G – Manipulator and Mechanism Design

Year and Semester: N/A

- **Course Description and Content Outline:** This course is designed to teach students the necessary skills to design or synthesize mechanisms and manipulators to perform desired tasks. Topics covered will include: synthesis of mechanisms for function generation, path generation, and rigid body guidance; graphical, analytical, and optimization based methods of synthesis; mechanism cognates, Chebychev spacing, Burmister curves; manipulator joint layout synthesis for spatial positioning and orientation; conditions of singularity and uncertainty; and solution of nonlinear problems of kinematics involved in mechanism synthesis using compatibility equations, 1/2 angle substitutions, and dialytic elimination.
- **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week.
- **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 30% of the course mark. Assignments will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of lectures.
- **Resources to be purchased by students:** N/A
- **Textbook requirements (sample):**
  McCarthy, J. M., 2000, *Geometric Design of Linkages*, Springer: New York.
- **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to:
  Outcome 1: design mechanisms for function generation, path generation, and rigid body guidance using graphical, analytical, and optimization based methods.
  Outcome 2: design manipulator joint layouts for specified tasks.
  Outcome 3: solve nonlinear problems in kinematics using compatibility equations, 1/2 angle substitutions, and dialytic elimination.

Information About Course Designer/Developer:
Course designed by faculty eligible to teach this course: S. Nokleby, PhD, PEng, Faculty of Engineering and Applied Science

Identify faculty to teach the course and/or statement "faculty to be hired":
S. Nokleby and D. Zhang

If the method of instruction includes on-line delivery (technology-based, computer-based and web-based), what percentage of the course content will be offered on-line? N/A

Faculty qualifications required to teach/supervise the course:
PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.

Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.

Equipment requirements: Software requirements include MATLAB, Working Model, and MSC.visualNastran 4D.

Course Title: ENGR 5263G – Advanced Control
Year and Semester: N/A
• **Course Description and Content Outline:** This course builds upon the knowledge students have gained in a first control course to cover more materials in advanced control systems. Topics covered will include: a. State variables and state space models: Relations between state space models and the transfer-function models (controllable and observable canonical forms, and diagonal form), Jordan form, solutions of linear state equations, transition matrix. b. Controllability and observability: Definition and criteria, state feedback and output feedback, pole assignment via state feedback, design of servo-controlled systems. c. State estimation and observer: Observer state-variable feedback control. d. Multi-input multi-output (MIMO) systems: Pole assignment via state feedback. e. Introduction to nonlinear systems: Describing functions for kinds of nonlinear systems (on/off, dry friction, dead zone, saturation, and hystersis), phase plane trajectories, concept of limit cycle.f. Stability analysis: Lyapunov function, and Lyapunov stability criterion.g. Introduction to optimal control: Linear quadratic regulator (LQR), Riccati equation, properties of LQR systems. h. Sampled data systems: Pulse transfer function, zero and first order hold systems, stability and root locus in the z-plane, transformations, Routh Hurwitz stability criterion in the z-plane, system compensation in the z-plane using root locus, and generalized PID controllers. • **Delivery Mode and Teaching Method(s):** This one-term course will be delivered using 3 hours of lectures per week. • **Student Evaluation:** The principal form of assessment will be a final exam worth 50% of the course mark and one research project worth 20% of the course mark. Assignments will count for 10% and a mid-term exam will count for the remaining 20%. The exact weighting of the various components will be presented to the students in the first week of the lectures. • **Resources to be purchased by students:** N/A • **Textbook requirements (sample):** Ogata, K., 2002, *Modern Control Engineering – 4th Edition*, Prentice Hall: New Jersey. • **Learning Outcomes.** Students who successfully complete the course have reliably demonstrated the ability to: Outcome 1: model and analyze the state space descriptions of dynamical systems. Outcome 2: apply the concepts of controllability and observability of control systems. Outcome 3: utilize the pole placement in state feedback control for SISO and MIMO systems. Outcome 4: design observer state feedback control. Outcome 5: apply knowledge about nonlinear control systems, limit cycle, and instabilities.
Information About Course Designer/Developer: Course designed by faculty eligible to teach this course: E. Esmailzadeh, Ph.D., Faculty of Engineering and Applied Science
Identify faculty to teach the course : E. Esmailzadeh, S. Nokleby, and D. Zhang
If the method of instruction includes on-line delivery what percentage of the course content will be offered on-line? N/A
Faculty qualifications required to teach/supervise the course: PhD degree in engineering and relevant experience in teaching and research. Faculty members will normally be registered Professional Engineers.
Classroom requirements: Standard computer enabled UOIT classroom equipped with VRC, DVD, data projectors, and wired and wireless internet access.
Equipment requirements: None

4.6 Collateral and supporting departments

The School of Energy Systems, which is affiliated with the Faculty of Engineering and Applied Science, is an integral component of this program. Both the Faculty of Business and Information Technology and the Faculty of Science at the University of Ontario Institute of Technology are supporting the proposed programs, in part by providing faculty members who contribute their expertise and time to the proposed programs and by sharing resources where mutually beneficial.

5 OUTCOMES

5.1 Enrolment and graduations

As this is an application for a new program, this section is not applicable.

5.2 Employment

Employment records of the graduates from the program will be maintained on an ongoing basis.

5.3 Publications

Publication records of the graduates from the program will be maintained on an ongoing basis.

5.4 Projected graduate intake and enrolments

Table 5-1 shows the projected graduate student enrolment (both full-time and part-time students) over the next seven years. As additional faculty are hired over the next few years, the planned enrolment in the program is expected to increase.

Table 5-1 Projected Intake and Enrolments for MASc and MEng Programs

YEAR	FULL-TIME				PART-TIME				TOTAL ENROLMENT		
	Intake		Enrolments		Intake		Enrolments		MASc	MEng	Combined
	MASc	MEng	MASc	MEng	MASc	MEng	MASc	MEng			
2006	5-10	5-10	5-10	5-10	1-3	5-10	1-3	5-10	6-13	10-20	16-33
2007	10-15	5-10	15-25	10-20	1-3	5-10	2-6	10-20	17-31	20-40	37-71
2008	10-15	5-10	20-30	10-20	1-3	5-10	3-9	10-20	23-39	20-40	43-79
2009	10-20	10-15	20-35	10-25	1-3	5-10	3-9	10-20	23-44	20-45	43-89
2010	10-20	10-15	20-40	10-30	1-3	5-10	3-9	10-20	23-49	20-50	43-99
2011	10-20	10-15	20-40	10-30	1-3	5-10	3-9	10-20	23-49	20-50	43-99

2012	10-20	10-15	20-40	10-30	1-3	5-10	3-9	10-20	23-49	20-50	43-99

In the spring of 2008, the first class of students will graduate from UOIT's undergraduate programs in Manufacturing Engineering and Nuclear Engineering, followed by the first Mechanical Engineering and Energy Engineering graduates in 2009, and the first Automotive Engineering graduates in 2010. It is expected that as more and more students successfully complete their undergraduate degrees at UOIT, the enrolments in the master's programs will rise as some of these students pursue post-graduate degrees.

Appendix A: Library Submission

LIBRARY SUBMISSION TO ONTARIO COUNCIL OF GRADUATE STUDIES (OCGS)
FOR:
THE MASTER OF APPLIED SCIENCE AND MASTER OF ENGINEERING IN MECHANICAL ENGINEERING
UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY (UOIT)

Compiled by: Carol Mittlestead, B.A., M.L.S., Associate Librarian

Introduction:

With respect to the University of Ontario Institute of Technology's Master of Applied Science and Master of Engineering in Mechanical Engineering within the Faculty of Engineering and Applied Science, the following document discusses the Library in relation to the collection; the accessibility of resources and services; and research support, staffing, and partnerships. The collection is defined as including both the traditional paper book or periodical, and the more nontraditional –but increasingly common-electronic index, book or journal database. Librarian recommended web sites are also a unique part of the collection in that they direct students and staff to valid academic sources. Accessibility addresses the physical presence of the Library, onsite reference assistance, the Library web page www.uoit.ca/library as a 24/7 portal, and interlibrary loan and document delivery. Research support, staffing, and partnerships emphasize the Library's role in teaching students, liaising with faculty, and connecting with government and corporate agencies.

Collections:

It is understood that the Library's acquisition plan must be based on evolving pedagogical needs as determined by the academic schools. In close liaison with the Deans and Professors, subject specialist Librarians will define collection development strategies for the ongoing curriculum-based purchase of resources as well as for the evaluation and review of existing material.

Books:

The Library offers a small but comprehensive collection. At present, there are approximately 70,000 volumes on the shelves. In mid-August, however, the Library took possession of its new building (described below) and this additional space will allow for the relatively quick expansion of the collection to 160,000 texts. Currently, there are approximately 7,500 volumes focusing on pure and applied science topics such as mathematics, metrology, statistical process control, physics, chemistry, electricity, statics, corrosion, thermodynamics, fluid power, machine design and computer automation. As this is only the second year that UOIT has offered courses with the Library understandably being in a growth phase, most of the texts mentioned above are meant for those beginning their engineering careers. It is realized that more specialized and academically focused books will be required for years three and four, and for postgraduate degrees. The Library, does, however, already have approximately 800 advanced manufacturing and over 700 upper level mechanical engineering books. The objective is to enhance the collection with respect to all engineering specialties– mechanical including automotive and manufacturing, electrical, and energy including nuclear.

The Library's goal is to increase its holdings by 2,000 to 3,000 volumes per year for several successive years with a current projected cost of $400,000. to $450,000. per annum. Books are selected primarily (Faculty suggestions are most welcome) by Subject Specialist Librarians both directly from noteworthy academic publishers (e.g. Wiley, CRC Press, Sage, Elsevier, Academic Press, Addison-Wesley, Kluwer, Springer-Verlag, Pearson Prentice Hall) and from Blackwell's Book Services, an arrangement that allows for the simultaneous purchase of titles from a wide array of vendors.

The importance of specialty publishers for both print and online documents is also recognized. The Library will access and/or purchase as necessary standards, proceedings, and technical reports from key scientific and engineering organizations. Example sources include the American Society for Testing and Materials (ASTM), the Canadian Standards Association (CSA), the American Society of Mechanical Engineers (ASME), the North American Energy Standards Board (NAESB), and the Institute for National Measurement Standards-National Research Council Canada (INMS-NRC).

With over 13,000 titles (not included in the total above), e-books are an integral part of the UOIT library collection. Currently, Access Science and the Encyclopedia of Materials Science and Technology are the databases most likely to interest these engineering students and faculty. Especially given UOIT's commitment to the laptop university concept, the Library's e-book collection is destined to grow.

Periodicals:

As of January 2005, the Library provided access to 2,983 science journals and 3,540 technology journals with 3,430 of these having an engineering focus. Mechanical and manufacturing topics are specifically addressed by 532 of these titles with 1,756 periodicals devoted to electrical and nuclear engineering. Journals are available as traditional paper subscriptions, single electronic titles (e.g. Science) or as one of several titles within an electronic database. The primary engineering databases include: ACM (American Computing Machinery Digital Library), ASME (American Society of Mechanical Engineering), Ebsco Academic Search Premier, Ebsco Inspec (IEE-Institution of Electrical Engineers), IEEE Xplore ((Institute of Electrical and Electronics Engineers) includes conference proceedings and standards as well as journals), Proquest Science Journals, Scholars Portal, and Wilson Applied Science and Technology Abstracts. Please note that Scholars Portal is a search template that consolidates the electronic periodical holdings of several well-respected academic publishers, the three most relevant to engineering being Academic Press, Elsevier (Science Direct) and Springer-Verlag. The databases that appear within Scholars Portal have been purchased through membership and participation in two university library consortia—OCUL (Ontario Council of University Libraries) and CRKN (Canadian Research Knowledge Network).

The databases identified as secondary for engineering faculty and students are as follows: ACS

(American Chemical Society), AIP (American Institute of Physics), CCOHS (Canadian Centre for Occupational Health and Safety), IOP (Institute of Physics), MathSciNet (American Society for Mathematics), RSC (Royal Society of Chemistry), and Science Citation Index (Web of Science – ISI (Institute for Scientific Information). This "primary" and "secondary" division is arbitrary in that one's research needs will dictate the resource to be used. For example, the Web of Science is comprised completely of abstracts and citations which may be perfect for an individual seeking a summary and overview of the works of others in a given field, but totally inappropriate for a person seeking full text articles only.

Following the mandate of the University of Ontario Institute of Technology as a laptop university with "round the clock" accessibility to resources, whenever possible, the Library will purchase significant holdings to a journal in electronic format. It is, however, realized that paper copies may sometimes be essential, and must be purchased accordingly.

Internet:

While the prevalence and importance of the Internet is recognized, it is also realized that not all information on the Internet is of equal value and/or prominence, and that not all people have equal search skills. The Library, therefore, strives to make staff and students aware of quality web sites appropriate to their Program. Listings of recommended web sites are part of the Library Faculty Guides that are prepared with each UOIT program in mind. Posted on the Library web site www.uoit.ca/library , these Faculty Guides are discussed in detail under "Accessibility". For example, relevant sites include: EEVL (Edinburgh Engineering Virtual Library), eFunda: Engineering Fundamentals, SME (Society of Manufacturing Engineers), IndustryNET, CANMET Energy Technology Centre (Natural Resources Canada), Atomic Energy of Canada, AEE (Association of Energy Engineers) and CADDET-IEA (Centre for Analysis and Dissemination of Demonstrated Energy Technologies-International Energy Agency).

Accessibility:

The Building:

A new state-of-the-art, 73,000 square foot Library was opened in August 2004. The intent of the design is to create a print/electronic library that accommodates new and emerging technologies without sacrificing the personal warmth of a traditional library. The building offers various types of study and activity spaces to accommodate different learning styles and user needs. These spaces include:

- Quiet public study spaces as well as a formal Reading Room, all within a "wireless" environment
- Collaborative learning spaces for groups of various sizes
- Common spaces and public service research workstations that facilitate intellectual interaction and engagement
- Electronic classrooms for regular ongoing educational sessions on library resources and research strategies

- Attractive and appealing display areas for art and library exhibitions
- Special needs adaptive technology equipment

Staff, students and faculty have welcomed this new building with its seating for over 500 patrons and 150 public access workstations with Internet access. The grand opening was October 29, 2004.

On Campus Reference Assistance:

Reference services are provided by professional librarians for 68 hours of the 89 hours per week that the Library is physically open or 76.5% of the time. Librarians liaise with professors so classes specific to student research topics can be offered. Both staff and students are also welcome to make individual or small group appointments with Librarians.

Library Web Page:

The Library web page is available at www.uoit.ca/library and is accessible 24 hours a day, seven days a week. A Library e-mail address is provided as well as telephone information so individuals can leave messages at any time. In collaboration with other Ontario University Libraries, the Library is also currently investigating a web-based service such as the Virtual Reference Desk (www.lssi.com) which uses chat software to deliver reference service to users regardless of time and location. The Librarian can "push" pages to patrons so they can literally see both the steps involved and the results achieved with a given search. Consequently, this technology promises to be more effective than e-mail and telephone. Beginning with limited hours and an after-hours e-mail default, the ultimate goal is to make virtual reference a "round the clock" service.

General reference assistance is provided through Library web page sections that explain topics such as computer search techniques, article searching, internet evaluation, and bibliographic citation. Amongst the services outlined are circulation procedures, reserves, and interlibrary loan. What makes the UOIT Library web page truly unique is its Faculty Guides. Prepared with each program in mind for a particular Faculty, every Guide outlines and links to pertinent Electronic Databases and Indexes; provides sample listings with links to relevant journals along with subject headings for further investigation; highlights the Catalogue with suggestions from the Reference collection; describes and links to the most appropriate E-book databases; and offers Recommended Web Sites. These Guides are indeed resource portals.

Interlibrary Loan and Document Delivery:

Interlibrary Loan is available free of charge to students and faculty. Individuals have the option of making their requests online or in person. RACER (rapid access to collections by electronic requesting) is a VDX (Virtual Document Exchange) interlibrary loan system currently being implemented in OCUL member libraries. Students and faculty can search the catalogues of all Ontario university libraries and place immediate online requests for any available item. The system populates the request automatically with the bibliographic information from the record chosen, and a patron name, i.d. number, and e-mail address are all that need to be added to the online form. As part of OCUL and the IUTS (Inter University Transit System), the Library now receives book loans in a very reasonable amount of time, and Ariel, an electronic transmission system for periodical articles, allows journal requests to be filled within a few days.

Faculty and students from UOIT may also visit any of Ontario's university libraries and may borrow books directly from them upon presentation of their UOIT photo identification card. Materials may be returned directly to the lending library or may be left at the UOIT Library where they will be returned to the appropriate lending library.
Since postgraduate engineering programs are being discussed here, the borrowing restrictions that the University of Toronto Libraries have on undergraduates are obviously not applicable. Interlibrary Loans and document delivery are also available from other lending institutions (e.g. CISTI or libraries outside the province of Ontario) as required.

Research Support, Staffing and Partnerships:

The following strategies are established and/or being developed:

1. As described above, the Library as part of a newly formed institution (June 2002) has already made significant progress in terms of collection development, instruction and resource accessibility. Continued efforts will be made to improve and expand information services. As professors arrive on the UOIT campus, librarians are meeting with them to identify their teaching and research objectives.

2. A professionally qualified librarian (M.L.S.) with subject expertise in the sciences and health sciences joined the UOIT Library staff in August 2002. Given the anticipated appearance and evolution of more UOIT postgraduate programs, the hiring of a Graduate Studies Librarian will occur within the next two years.

3. The importance of liaising with the UOIT Centre for Academic Excellence and Innovation (CAEI), a facility where faculty are introduced and mentored in the use of instructional technology such as computerized teaching packages, presentation software, web development, and distance learning delivery is recognized. This would ensure that the Library's resources, in digital format, are included amongst the links for courses developed within the Faculty of Engineering and Applied Science. A link to the Library Web Page Faculty Guides from each student's "My WebCT" template is planned.

4. The Library will connect to national and global resources (e.g. Ontario Power Generation (OPG), General Motors Corporation (GMC)) that both enhance student employment opportunities and that support high levels of applied scholarly research.

The Library is indeed preparing for the University of Ontario Institute of Technology's initial postgraduate degree offerings, and lends its support to the resource and research needs of both faculty and students.

CM

03/30/2005

Revised January 31, 2005

VOLUME II: Curricula Vitae

NB: Curricula vitae should be in alphabetical order, the pages of each numbered consecutively(with a header indicating name, page X of Y), and a table of contents provided.

Doe **1 of 4**

SAMPLE CURRICULUM VITAE

N.B.: OCGS is grateful to the University of Ottawa for providing the sample CV style.

Program: Religion July 2002

CURRICULUM VITAE

a) NAME: rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

DOE, John, full professor, tenured
Member of the Graduate Faculty: yes

b) DEGREES: designation, institution, department, year

Ph.D. Theology, University of London, U.K., 1975
B.A., Theology, University of London, U.K., 1971

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm

1989-	Professor, Department of Religion, University of Outer Space
1989-	Adjunct Professor, Department of Theology, University of Ontario
1973-89	Associate Professor, Dept. of Religion, University of Ontario
etc...	

d) HONOURS: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)

Senior Staff Award, University of Outer Space, 1998
Merit Award, University of Ontario, 1993

e) SCHOLARLY AND PROFESSIONAL ACTIVITIES: past 7 years only (eg. executive and editorial positions but not memberships in societies)

1996	Ext. Assessor of Graduate Programs, Religious Studies, Moon University
1995-96	Member, Editorial Board, Journal of Theological Studies
1991-92	Treasurer, Canadian Federation for the Humanities
1990-91	Executive Secretary, Canadian Theological Society

f) GRADUATE SUPERVISIONS: master=s, doctoral, postdoctoral - completed/in progress

Completed: 5 M.A., 1 Ph.D.

Doe **2 of 4**

In progress: 1 M.A., 2 Ph.D.
NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:

. Victoria Shamowski (MA), Ab nmotrim sub nos prtewim. Sept. 2001-June 2002 (major research paper)
. Garth Hanmer (PhD), Isto knofge gremt sam truvft. Sept. 1999-
. Leslie Davidson (PhD), Prugris trastor revfer . Jan. 1998-June 2002

g) GRADUATE COURSES: past 7 years, by year

Seminars:

2001-02 Contemporary Religious Phenomena
1999-00 Contemporary Religious Phenomena
1998-99 Theology of Evangelization
1997-98 Faith, Religion and Culture

Directed Studies:

June Dowell, Ph.D. 2002
Scott Brown, M.A., Ph.D., 2002
Jane Smith, Ph.D., 2000

h) EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

Year	Source / Purpose**	Type*	Amount per year
1998	Cdn. Fed.for Hum. publication Aid to Sch. Pub. Prog.	C	$5,000
		Principal investigator: J. Smith.	

etc...

*Type: C-Granting councils; G-Government; F-Foundations; O-Other
** Purpose: research, travel, publication, etc.

i) PUBLICATIONS: The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

Doe **3 of 4**

1) Life-time summary (count) according to the following categories:

- Books authored...3
- Books edited...2
- Chapters in books..4
- Papers in refereed journal 15
- Papers in refereed conference proceedings...3
- Technical reports 1
- Abstracts and/or papers read 6
- Others (workshops presented) 2

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Books authored:

1. Wjroyoppps rit portismwn (University of Toronto Press, 1996), 189 pp.

etc...

Books edited:

1. Vrtift gter ttresnem ed. by **John Doe** and Frances Crick, University of Ottawa Press, 1999, 480 pp.

   a) **Doe, John:** Andnt kitmn trmsn rtet (Chap.5) p.110-125

   b) Danis, L. & **Doe, J.** Trel mjets klomtsn (Chap.10) p. 432-450

etc...

Chapters in Books:

1. ?Grensmt trenmts tremnbds @, in K. Scholer and F. Marsden (eds), Tremnnr tt eswqmnbe qwe asdft (University of Calgary Press, 1991) pp 490-510

etc...

Papers in refereed Journals:

1. **Doe, J.,** as Dfghjk qwert uiopl asdf rewqmnbe ssdr . The Journal of Modern Thinking. 15:13-15, 2001

2. **Doe, J.,** McMartin, W., Reeves, S., Rewqamt wer scfhtrjod. Canadian Journal of Biblical Studies. 31:56-92, 1998

Doe **4 of 4**

3. Davis, L., Jones, V., **Doe, J.,** Fournier, B., Mnbvca dfrew sfeghj sdtuom , Canadian Journal of Biblical Studies. 22:425-431, 1997

etc...

Papers in Refereed Conference Proceedings

etc...

DATE:

VOLUME III

List of Proposed Consultants

NB: The consultants should be listed either alphabetically or by speciality (related to the program's fields). The pages should be numbered sequentially and a table of contents with page numbers should be provided.

SAMPLE RESUME FOR PROPOSED CONSULTANT

NOTE: *This information is requested to enable the Appraisal Committee to make the most appropriate selection of consultants for the program. It is important that it be as complete as possible. The proposed consultants should be experienced in carrying out evaluations and should have first hand experience with graduate supervision and administration of graduate programs.*

The University may approach the proposed consultants through the Dean of Graduate Studies or his/her delegate, provided that it is made clear that the person′s name is part of a slate being submitted to OCGS.

Where available, please provide the URL to the prospective consultant's web site.

PROGRAM:

1. NAME OF PROPOSED CONSULTANT:

2. RANK:

3. INSTITUTION: (include mailing address, telephone and fax numbers and E-mail address)

4. DEGREES UNIVERSITY DISCIPLINE DATE

5. AREA(S) OF SPECIALIZATION: (relate this to those offered by the program being appraised).

6. Experience/Expertise relevant to service as a consultant (e.g. membership on

editorial boards, administrative experience, academic recognition). *A short statement regarding the appropriateness of the nominee as a consultant for this program would help the committee.*

7. Recent scholarly activity (*if possible cite 3 to 5 recent publications giving title, date, kind of publication, journal, or publisher if a book*).

8. Previous affiliation with the University if any (e.g. visiting professor - give dates, internal consultant, former employee, any former professor/student relationships with faculty members). *Consultants should be at "arm's length" from the program, which means not a close friend, not a regular and current collaborator, not having been supervised recently by, not having been a visitor/teacher for some time at, and not a former colleague. Full disclosure of all past affiliation is required to assist the committee in the selection and to ensure an arm's-length relationship. Normally the Appraisal Committee will not select as consultants persons who may have been retained by the university to review the program.*

9. Any major blocks of time over the next 12 to 18 months when the proposed consultant may not be available.

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