Master of Engineering (MEng)
Introduction of a New Field
"HVAC Systems"
Major Modification

OVERVIEW OF THE NEW FIELD

Heating, Ventilating and Air Conditioning (HVAC) deals with providing air at specific conditions (temperature, humidity, air quality, etc) to a building space. HVAC systems are installed in almost all types of buildings, such as, commercial, institutional, residential, health care, storage, etc. As the HVAC systems provide air at the desired conditions, their demand is equally important in both cold as well as warm environments. As a result, the HVAC industry is well-established all over the world. Globally, buildings consume up to 40% of the total energy and almost 50% of the building energy is consumed by the HVAC systems[1]. There is a continuous growth of the HVAC industry. The increase in demand for the HVAC systems has been projected as 6.2% per year reaching $93 billion by 2014[2].

HVAC industry is heavily relied on mechanical engineers. The demand of mechanical engineers in the HVAC industry is at three levels; (i) designing stage, (ii) installation/commissioning stage, and (iii) operation and maintenance stage that covers the entire lifetime of the system. As the HVAC systems are utilized everywhere, there is a consistent demand of mechanical engineers in the HVAC industry all over the world. With the recent environmental awareness and the rise in the energy cost, there is a strong pressure on the HVAC industry to develop new concepts involving renewable energies to minimize the building energy consumption from conventional resources, which opens a new venue in this field.

The Department of Mechanical and Materials Engineering (MME) proposes the introduction of a new field (HVAC Systems) in the existing Non-thesis Master of Engineering (MEng) program.

Program Objectives:

The program is aimed at graduate mechanical engineers who want a career in the dynamic and growing HVAC industry. The proposed change is structured to widen the knowledge base of the engineering graduates in the HVAC-related fields from fundamental as well as applied aspects.

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[1] *Pérez-Lombard et al. A review on buildings energy consumption information, Energy and Buildings, Vol.40, 394-398, 2008.*

[2] *World HVAC Equipment, Published by The Freedonia Group, Inc., 2010.*

Strategic value to Western:

The proposed field falls within the broader areas of advanced fluid mechanics (from fundamental aspect) and environmental sustainability (from energy efficiency and renewable energy aspects) which are recognized as areas of research strength at Western in the UWO Strategic Plan 2008-11. The proposed MEng field in HVAC systems is considered as one of the niche areas in the Western Engineering Strategic Academic Plan 2011-14.

Program Details:

Mechanical engineering graduates with a Bachelor's degree in Engineering, or an equivalent degree from an accredited University with a minimum of 70% (computed based on the last two years of a bachelor's degree marks, or on their previous graduate marks) are eligible to register in the existing MEng Program. These existing requirements will be also apply to admission to the proposed HVAC field.

The MEng program is comprised of 10 half courses or 8 half courses and a project (equivalent to two half courses), divided into three categories.

The first category (Category A) is comprised of courses that cover the advanced topics from the mechanical engineering core which are essential as they bring the minimum knowledge base of bachelor's degree holder mechanical engineer to the graduate level. There are six core half courses in this category as listed below, and students have to complete four out of six courses.

Category A

MME 9515	*Fluid Machinery*
MME 9610	*Applied Measurements & Sensing Systems*
MME 9612	*Finite Element Methods*
MME 9614	*Applied Computational Fluid Mechanics and Heat Transfer*
MME 9617	*Energy Conversion*
MME 9621	*Computational Methods in Engineering*

Note that the courses in this category are offered on a regular basis as part of the existing graduate program in the Department of Mechanical and Materials Engineering.

The second category (Category B) is comprised of professional engineering courses which are general requirements for the existing MEng program in the Faculty of Engineering. There are four half courses in this category as listed below, and students are required to complete two out of four courses.

Category B

CBE 9185	*Risk Assessment and Management in Engineering Systems*
CEE 9510	*Engineering Planning and Project Management*
ECE 9010	*Intellectual Property for Engineers*
MME 9670	*Engineering Communication*

Note that the courses in this category are offered on a regular basis as a part of the existing graduate program in the Faculty of Engineering.

The third category (Category C) is the specialization in the HVAC systems. There are four courses in this category, as listed below, which cover the necessary aspects of the HVAC systems engineering. Two courses (MME 9516 and MME 9517) are already offered on a regular basis as a part of the graduate program in the Department of Mechanical and Materials Engineering. We have found these HVAC courses to be very popular and effective; however, broader knowledge base and depth in this area is necessary to become a specialist in this field. Therefore we have expanded our offering by introducing two new courses (MME 9641 and MME 9642), which provide the required broader knowledge base and depth. Furthermore, an MEng project option is also available in this category which is equivalent to two half courses. The MEng projects will be mainly industry-oriented which will provide a practical experience and an exposure to the HVAC industry. In this category, students have two options, (i) complete all four courses, or (ii) complete two courses and an MEng project. The second option (ii) will only be available to the students who have already completed HVAC I and HVAC II or equivalent courses in the previous degree.

Category C

MME 9516	*HVAC I*
MME 9517	*HVAC II*
MME 9641	*Thermal Systems Engineering*
MME 9642	*Building Systems Engineering*

The four specialized graduate courses to be offered in Category C cover all relevant areas of the HVAC Systems engineering and develop the knowledge base. A brief review of each of these courses is provided below:

MME 9516 (HVAC I) covers the main HVAC psychrometric processes, heating and cooling load calculations, and refrigeration cycles. The course also has a lab component and a design project. Students also learn an HVAC modeling software HAP, which is widely used by the HVAC industry.

MME 9517 aims to developing students' knowledge and understanding of the design of main HVAC sub-systems for example, air and water distribution systems, fan/pump sizing and selection, and the selection of HVAC system components such as chillers, boilers etc. The course has a design project. Field trips to the local HVAC systems' sites are also a part of the course. In addition, guest lectures are also arranged where industry experts in various HVAC components share their knowledge and experience with the students.

MME 9641 (*Thermal Systems Engineering*) covers the fundamental theory, basic design criterion and in-depth analysis of different thermal sub-systems used in the HVAC systems, which include heat exchangers, refrigeration systems, heat pumps, and engines. The course also has a lab component.

MME 9642 (Building Systems Engineering) covers the fundamentals of the building sub-systems. As the HVAC systems are installed in all types of buildings, the knowledge of the building sub-systems and the building energy consumption is vital for the proper designing, selection, operation and maintenance of the HVAC systems. The course also introduces the energy efficiency in buildings and the use of renewable energies in buildings, which are in line with the new trends in the HVAC industry.

The six graduate courses to be offered in Category A cover the broader knowledge base to further strengthen the fundamentals that can be applied in the HVAC field. For example, MME 9515 (Fluid Machinery) conducts an in-depth analysis of pumps which are essential components in the HVAC systems; MME 9610 (Applied Measurements & Sensing Systems) widens the knowledge base from instrumentation and measurement perspective which is important from the monitoring and control aspects of HVAC systems; MME 9612 (Finite Element Methods) covers the stress analysis which is useful from the structural aspects; MME 9614 (Applied Computational Fluid Mechanics and Heat Transfer) trains students on using simulation tools to simulate fundamental thermo-fluid processes, which are also involved in HVAC systems; MME 9617 (Energy Conversion) focuses on various energy resources and energy conversion processes which would be useful in developing energy efficiency strategies and integrating renewable energies to minimize the building energy consumption from conventional resources; MME 9621 (Computational Methods in Engineering) covers important methods and techniques used in the numerical analysis of mechanical engineering problems, which could be helpful in the general analyses.

Consultation process in the preparation of the brief, including faculty and student input and involvement

The proposed program was presented and discussed at the MME Department Council meeting and unanimously approved. The program was also consulted with the local HVAC industry and the local chapter of the American Society of Heating, Refrigerating and Air-Conditioning Engineers

(ASHRAE) and they have assured cooperation in soliciting industry-oriented projects. The program was then discussed at the Graduate Chairs committee meeting in the Faculty of Engineering and approved. Finally, the program was discussed at the Faculty council and unanimously approved.

Evidence to support the introduction of the program

As mentioned earlier, HVAC is a growing industry but at the same time it is not significantly influenced by the economic variations as the HVAC systems are considered as basic necessities. Therefore, there is a consistent demand of mechanical engineers in the global HVAC industry. The advanced knowledge of the HVAC profession and the practical experience (in the form of MEng projects) will place the graduates from this program in a preferred standing for the potential HVAC industry employers as compared to the regular mechanical engineering graduate. In MME, we offer two toggled HVAC courses as fourth year technical electives. Both of these courses are very popular among 4th year undergraduates and we expect that the proposed program will motivate a large number of these students to pursue Master's degree.

Special matters and innovative features

The proposed program is unique to Ontario and Canada. Even very few universities in the US or around the world offer graduate program in HVAC. Therefore, it would serve as a niche area in the Western Engineering. Due to the uniqueness of the program at the national and international levels, it will attract national as well as international students.

Listing of faculty members in the program

Primary members:

a) tenured or tenure-track core faculty members whose graduate involvement is primarily in the graduate program under review

1. Dr. Roger Khayat, Associate Professor, Mechanical and Materials Engineering
2. Dr. Michael Naish, Associate Professor, Mechanical and Materials Engineering
3. Dr. Eric Savory, Associate Professor, Mechanical and Materials Engineering
4. Dr. Kamran Siddiqui, Associate Professor, Mechanical and Materials Engineering
5. Dr. Anand Singh, Professor, Mechanical and Materials Engineering
6. Dr. Anthony G. Straatman, Professor, Mechanical and Materials Engineering
7. Dr. Chao Zhang, Professor, Mechanical and Materials Engineering

Other:

1. Walid Altahan, Laboratory Manager, Mechanical and Materials Engineering

- There are 7 full-time Primary tenured professors and one staff member. These members will have the primary responsibility for the courses in Categories A and C. Four primary professors (E. Savory, K. Siddiqui, A. Straatman and C. Zhang) and the staff member (W. Altahan) will also be responsible for the supervision of the MEng projects in the program. The staff member Walid Altahan is a permanent staff member (Laboratory Manager) in the department since 2003. He holds an MESc degree in Mechanical Engineering and has a vast industrial experience in HVAC systems. He is eligible to tech graduate courses in the department and has been teaching HAVC I and HAVC II since 2007. Walid has made several improvements in the content and delivery of both courses and has received USC Teaching Honour Roll Award and Terry Base Teaching Award for these courses. Two primary tenured professors (K. Siddiqui and C. Zhang) have taught HVAC courses in the past and could take over these courses if necessary.
- The department also has an HVAC Resource Laboratory equipped with an educational Air Handling Unit and computer work stations with HVAC modeling software HAP.