Heat and Mass Transfer (ENGG*3430)
Winter 2013 Course Outline

Instructor: Shohel Mahmud, Ph.D., P.Eng.
Assistant Professor
Room: 1410, Thornbrough Bldg
Tel: 519 824-4120 ext: 54058
Email: smahmud@uoguelph.ca

Teaching Assistants:

TA1: Bimal Acharya (bacharya@uoguelph.ca)
TA2: Emily Austin (eaustin@uoguelph.ca)
TA3: Stephen Gopaul (sgopaul@uoguelph.ca)
TA4: Poritosh Roy (poritosh@uoguelph.ca)
TA5: Mohammad Tushar (mtushar@uoguelph.ca)

GTA Office Hours: Please visit CourseLink for an updated information on GTA office hours and locations

Lectures:

Monday, Wednesday, and Friday (10:30am – 11:20am), Room: THRN-1200

Course Textbook:

Heat and Mass Transfer: Fundamentals and Applications, 4th Edition (2010)
Authors: Y. Cengel and A. Ghajar, Publisher: McGraw-Hill

(**Note**: Quiz, Midterm, and final are open book exams. Therefore, you need a copy of the course textbook for successfully complete these exams)

Other References:

Fundamentals of Heat and Mass Transfer, 6th Edition (2007)
Authors: F.P. Incropera, D.P. DeWitt, T.L. Bergman, and A.S. Lavine, Publisher: John Wiley and Sons
Introduction to Heat Transfer, 1st Edition (1999)
Authors: V.S. Arpaci, S.H. Kao, A. Selamet, Publisher: Prentice Hall
Heat Transfer, 1st Edition (1993)
Author: A. Bejan, Publisher: John Wiley and Sons

Undergraduate Calendar Description

ENGG*3430 Heat and Mass Transfer W (3-1) [0.50]: Analysis of steady and transient thermal systems involving heat transfer by conduction, convection and radiation and of mass transfer by molecular diffusion and convection. Other topics include the thermal analysis of heat exchangers and heat transfer systems involving a change of state.

Prerequisite(s): ENGG*2230, ENGG*3260, MATH*2270

COURSE OBJECTIVES

This course is to introduce the basic principles of heat and mass transfer with emphasis on their analysis and applications to practical engineering problems. On successful completion of this course, you should be able to:

- Identify important thermal processes, and derive the basic expressions for heat conduction, convection and radiation based on the First Law of Thermodynamics
- Analyze heat transfer using electrical resistance network analogy
- Determine steady state and transient temperature distribution in various solid geometries of practical importance
- Understand the physical significance of dimensionless parameters in convective heat/mass transfer
- Select and apply the appropriate correlation for different convective heat and mass convection processes
- Analyze and perform the thermal design of heat exchangers using conventional methods
- Determine radiation exchange within an enclosure based on the view factor method
- Analyze mass diffusion in a stationary medium and low rate mass convection based on the analogy between heat and mass transfer

COURSE SCHEDULE

The following table contains the tentative schedule of lecture topics and reading assignments. **It is strongly suggested that you scan the reading materials prior to the lectures.**

Week	Topics	Chapter	Sections
1	Basic heat transfer	1	1.1 to 1.8
1	Heat conduction equation	2	2.2 to 2.6
2, 3, 4	Steady heat conduction	3	3.1 to 3.7
4, 5	Transient conduction	4	4.1 to 4.2
5	Numerical methods in heat conduction	5	5.1, 5.4
5, 6	Fundamentals of heat convection	7	6.1, 6.3, 6.4, 6.7
5	**Midterm Exam (Date: 8th February, 2013, Time:7:30pm to 9:30pm, Location: ROZH 104)**		
6	External forced convection	7	7.1 to 7.4
7	Internal forced convection	8	8.2, 8.4, 8.5
8	Natural convection	9	9.1, 9.2, 9.3, 9.5
8, 9	Fundamentals of thermal radiation	11	11.2, 11.3, 11.6
9, 10	Radiation heat transfer	13	12.1, 12.2, 12.3, 12.4
10, 11	Heat exchangers	11	13.1, 13.2, 13.3, 13.4
11, 12	Introduction to mass transfer	14	14.1, 14.2, 14.3, 14.5, 14.9
12	Boiling and condensation	10	10.1 to 10.4
	Final Exam (Date: 13th April, 2013, Time: 2:30pm to 4:30pm, Location: TBA)		

1. Course topics are covered by both lectures and tutorials. The main purposes of the tutorials are two-fold: i) to allow an opportunity to explore issues and ask questions about the material covered in the lectures, text and previously assigned material that requires further clarification; and ii) to write a short quiz dealing with the problems recommended for that particular week.
2. A major objective of this course is to prepare students to solve engineering problems that involve heat and mass transfer processes. It is thus important for you to work out each assignment problem by **yourself** to gain the deeper appreciation for the fundamentals of the subject and build your confidence in

applying these fundamentals to the solution of engineering problems. Do not deny yourself the joy of self-discovery!

3. Please note that to be successful in the course it is imperative that you keep up with the material on a weekly basis regardless of the pressure imposed by other courses or circumstances. Experience has shown that once a person falls behind in the course there is little chance of catching up later. Similarly, if you have difficulties with the material, review thoroughly the lecture materials, class and tutorial problems, solutions to the suggested problems from the textbook, see one of the teaching assistants – **DO NOT WAIT UNTIL THE MIDTERM OR FINAL TO RESOLVE YOUR DIFFICULTIES.**

SUGGESTED PRACTICE PROBLEMS

Solutions to the selected problems from different chapters of your course textbook will be available in COURSE LINK. It is your responsibility to check COURSE LINK time to time to download the problems and solutions. You are heavily encouraged to solve these problems in a regular basis.

TUTORIAL

Each tutorial is divided into two parts. In the first part (approximately 30 minutes), your TA will solve and discuss one problem. In the second part of your tutorial (approximately 20 minutes) you will be asked to solve a problem. You need to make a group of two students (including yourself) for solving the problem in the second part of the tutorial. At the end of each tutorial you must submit your solution to your TA for marking. A total 7.5% mark is allocated for such problem solving activates. You are heavily encouraged to attend the tutorial regularly.

Tutorial Schedule for ENGG*3430*:

Week	**Section 101** Monday 9:30am-10:20 am MACK 236	**Section 102** Tuesday 3:00pm-3:50 pm MACK 238	**Section 103** Wednesday 9:30 am-10:20 am MACK 238	**Section 104** Wednesday 11:30 am-12:20 pm MACK 235	**Section 105** Thursday 3:00 pm-3:50 pm MACK 238	**Section 106** Friday 03:30 pm-4:20 pm MACK 234
1 (7th Jan – 11th Jan)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA2**
2 (14th Jan – 18th Jan)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA4**
3 (21st Jan – 25th Jan)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA5**
4 (28th Jan – 1st Feb)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA1**
5 (4th Feb – 8th Feb)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA3**
6 (11th Feb – 15th Feb)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA2**
18th Feb – 22nd Feb	Winter Break Week					
7 (25th Feb – 1st Mar)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA4**
8 (4th Mar – 8th Mar)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA5**
9 (11th Mar – 15th Mar)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA1**
10 (18th Mar-22nd Mar)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA3**
11 (25th Mar-29th Mar)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**Holiday**
12 (1st Apr – 5th Apr)	**TA2**	**TA4**	**TA5**	**TA1**	**TA3**	**TA2**

****Students are not allowed to change their tutorial sections without the approval of the instructor.***

Heat Transfer Lab: The purpose of performing the Heat Transfer Lab is to verify some of the theoretical learning in our class by experiments. Heat Transfer Lab is located inside the “Sustainable Energy Lab (THRN 3402)”. Two tutorial classes out of your last three tutorials (Week 10 to Week 12 - 18th March’ 2012 to 5th April’ 2012) are reserved for the Heat Transfer Lab. Four experiments are designed to cover most of the basic aspects of Heat and Mass Transfer. ‘Lab Manual’ will be available in COURSE LINK in Week 9. You need to make a group of two students (including yourself) for performing the lab. The lab report is due before 5th April, 2013. A total 7.5% mark is allocated for performing all lab components.

GRADING SCHEME

Problem solving (in Tutorial)	: 7.5%
Lab Experiments and Report Writing	: 7.5%
Midterm Exam (open book)	: 35%
Final Exam (open book)	: 50%
Total	= 100%

Open Book means that you are allowed to bring the course textbook but not your notes and assignment solutions (If you copy solutions to the problem sets into your textbook, you will not be allowed to use it during the various tests). You are also allowed to use a **non-programmable** calculator during the tests and exams.

Useful Information:

First Law of Thermodynamics for closed system: $\dot{E}_{in} - \dot{E}_{out} = \left.\frac{dE}{dt}\right|_{system} = \left.\frac{dU}{dt}\right|_{system} = mC_v\frac{dT}{dt} = (\rho V)C_v\frac{dT}{dt}$

Simple Integrations:

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C_1$$

$$\int \frac{1}{ax+b}dx = \frac{\ln(ax+b)}{a} + C_1$$

$$\int e^{ax}dx = \frac{e^{ax}}{a} + C_1$$

$$\int \ln(x)dx = x\ln(x) - x + C_1$$

$$\int \sin(ax+b)dx = -\frac{\cos(ax+b)}{a} + C_1$$

$$\int \cos(ax+b)dx = \frac{\sin(ax+b)}{a} + C_1$$

Differential Equations:

$$\frac{d^2y}{dx^2} + m^2y = 0 \quad \Rightarrow \quad y = C_1\sin(mx) + C_2\cos(mx)$$

$$\frac{d^2y}{dx^2} - m^2y = 0 \quad \Rightarrow \quad y = C_1\sinh(mx) + C_2\cosh(mx) = C_1e^{mx} + C_2e^{-mx}$$

$$\frac{d^2y}{dx^2} + m^2y = G \quad \Rightarrow \quad y = C_1\sin(mx) + C_2\cos(mx) + \frac{G}{m^2}$$

$$\frac{d^2y}{dx^2} - m^2y = G \quad \Rightarrow \quad y = C_1\sinh(mx) + C_2\cosh(mx) - \frac{G}{m^2} = C_1e^{mx} + C_2e^{-mx} - \frac{G}{m^2}$$

Calculus:

$$\Phi = f(t,x,y,z) \quad \Rightarrow \quad d\Phi = \frac{\partial\Phi}{\partial t}dt + \frac{\partial\Phi}{\partial x}dx + \frac{\partial\Phi}{\partial y}dy + \frac{\partial\Phi}{\partial z}dz$$

Simple electrical circuit:

Equivalent resistance (R_{eq}) when n resistances are in series: $R_{eq} = R_1 + R_2 + R_3 + \cdots\cdots + R_n$

Equivalent resistance (R_{eq}) when n resistances are in parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots\cdots + \frac{1}{R_n}$