Winter 08

ENGG*3430: HEAT AND MASS TRANSFER

Instructor:	Dr. Lambert Otten	Room 211 (old bldg), ext. 53070	lotten@uoguelph.ca
	Office hour:	Monday 9:00 am to noon or by appointment via e-mail	
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	Alicia Wind	Room 326	awind@uoguelph.ca
Lectures:		Monday, Wednesday, Friday @ 1:30 pm; Thornbrough1200	
Tutorials:		Start the week of January 7th	
	Section 0101:	Monday @ 10:30 am, ROHZ 108	
	Section 0102:	Wednesday @ 10:30 am, MACK 234	
	Section 0104:	Wednesday @ 2:30 pm, MACK 234	
	Section 0105:	Thursday @ 2:30 pm, MACK 237	
	Section 0106:	Friday @ 2:30 pm, ROHZ 109	
	Section 0108	Thursday @ 4:30 pm, MACK 317	

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:

1) Identify important thermal processes, and derive the basic expressions for heat conduction, convection and radiation based on the First Law of Thermodynamics,
2) Analyze conduction heat transfer using an electrical resistance network analogy,
3) Determine steady state and transient temperature distribution in various solid geometries of practical importance,
4) Understand the physical significance of dimensionless parameters in convective heat/mass transfer,
5) Select and apply the appropriate correlation for different convective heat and mass convection processes,
6) Analyze and perform the thermal design of heat exchangers using conventional methods,
7) Determine radiation exchange within an enclosure based on the view factor method, and
8) 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.

Start	# of Lectures	Topic	Text
Jan. 7	1	**Orientation and course outline** **Introduction**	
Jan. 9, 11	2	**Rate Equations and Conservation Laws** Rate equations of heat transfer Thermal properties of materials Conservation of energy	 1.1, 1.22.2 1.3 to 1.6

Jan. 14, 16 Jan. 18	3	**1D Steady-State Conduction** Diffusion equation and boundary conditions Plane wall conduction Radial conduction Conduction with thermal generation	 2.1, 2.3, 2.4 3.1 to 3.2 3.3 to 3.4 3.5
Jan. 21, 23	2	**2D and 3D Steady-State Conduction** Introduction to analytical solutions Conduction shape factor method	 4.1 and 4.2 4.3
Jan. 25, 28, Jan. 30 Feb. 1	4	**Transient Conduction** Lumped capacitance method Introduction to analytical solutions Semi-infinite solid solutions Multi-dimensional solutions	 5.1 to 5.4 5.5 to 5.6 5.7 5.8
Feb. 4, 6	2	**Numerical Methods in Heat Conduction** Numerical formulation and error control Steady state heat conduction Transient heat conduction	Notes 4.4 to 4.5 5.9
Feb. 8, 11, 13, 15	4	**Heat Convection** Convection heat transfer and boundary layer Forced convection Free or natural convection	 Chapter 6 Chapters 7, 8 Chapter 9
Feb. 18-22		**WINTER BREAK**	
Feb. 25	1	**REVIEW CLASS**	
Feb. 26	7-9 PM	**MIDTERM**	
Feb. 27, 29 Mar. 3, 5, 7	5	**Radiation** Mechanisms and properties of radiation Radiation view factor Heat exchange between black bodies Heat exchange between non-black bodies	12.1 to 12.7 13.1 13.2 13.3
Mar. 10, 12, 14, 17, 19	5	**Mass Transfer** Rate equation and boundary conditions State-state mass diffusion Unsteady-state mass diffusion Convective Mass transfer	 14.1 to 14.3 14.4 and 14.5 14.6
Mar. 21		**Holiday**	
Mar. 24, 26, 28	3	**Heat Exchangers** Introduction to heat exchangers Effectiveness-NTU method	11.1, 11.2, 11.4, 11.6
Mar. 31, Apr. 2, 4	3	**REVIEW CLASS**	
Apr. 4		**CLASSES CONCLUDE**	
Apr. 8		**FINAL EXAM (7:00 to 9:00 pm)**	

1. Course topics are covered by both lectures and tutorials. The main purposes of the tutorials are two-fold: 1) 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; 2) 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, see one of the teaching assistants or myself immediately – **DO NOT WAIT UNTIL THE MIDTERM OR FINAL TO RESOLVE YOUR DIFFICULTIES.**

SUGGESTED PRACTICE PROBLEMS

The following table provides a schedule of problem sets to be completed prior to the dates shown. The problems are not graded. Instead, the solutions are discussed at the start of the tutorials on and after the dates shown in the second column. At the end of the tutorials a short quiz will be given to evaluate your understanding of the material relevant to the problems. Solutions to the problems will be made available on the web after the last tutorial of the week.

Please note that the course is primarily analytical in nature and the more problems that are attempted, the better. The suggested problems should be regarded as a minimum effort. If you have difficulties with them, you need to attempt additional problems. A list of suitable problems is found on the Blackboard course site. This list contains the problems suggested in W07 and the corresponding solutions are also provided on the Blackboard site. If you decide to do additional problems for which you have no solutions, the TAs are pleased to review them.

Problem Set	**Complete before**	**Problem Set**	**Complete before**
P1	Jan. 14	P6	Febr. 25
P2	Jan. 21	P7	Mar. 10
P3	Jan. 25	P8	Mar 24
P4	Feb. 4	P9	Mar. 31
P5	Feb. 11		

GRADING SCHEME

Quizzes (7 weekly) (Open or Closed book)	15 %
Midterm (Open book)	35 %
Final Exam (Open book)	50 %

The quizzes will typically last 10 minutes and will be held during the weekly tutorials. Students should clearly understand concepts in order to prepare for any tests rather than simply memorizing the solution schemes

The **quiz grade** will not reduce your final grade if the combined midterm and final examination grades are higher. Thus, if the quiz grade is lower, it will be dropped and the course grade will be determined by scaling the average midterm and final grades from 90 to 100%.

Open Book means that you are allowed to bring the 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.

You must achieve a passing grade in the combined midterm and final grades to pass the course. If not, you will be assigned the failing grade.

MISSED QUIZZES AND MIDTERM

If you **miss a quiz** due to illness, please inform your TA. The quiz will not be counted in determining the overall quiz grade.

If you **miss the midterm** and have an acceptable, properly written reason in accordance with University Calendar, the weight of the midterm will be added to the weight of the final exam.

You may appeal any mark with the written reasons for remarking **within one week** of receipt of the graded test or midterm.

Please note that all other university policies specified in the Undergraduate Calendar 2007/08 will be followed. In particular, you may wish to review the section on academic misconduct.

TEXTBOOK

Incropera, F.P., DeWitt, D.P., Bergman, T.L. and Lavine A.S. (2007). *Fundamentals of Heat and Mass Transfer,* 6th Edition, John Wiley and Sons, New York, NY, 981p.

Notes on pertinent material not found in the text will be provided throughout the semester.

PREREQUISITES

05-223	Fluid Mechanics
05-326	Thermodynamics
63-227	Applied Differential Equations

Note: If you do not meet this requirement, you must have the instructor's approval to stay in the course.

CAUTION: The Heat and mass Transfer course requires a working knowledge of the prerequisite course. Generally, a grade <70% in a prerequisite does not reflect a working knowledge and you need to review the material important to this course. If you have a grade between 50 and 60% in one or more of the prerequisite course, especially in Applied Differential Equations and thermodynamics, you can expect the course to be difficult and require considerable time and effort.