UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
DEPARTMENT OF MECHANICAL SCIENCE AND ENGINEERING

ME 320: HEAT TRANSFER
COURSE INFORMATION
Spring Term 2017

I. CREDIT AND CONTENT

Heat transfer is ubiquitous in our lives, from cellular biology inside the human body to the industrial world around us. This course is an introduction to the manner in which heat is transferred between objects and very importantly, how to predict and engineer such transfer. The knowledge you gain here will enable you to design and build heat transfer solutions for a variety of applications, from iPhones to power plants. In fact, you can make a career out of just heat transfer engineering if you so wish.

Topics to be covered include: conservation laws, conduction, convection, phase change (condensation and boiling) and radiation. Problems and examples will include theory and applications drawn from nature and a spectrum of engineering applications.

II. CLASSES

Lectures: Mon., Wed., Fri. from 10:00 to 11:00 AM in 208 MEB

Tutorials: None

Lecturer: Professor N. Miljkovic, nmiljkov@illinois.edu, MEL 2136, 617-981-9247

T.A.: Eric Wood, ejwood2@illinois.edu

Office Hours: T.B.A.

Textbook: Bergman, Lavine, Incropera, and Dewitt, *Fundamentals of Heat and Mass Transfer*, Wiley, 7th Edition

III. EXAMS AND GRADING

There will be two in class quizzes as indicated on the course schedule. There will be a comprehensive final exam at a time and place to be announced in lecture. Absolutely no make-up exams will be given, except in the case of an excused absence or excused conflict. Letters of Accommodation from the Disability Resources and Educational Services (DRES) office should be given to the instructor within the first two weeks of class.

Course grades will be based on exercise, exam, and laboratory grades, according to the following weighting scheme (as a percentage of total points available in the class):

Laboratory Grade 25%
Lecture Grade 75%

Your lab grade will be based on lab reports as described in handouts made available to during your first laboratory section meeting. Your lecture grade will be comprised of 20% from exercises, 30% from the in-class quizzes, and 50% from the final exam. Final grades will be assigned using the following scale.

A+	98-100%
A	93-97%
A-	90-92%
B+	88-90%
B	83-87%
B-	80-82%
C+	78-80%
C	73-77%
C-	70-72%
D+	68-70%
D	63-67%
D-	60-62%
F	<60%

The quiz dates are as follows:

Quiz 1: Wednesday, February 22

Quiz 2: Friday, March 31

Final Exam: May 5-12 final exam period, time and place TBA.

Homework Problems:

A set of six graded homework problem sets be assigned during the course. You should work all of these problems carefully as they are essential aid to learning the material. Though these homeworks constitute a small fraction of the total course grade, experience shows that students who do them well on their own usually do well on exams.

• Graded homeworks will be assigned on the ME320 Compass-2G site on the Friday lecture of that week and completed as homework and handed in on the Friday lecture two weeks from the hand out date. The frequency of these assignments is expected to be biweekly, though the schedule is subject to change. These assignments are expected to be yours in every sense.

IV. PREREQUISITES

The foundations for this course lie in thermodynamics and fluid mechanics, which you are expected to know. Also, familiarity with linear ordinary differential equations is essential for the course. Finally, familiarity with mathematical software is needed to perform some of the assignments for the course. There is no restriction on the software to be used but common preferences are MATLAB, Mathematica and MathCAD. Typically, help with debugging programs will not be provided. Skills in these or any software of choice are assumed to have been learned earlier. Note however that if you have gaps in these areas, it shouldn't prevent you from doing well in this class.

V. COURSE GOAL

The goal of the course is to introduce you to undergraduate material in heat transfer, and to aid your transition from undergraduate work into graduate courses on heat transfer, energy sciences, and fluid mechanics. By the end of the class, you should understand the modes of energy transfer, and the theoretical and empirical bases for calculating conduction, convection, and radiation heat transfer. Moreover, you should acquire a “feel” for this part of your discipline, so that you are able to apply judgment to the evaluation of thermal designs and systems.

An important aspect of this class is the analytical method: when confronted with a complex thermal problem, you should be able to simplify it appropriately, analyze it, and make a judgment as to the meaning and application of your results. Heat transfer is a rich area for engineering research, and contemporary problems related to biological systems, micro-/nano-systems, ozone depletion, global warming, fossil-fuel depletion, and energy storage/conversion will require the creative application and extension of our current knowledge. I will strive to make this part of your education interesting and exciting – with the hope that one of you may play a role in solving some of these problems.

VI. COLLABORATION

You may not collaborate on the homeworks, quizzes, or final exam.

VII. LEARNING STRATEGY

To learn the material effectively, you will need attend lectures, participate in class, and ask questions when confused. Staying engaged in class is key to doing well. Also, the homework problems will prepare you above and beyond for the quizzes and final exam.

Properties of selected fluids at 20°C = 293K and 1 bar = 10^5 N/m^2

Fluid	Density ρ (kg/m^3)	Viscosity μ (kg/m s)	Thermal conductivity k (W/m K)	Coefficient of thermal expansion β (K^{-1})	Isothermal Compressibility κ_T (m^2/N)	Specific heat at constant pressure c_p (J/kgK)
Helium	0.164*	1.92×10^{-5}	0.150	3.41×10^{-3} *	1.00×10^{-5} *	5.21×10^{3} *
Air	1.19*	1.98×10^{-5}	0.0262	3.41×10^{-3} *	1.00×10^{-5} *	1.00×10^{3} *
Water	1.00×10^{3}	1.00×10^{-3}	0.597	1.8×10^{-4}	4.6×10^{-10}	4.18×10^{3}
Glycerin ($C_3H_8O_3$)	1.26×10^{3}	1.49	0.286	5.0×10^{-4}	3.7×10^{-10}	2.39×10^{3}
Mercury	1.36×10^{4}	1.55×10^{-3}	8.69	1.82×10^{-4}	0.40×10^{-10}	1.39×10^{2}

* Calculated from ideal gas relationships.

The isothermal compressibility κ_T and the coefficient of thermal expansion β are defined by the equation

$$\frac{d\rho}{\rho} = \kappa_T dp - \beta dT \ .$$

Surface tension at a clean air-water interface at 20°C : $\sigma = 0.073$ N/m