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Peer Review of Teaching Project

2014

MENG 4200: Heat Transfer—A Peer Review of Teaching Project Benchmark Portfolio

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MENG 4200: Heat Transfer

A Peer Review of Teaching Project Benchmark Portfolio

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2014

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INTRODUCTION

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Course: MENG 4200 Heat Transfer
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OBJECTIVE OF THE COURSE PORTFOLIO

The main goal of attending this course review project is to improve my teaching performance of technical courses so that both the students and I can enjoy the mutual-learning process. Teaching to me is really rewarding. I believe teaching is an art, which can be continuously improved through learning from the peers, collecting and analyzing students' feedback and practice, regardless whether it is technical or practical. With good teaching, any course can be taught in a joyful manner.

The specific objectives of the course portfolio include the follows:

1. Document the main materials for future refining through the documentation process of this project. I have been teaching this required course to sophomore students in three options of Architectural Engineering since 2012. Heat Transfer, as Thermodynamics and Fluid dynamics, serves a base to the advanced courses. This course is difficult to teach due to the technical characteristics. Heat transfer, including conduction, convection, radiation and multi-modes, are not tangible to the students. I prepared the class in a way revealing the concepts, equations, and their applications step-by-step. Instead of letting students be merged in lengthy texts and various complex heat transfer problems, I always start with a review on the previous lecture, then explain the concepts or deduce the equations, and provide examples. Documenting the course materials from the syllabus, homework to exams, provides me with a base of understanding the students' learning process so that adjustments can be made in the future.

2. Self-evaluating my teaching performance and identifying the potentials for improvements. Students' learning performance in a technical course is largely dependent on how the materials are taught. Boring repetition of textbook concepts and equations from the teacher can easily kill the students learning interest. Consequently, the teacher will lost his/her interest in teaching. I always try to constantly adapt my teaching based on the students' reaction. For example, I added two more recitations to the tight schedule and reduced some theoretical deduction in the second half of the semester. Even so, I noticed that some students can not follow the teaching and digest the contents. There are rooms for improvement to make the students enjoy the learning process.

3. Serving as a foundation for developing new courses in both undergraduate and graduate level to enhance the curriculum in the school. As a junior faculty, I am eager to develop new courses focusing on building system operation where most primary energy was consumed. Starting from the scratch without the textbook and classnotes is always a challenge. Systematically collecting the materials in other technical courses and conducting self-evaluation in this project can help me identify the strengths and shortcomings in my teaching, understand the students learning preference and utilize the findings for new courses.

DESCRIPTION OF THE COURSE

Description

Heat transfer (See **Appendix A** for syllabus) is listed as a required courses to the students in Architectural Engineering. Three basic heat transfer modes, including heat conduction, heat convection, and radiation are covered. Despite the complexity of heat transfer in reality, the course focus on the process of simplification process and mainly steady-state one-dimensional heat transfer. Three coordinates, including Cartesian, cylindrical, and spherical systems are included to facilitate the analysis in different scenarios. The lumped capacitance analysis is used to investigate the transient heat conduction process where the differences within the solid object can be ignored.

Heat diffusion equation are deduced to obtain the temperature distribution within a material. Thermal resistance network is introduced as a basic analytical tool for heat transfer problems. Extended surfaces, which are widely in engineering to promote heat transfer between different fluids, are investigated. Convection heat transfer is categorized and studied in both internal and external conditions. The emphasis is placed on identifying the proper geometry and flow condition and utilizing the education forms for obtaining the heat convection coefficient. Free convection and heat convection with latent heat is briefly introduced. Radiation heat transfer between a small surface to large ambient environment and the condition with multiple surfaces is studied. Types of heat exchanger and the two main design and post-design analysis methods are introduced. Methods and skills for solving multi-mode heat transfer are presented throughout the course.

Goal and Objectives

The goal of this course is to build up the students' interest in fundamental heat transfer problems and develop the skills of applying knowledge in solving the problems.

The detailed objectives and the priority can be quantified as the ABET points as in the following table:

ABET (Accreditation Board for Engineering and Technology) Expected outcome	**Emphasis in this course**
a) an ability to apply knowledge of mathematics, science, and engineering	2

b) an ability to design and conduct experiments, as well as to analyze and interpret data	1
c) an ability to design a system, component, or process to meet desired needs	
d) an ability to function on multi-disciplinary teams	
e) an ability to identify, formulate, and solve engineering problems	3
f) an understanding of professional and ethical responsibility	
g) an ability to communicate effectively	1
h) the broad education necessary to understand the impact of engineering solutions in global and societal context	
i) a recognition of the need for and an ability to engage in life-ling learning	
j) a knowledge of contemporary issues	
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	

Students Composition and Demographics

Enrollment: 26; Male: 19; Female: 7.

Other information on students' composition are as Fig. 1 (major distribution) and Fig. 2.

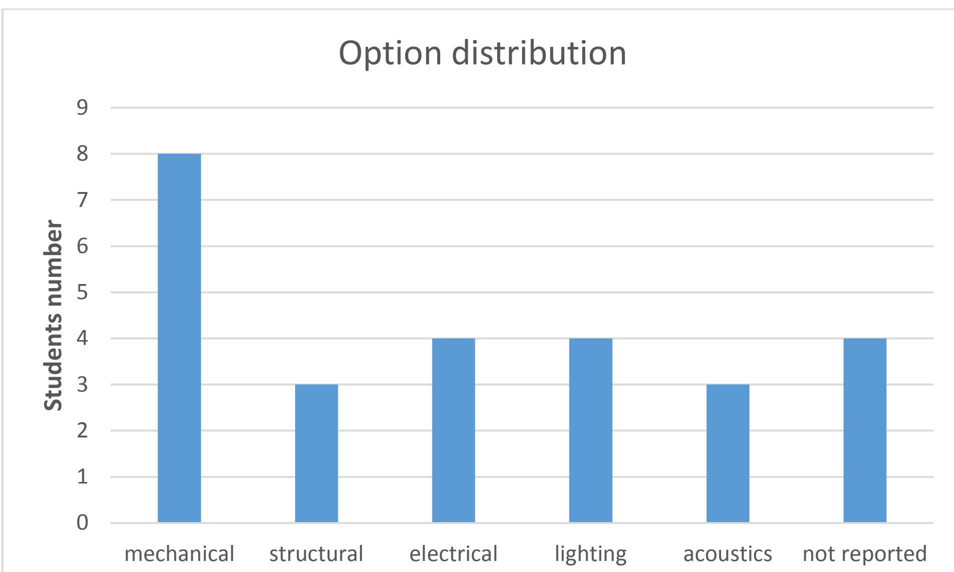


Fig. 1: Major distribution of students in this course

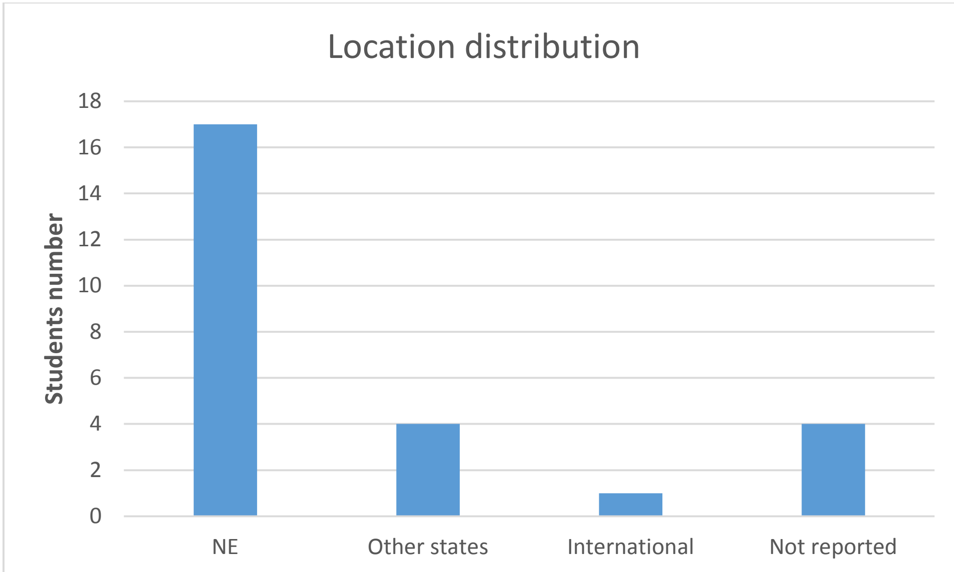


Fig. 2: Location distribution of students in this course

TEACHING METHODS/COURSE MATERIALS/COURSE ACTIVITIES

The course is the fundamental class on the key concepts of heat transfer modes and rate equations. The course describes how the energy is transferred between systems. The main teaching methods include lectures, homework, recitations, supportive materials, and in-class discussion.

Lectures

A. Included a little bit more examples from the text book problems in addition to the text book examples. Instead of just laying out the solution, added the rationale on summarizing the essence of each questions so that the students know where the basic heat transfer modes are happening, what basic skills are needed, and how the heat transfer equations are applied in order to obtain the right solution. Students learned from the examples the basic steps of simplifying and solving the complex heat transfer problems.

B. The lectures almost always start with a brief review on the class right before the current one. After that, a summary of what is to be taught is laid out. I want the students to see the points and also the link rather than getting lost in the equations and terminologies. The lectures end with a slide to repeat the key points in the lecture.

C. The time spending on theoretical deduction and examples has been reallocated to balance the capability of students. This is based on the students' feedback from last year course evaluation. It was found that while some students really enjoy the revealing process, many students want to skip the deduction and have more examples.

D. Handout two versions classnotes before the lectures so that the students can pick which one they prefer depending on their learning habit. Some students want to have blanks on the classnotes so that they can follow my blackboard writing. They believe the best learning technique is through writing. Others want to have the full classnotes so that they don't need to write anything but to follow my reasoning and talking during the lecture.

Homework

A. Homework is also considered as a teaching method since the design of problems can be used to guide the students going through the current and previous class notes. Specifically, some problems were very much related to the real life scenarios.

B. The solution to each homework assignment is posted on the blackboard so that the students can compare and see the differences. Meanwhile, I set an open-door policy for office hour and encouraged the students for communications on any related issues or problems that might improve their understanding of the technical materials.

Recitation

A. Two to six more sessions of recitation are added to the original schedule. The questions are collected from the homework, exams, text book problems, and real life. Usually I post the recitation questions before the lecture, so that the students who want to have proper challenges can do them on their own. During the recitation, I will give the students about 5-10 minutes to warm up. For each recitation, I will cover at least three different types of problems to avoid the students from getting bored or getting used to just one type of questions.

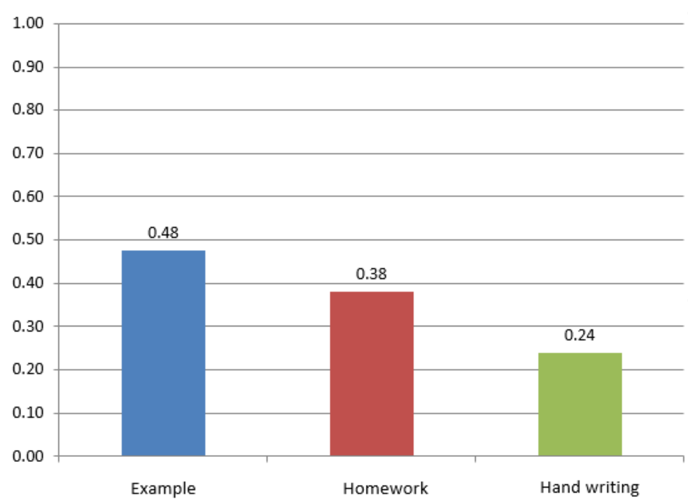
B. I encourage students to first draw some illustrations based on the texts and then lay out the procedure that they think how the question should be solved before they get lost in any details. Students can group up on their own to share their understanding to the classmates. The process is explained when I work on the question.

Supportive Materials

The Blackboard system is utilized to upload the supportive materials that are considered helpful to the understanding of the course. Class software, experiments conducted by others, etc., are provided to the students as supportive materials.

In addition to the previous teaching methods, an mid-term evaluation is also conducted to make sure that I understand the students capability and adjust my teaching methods accordingly. Fig. 3 to

IMPROVEMENTS TO BE MADE



How	Y/N
Examples	
More numerical examples and **complete them in class**.	Y
Make examples similar to the homework.	
Let students work on examples in class.	Y
Ask more question of class and more class involvement.	Y
More examples and **slow down**.	Y
Slow down on explaining examples.	Y
Real-life applications.	
Homework	
Make clear what problems are assigned and when they are due.	Y
Homework assignment.	Y
Hard to follow homework problems lately.	Y
Number the homework and labeled with a due date.	Y
Homework announcement.	Y
Hand writing	
Label and explain diagrams better.	Y
Better and readable handwriting.	Y
Add units.	
Bigger writing on the board and bigger.	Y

Fig. 3: Points for improvement

CLASS PACE

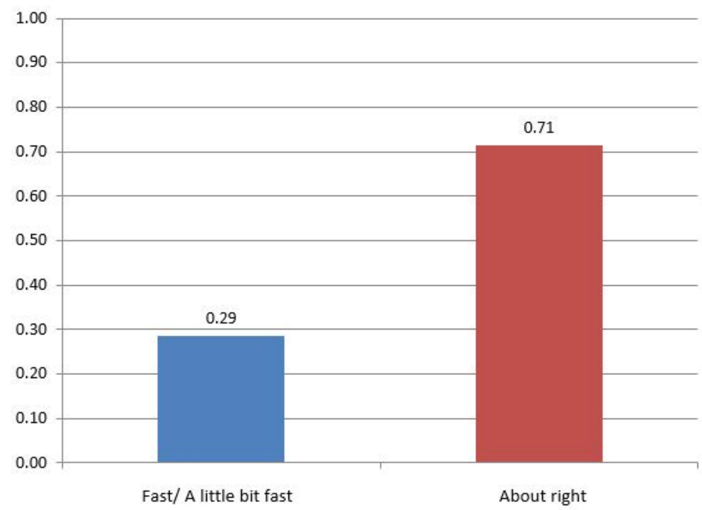


Fig. 4: Lecture pace

SUGGESTIONS TO YOU

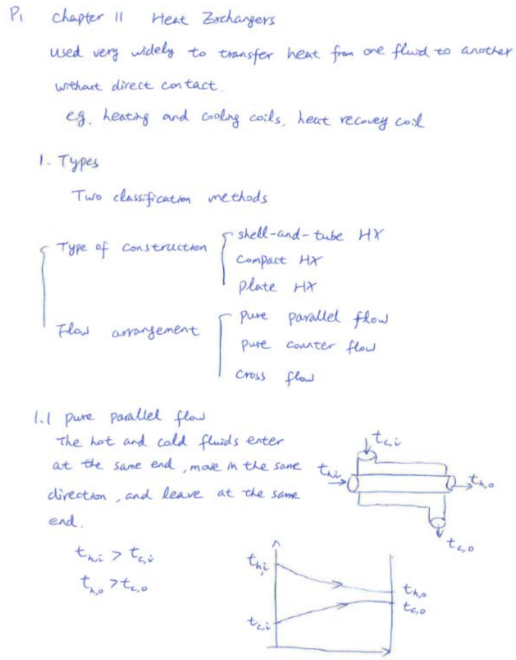
- This is a fundamental technical class. **Adequate challenges are expected**;
- **Speak out** when you don't understand the points in the class.
- Go through the examples shown in the notes **before** the class.
- **Make use** of the office hour and tools for communication with me.

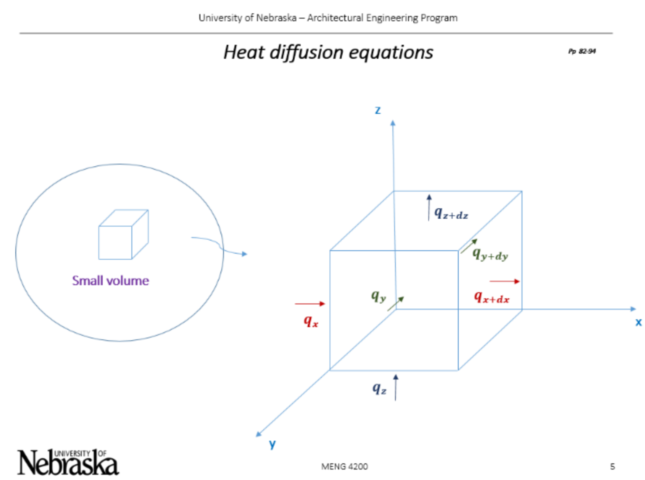
Stay with me and you will just be fine.

Fig. 4: My suggestions to the students

The classnotes have been entered as electronic version as shown in the following table:

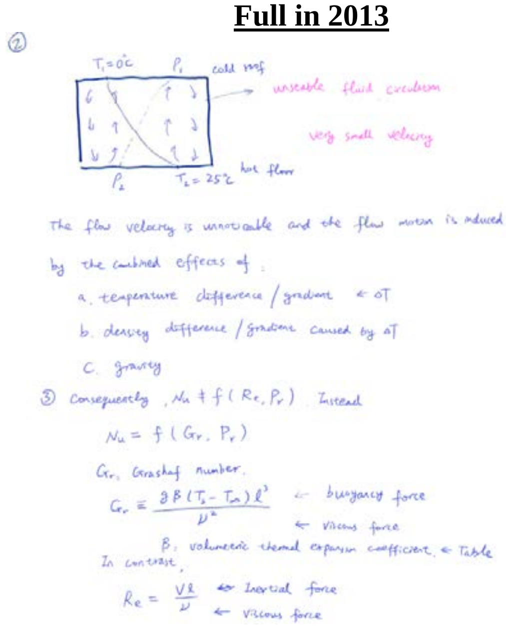
Preparation in 2013 **Preparation in 2014**

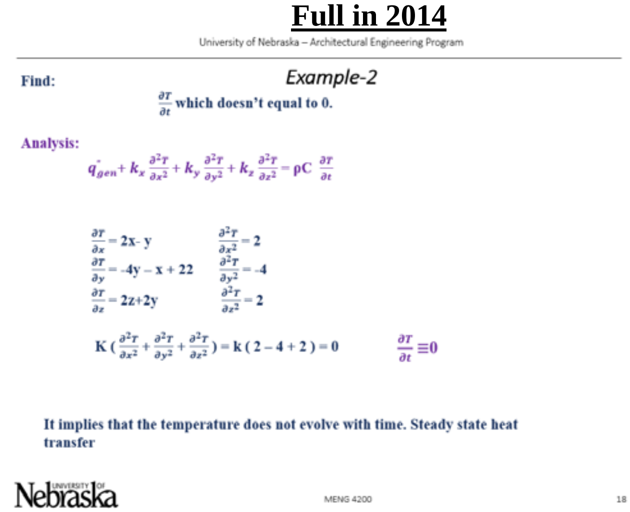




Full in 2013

Full in 2014





THE COURSE AND THE BROADER CURRICULUM

Heat transfer is one of the fundamental classes to those students in architectural engineering. Thermodynamics is a prerequisite for taking this course. In Thermodynamics, students learned how to analyze the systems' initial and end states. In this course, they are further exposed to the tools of analyzing how the interaction is happened and the process to quantify the variables, including the temperatures and heat transfer rate.

The materials taught in this course can be utilized to analyze the building load, energy conversion and conservation means, design and size the heating ventilation and airconditioning equipment and process, recommend system retrofitting, and also advanced modeling and simulation in graduate school.

PLANNED CHANGES

Having taught MENG 4200 Heat Transfer two times now, there are three major changes to be made based on the performance of the improved lecture:

A. Add the periodic recitations throughout the course. It is believed that the students can benefit more in the working-through process. For each question given in the recitation, work to the final steps and explain in detail all the variables. I will also pay attention to the students in the process by asking them to work together.

B. Improve handwriting in the lecture and have some part given as PPT slides. Two versions of classnotes are prepared for the course. They are used mainly as a tool for the students to warm up and review after the lectures. Handwriting cannot provide enough diversity to the teaching. I will switch to slides when it is considered necessary.

C. Have the students to discuss the homework assignments and lectures after every several lectures. It was found that although I have myself available to the questions in addition to the office hour, very few students stop by. Some of them have time conflict due to other courses or internship, the others are just not used to use the opportunity. They might not know where to start when they get a complex heat transfer question.

D. Change the difficulty profile of the homework assignment and exams. Students should be exposed to proper challenges. If they are set too simple, they lose interest very soon since they will take it for granted. It the questions are too difficult, they will be intimidated quickly and be oppose to any teaching. I will summarize the performance of students so that they see where they are and make the improvements from their side as well.

SUMMARY AND OVERALL ASSESSMENT OF PORTFOLIO PROCESS

The main reason for me to participate in this peer review project is to improve the effectiveness of making Heat Transfer a pleasant learning process to the students. Majority of the students just are getting in to the second and preparing for their key courses. Having them properly challenged and also knowing how to apply what they learned before they enter their major can help them improve their study efficiency and effectiveness.

Further, I am able to improve my teaching materials. The preparation of this portfolio has provided me with an opportunity to formally document and reflect on my teaching practices. I believe I will be able to achieve the goal set for this course that to build up the students' interest in fundamental heat transfer problems and develop the skills of applying knowledge in solving the problems.

APPENDICES

Appendix A: Course Syllabus

MENG 4200 SYLLABUS

Heat Transfer

Instructor Contact Information

Name: Yuebin Yu, Ph.D.

Office: 104F PKI

Email: yuebin.yu@unl.edu (yyu@unomaha.edu) Please send to both for quick response.

Phone: 554-2082

Office Hours:

Anytime when I am at office and not engaged in meetings and phone calls. An email reservation is encouraged if it is not in the official office hours.

Office Hour Information

I will assume the work and please come to my office directly.

Office Hours: Monday, 1:30 – 2:30 pm (homework associated questions)

Course Information:

General: 3 Credit hours

Meetings: TR — 10:30 AM to 11:45 AM at PKI 153

Prerequisites: CIVE 310 (Fluid Mechanics) and MENG 2000 (Thermodynamics)

Text Books

Required: Fundamentals of Heat and Mass Transfer 7/e, by Incropera, DeWitt, Bergman and Lavine, John Wiley & Sons

Course Topics:

Introduction to heat transfer

Conduction:

Convection:

Radiation:

Heat exchangers:

Course Schedule

WK	Date	Topic	Reading chapters	Note
1	01/12	Introduction	Pp 1-10	
2	01/19	Conduction	Pp 8-10, Pp 12-38	ASHRAE Meeting. No class on Tuesday
3	01/26		Pp 68-82, Pp 82-94	
4	02/02		Pp 112-154, Pp 154-177	
5	02/09		Pp 280-299	Exam I
6	02/16	Convection	Pp 378-397	
7	02/23		Pp 434-474	
8	03/02		Pp 518-555	
9	03/09		Summary, Pp 594-618	Exam II
10	03/16	Radiation	Pp 768-829 (brief reading)	
11	03/23			Spring Break – No class
12	03/30		Pp 862-896	
13	04/06		Pp 862-896	
14	04/13	Heat Exchanger	Pp 706-730	Exam III
15	04/20		Pp 706-730	
16	04/27	Review		
17	05/04	Final week, follow the school calendar		

* Unless otherwise specified, all the exams will be scheduled on a Thursday in the week as shown in the table.

* Ignore examples with mass transfer and complex geometry.

Course Assignment and Weights

Category	Percentage	Cumulative or not

Homework		35%	NA
Exam I	15%	Closed book	No
Exam II	15%	Open book	No
Exam III	15%	Closed book	No
Final Exam	20%	Closed book	**Yes**

Homework: Approximately one assignment will be assigned for each class period, which will be due one week after the assignment is given out or otherwise specified. Homework grading will focus as much on presentation, process and documentation as on getting the right answers. Do your homework as neatly as you would do consulting work.

Please do your homework on your own. Any two or more identical homework will be regarded as plagiarism and get zero credit.

One of your lowest homework will be dropped in the final grade calculation.

Course Grading Key

Minimum %	Letter Grade	Maximum %
97	A+	100
93	A	96
90	A-	92
86	B+	89
83	B	85
80	B-	82
76	C+	79
73	C	75
70	C-	72
66	D+	69
63	D	65
60	D-	62
0	F	59

Policies, Rules, and Philosophies

Attendance: Class attendance is expected. My own experience educated me that ONE hour in class is worth TEN hours' study on your own. If you need to miss a class, please be aware that you are responsible for all information and announcements presented in class.

Late Work: All assigned work is due at the start of class on the day it is due. All other work is late. There will be a 10% deduction for each day past the due date unless you have a justified excuse.

Academic Integrity: Violations of academic integrity will be handled in accordance with University Policy. Read the section on Academic Integrity on the newest Undergraduate Catalog for a description of these violations and their consequences.

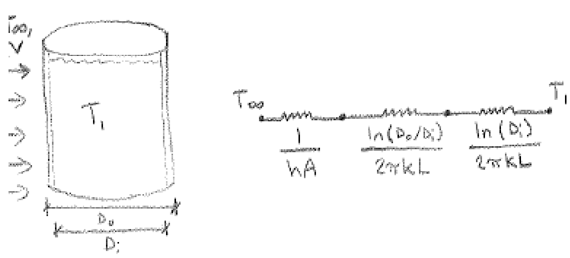
Instructor Communication: Email and computer use are essential parts of University life. I will notify you via email about course announcements, AE meetings, and other items of interest. If you have an important problem or issue, I encourage you to call or see me during my office hours. You can also email me with short questions or other issues. If you send me an email, I will respond for sure. If you don't get a response, then your email is not received somehow and please try again or call my office. I will appreciate it if you can send me your following information:

1. Name
2. A recent photo
3. Where are you from
4. Your option
5. Any suggestions or comments about this course

Appendix B: Samples of student work

Problem 2: (30 points) Please formulate a heat transfer problem from your real life experience, to which we may apply the knowledge we learned. Please give some background, assumption, then, illustrate what measurements (variables) you might need and how you might finally solve it. Please be clear about the steps.

I am a member of the UNO marching band, and at each of our chearsals during the summer, we always bring large water jugs so the narching band members have water to drink. We can apply knowledge from heat ransfer to determine the rate at which the water will lose heat/energy. Information needed for this problem would include the starting temperature f the water (T_1), the temperature of the air (T_∞), the velocity of the ir (V), properties of air and water (including ρ, μ, k, Pr), and the dimensions nd k-value of the jug. We would assume that the jug is completely illed with water. Once all of the necessary information is gathered. The irst step would be illustrating the thermal network. Then, the Re_D number ould need to be determined in order to find $\overline{Nu_D}$ and then h of the ir. Equations necessary for this include $Re_D = \frac{\rho V D}{\mu}$, $\overline{Nu_D} = C Re_D^{\,m} Pr^{1/3}$, and $\overline{Nu_D} = \frac{hD}{k}$. Once h is determined you can solve for the total thermal esistance, R_{TOT}, and then solve for either the energy loss, q, or the mperature after a certain amount of time, T_2.



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5.6 12 mm DIA. STEEL BALLS ARE ANNEALED BY HTG TO 1150 K + THEN SLOWLY COOLING TO 400K IN AIR ENVIRONMENT FOR WHICH $T_\infty = 325\,K$ + $h = 20\ W/m^2 \cdot K$; PROPERTIES OF STEEL to BE $k = 40\ W/m \cdot K$, $\rho = 7800\ kg/m^3$ + $c = 600\ J/kg \cdot K$

$$B_i = \frac{hL_c}{k} \qquad L_c = \frac{r}{3} = \frac{6\times10^{-3}}{3} = 2\times10^{-3} \Rightarrow B_i = \frac{(20)(2\times10^{-3})}{(40)} = 1\times10^{-3}$$

$$+B_i F_o = \ln\left[\frac{T-T_\infty}{T_i-T_\infty}\right] = \ln\left[\frac{400-325}{1150-325}\right] = \ln\left[\frac{75}{825}\right] = \ln\left[0.0909\right] = +2.3978$$

$$F_o = \frac{2.3978}{1\times10^{-3}} = 2397.8$$

$$F_o = \frac{\alpha t}{L_c^2} \qquad \alpha = \frac{k}{\rho c} = \frac{(40)}{(7800)(600)} = 8.547\times10^{-6}\ m^2/s$$

$$\Rightarrow t = \frac{F_o L_c^2}{\alpha} = \frac{(2.397\times10^3)(2\times10^{-3})^2}{(8.5470\times10^{-6})} = \boxed{1121.79\ sec = 0.3116\ HR}$$

5.9 300 mm DIAMETER SOLID STEEL SPHERE IS COATED W/ DIELECTRIC MATERIAL LAYER OF 2 mm + $k = 0.04\ W/m \cdot K$. INITIALLY @ 500°C THEN QUENCHED IN A LARGE OIL BATH $T_\infty = 100°C$ + $h = 3300\ W/m^2 \cdot K$

$t = ?$ WHEN TEMP REACHES 140°C

$$L_c = \frac{r_o}{3} = \frac{0.15}{3} = 0.05\,m \qquad R = \frac{t}{k} + \frac{1}{h} = \frac{0.002}{0.04} + \frac{1}{3300} = 0.0503\ \frac{m^2 K}{W}$$

$$h' = \frac{1}{R} = \frac{1}{0.0503} = 19.8807\ W/m^2 K \qquad B_i = \frac{h' L_c}{k} = \frac{(19.8807)(0.05)}{48.8} = 0.0203$$

$B_i < 0.1$, LUMPED CAPACITANCE APPROACH IS APPLIED

$$\frac{\rho V c}{h' A} \ln\frac{\theta_i}{\theta} = t, \quad \theta_i = T_o - T_\infty \quad \theta = T - T_\infty \quad \frac{V}{A} = \frac{r_o}{3} = \frac{D}{6}$$

$$t = \frac{(7832)(559)(0.05)}{19.8807} \ln\left[\frac{500-100}{140-100}\right] = \boxed{25{,}354.37\ sec = 7.03\ HRS}$$

•