Sample Syllabus
ME410 Heat Transfer - Spring Semester 2019
Professor Matthew J. Rau
Sect. 3: 12:20 – 1:10pm, Hammond 220

TEXTBOOK (mandatory):

Prerequisites: AERSP308, AERSP311, C E 360, or M E 320; MATH 220 or NUC E 309; MATH 251

OFFICE HOURS
Prof. Rau: M W: 1:15-2:30pm, 301B Reber Building (matthew.rau@psu.edu)
*If you cannot make it to Dr. Rau’s scheduled office hours please arrange another time to meet through email.

Teaching assistant: Emanuel Chirayath Tuesday: 10:00am-12:00pm Desk in 337 Reber

GRADING

| Homework (4)   | 15% |
| Midterm exams (3; 15% each) | 45% |
| Attendance/Pop quizzes (7/8)   | 10% |
| Project #1          | 13% |
| Project #2          | 17% |

Typical Cutoffs for Letter Grades
A ≥ 93
A- ≥ 90
B+ ≥ 87
B ≥ 83
B- ≥ 80
C+ ≥ 77
C ≥ 70
D ≥ 60
F < 60

IMPORTANT DATES
Regular drop deadline Jan. 12th
Late drop deadline Apr. 5th

READING
It is expected that you read the relevant sections in the text BEFORE attending class.

SCHEDULE (changes to the schedule may occur) Text Suggested Problems

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<tr>
<th>Date</th>
<th>Period</th>
<th>Topic</th>
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<th>Problems</th>
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<td>1/7</td>
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<td>Introduction, conservation of energy</td>
<td>1.1-1.2.3</td>
<td>1: 3,7,10,18</td>
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<tr>
<td>1/9</td>
<td>2</td>
<td>Radiation - Concepts and Intensity</td>
<td>12.1-12.2</td>
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<td>View Factors, Radiation project demonstration</td>
<td>13.1-13.2</td>
<td>13: 3,6,8</td>
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<td>Martin Luther King Day – No Class</td>
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<td>13: 33,57</td>
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<td>2.1-2.5</td>
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<td>3.6</td>
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<td>2-D Conduction, Finite Difference Methods</td>
<td>4.1-4.2.4.4</td>
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<td>5.4-5.6</td>
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Spring Break, no class

3/11  24  Semi-Infinite & Multi-Dimensional Effects  5.7  5: 70,73
3/13  25  HW3  Finite-Difference Methods  5.10  5: 87,91
3/15  26  Introduction to Convection  6.1-6.3  6: 5,9,11
3/18  27  Conservation Equations - Boundary Layer  6.4-6.6  6: 15,22
3/20  28  MIDTERM EXAM #2
3/22  29  BL Analogies, Turbulence Correlations  6.7-6.8  6: 36,38
3/25  30  Convection - External Flow  7.1-7.3  7: 2a-c, 4, 8,10,24
3/27  31  Cross Flow, introduction to Project #2  7.4-7.5  7: 35,36,42,57
3/29  32  Cross Flow over a Cylinder/Sphere cont.

4/1   33  Convection - Internal Flows  8.1-8.2  8: 5,7,8
4/3   34  Energy Balance  8.3  8: 13,15,21
4/5   35  Correlations  8.4-8.6  8: 25,27,49
4/8   36  Heat Exchangers – Introduction  11.1-11.2  11: 2,5,7,8
4/10  37  HW4  LMTD and NTU-ε Heat Exchanger Analysis  11.3-11.5  11: 12,15,25,30,38
4/12  38  Project work day
4/17  40  MIDTERM EXAM #3
4/19  41  Laminar/Turbulent Flow: External Surfaces  9.4-9.5  9: 22,39
4/22  42  Correlations for Enclosures  9.6, 9.8  9: 76,81
4/24  43  Project work day
4/26  44  Project work day

4/29  Project #2 due Tuesday 4/30 by 5pm

EVALUATION and ACADEMIC INTEGRITY

Pop Quizzes:  Class attendance is mandatory. Eight in-class pop quizzes will be given throughout the semester to gauge class attendance. Full credit will be given purely for attendance; however, extra credit will be given for correct answers. Each quiz will last 5-10 minutes and cover a conceptual question from previous lectures/homeworks. Your lowest quiz score will be dropped when calculating your final grade. No makeup quizzes will be given. Absences will be excused only with prior written approval from Dr. Rau.

Homework:  Four homeworks will be assigned and be due on Canvas before the beginning of class on dates indicated. It is expected that you solve these problems on your own; copying of problem solutions may lead to disciplinary action and no credit will be given. No late homework will be accepted.

Projects:  Two class projects will be assigned. It is expected that all group members participate equally in the completion of the project. At the end of each project, each group member will conduct a peer-evaluation.

Exams:  Three in-class exams will be given on the dates indicated above. An equation sheet will be provided for each exam and made available beforehand. Exam problems will be very similar to previous homework problems and the suggested problems on this syllabus.

Makeup exams will be given only under extremely unusual circumstances. A written request for a makeup exam must be presented one week (or earlier). It is possible that the makeup exam is oral.

Grade appeal:  Within one week after returning a graded exam or assignment, you may appeal the grading by briefly describing the points of disagreement and then hand in the exam to me or to the TA.

Cheating/copying on homework and exams:  Students caught cheating will be dealt with according to University Policy (see Academic Integrity section below).

DEFERRED GRADES
My concurrence of a deferred grade is given only if you cannot complete the course within the prescribed time for “reasons beyond your control”. Consult policy 48-40 in “Policies and Rules for Students 2017-18” for further information.
ACADEMIC INTEGRITY
This course adheres to University Senate Policy 49-20: “Academic integrity is the pursuit of scholarly activity in an open, honest, and responsible manner, serving as a basic guiding principle for all academic activity. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.” Unless explicitly directed otherwise by the instructor, all assignments are expected to be the student’s own original work completed individually without collaboration. Violations of this code of conduct can result in reduced grades and can be reported to the College or University for further action.

DISABILITY SERVICES AND ACCESS
In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: http://equity.psu.edu/student-disability-resources/apply-for-services. For further information, please visit the Student Disability Resources Web site: http://equity.psu.edu/student-disability-resources.

COUNSELING AND PSYCHOLOGICAL SERVICES (CAPS)
CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. To discuss your concerns, you can contact CAPS by calling 814-863-0395, (M-F, 8am-5pm, http://studentaffairs.psu.edu/counseling/) to schedule an appointment or visit them at their office location, 5th Floor Student Health Center.

STATEMENT OF NONDISCRIMINATION
The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state of federal authorities. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status.
Direct all inquiries regarding the nondiscrimination policy to:
Affirmative Action Director
The Pennsylvania State University
201 Willard Building
University Park, PA 16802-2801
Telephone: (814) 863-0471 U.Ed.OVP98-1
ME 410 HEAT TRANSFER

Course Objectives: (Mapping to Program Outcomes shown in brackets)
A. Develop both qualitative and quantitative understanding of the three modes of heat transfer. [1b]
B. Make appropriate approximations, develop and apply simplified model equations for specific applications. [2b]
C. Apply mathematical and numerical methods to solve heat transfer problems. [1c, 1d, 1f, 5e]
D. Understand the role of and use dimensionless parameters in heat transfer analysis. [2b]
E. Design thermal systems for engineering applications. [2c, 2e, 5b]
F. Advance proficiency in professional communications and interactions. [3f]

Course Outcomes: (Mapping to Course Objectives shown in brackets)
1. Sketch and interpret temperature distributions and heat flux distributions for mathematical models of heat conduction with planar and radial geometries, including heat generation. [A]
2. Derive fundamental differential thermal energy equations and develop mathematical models for thermal/fluid systems, including:
   a. Lumped capacitance for unsteady heat transfer
   b. 1D unsteady heat conduction equation with heat generation
   c. Quasi 1D heat conduction for extended surfaces (fins), including variable cross-sectional areas
   d. Mean axial temperature variation for internal flows with uniform surface temperature or uniform wall heat flux. [B]
3. Apply ODE solution methods to solve the differential heat transfer equations for applications including:
   a. Lumped capacitance for unsteady heat transfer
   b. Steady 1D planar and radial conduction with heat generation
   c. Quasi 1D fins with variable cross-sectional area
   d. Internal flows with uniform surface temperature or uniform wall heat flux. [C]
4. Apply existing PDE solutions to analyze 1D and quasi 1D unsteady heat conduction systems. [C]
5. From an energy balance, derive the finite difference equations for conduction with surface convection. Describe numerical solution methods used to solve the finite difference equations. [B]
6. For convective heat transfer over a flat plate with uniform surface or uniform wall heat flux, sketch and interpret:
   a. Hydrodynamic and thermal boundary layer thicknesses
   b. Hydrodynamic and thermal boundary layer profiles
   c. Local skin friction and local heat transfer coefficient as a function of distance from the leading edge. [A]
7. Sketch and interpret hydrodynamic and thermal profiles for internal flows with uniform surface or uniform wall heat flux. [A]
8. Develop and apply conduction and convection thermal circuits. [B]
9. Choose and apply appropriate dimensionless correlations for external and internal flows to solve convection heat transfer problems. [D]
10. Understand and apply the Reynolds Analogy for convection heat transfer. [B]
11. Analyze thermal sensors such as hot wires and thermocouples. [E]
12. Define and properly apply in an energy balance the following terms: emission, radiosity, irradiation, net radiation heat flux, emissivity, absorptivity, reflectivity, and transmissivity. [A]
13. Understand the spectral characteristics of radiation heat transfer including black and gray surfaces. [A]
14. Develop thermal circuit diagrams for radiation analysis and determine surface temperatures for two and three surface geometries including reradiating surface and radiation shield. [B]
15. Set up and solve combined conduction, convection, and radiation heat transfer problems. [B & C]
16. Apply fundamental heat transfer principles to perform heat exchanger design and performance calculations. [E]
17. Make effective use of spreadsheets as an analysis tool. [C]
18. Demonstrate the ability to solve problems in a clear step-by-step manner and follow policies and instructions as outlined in the syllabus and other course materials. [F]
19. Demonstrate professionalism in interactions with colleagues, faculty, and staff. [F]