San Jose State University
Department of Mechanical Engineering
ME 211, Advanced Heat Transfer, Spring 2020

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Office Hours:	Mondays 4:30–5:45 PM and 8:45 – 9:30 PM
Class Days/Time:	Mondays and Wednesdays 7:30 – 8:45 PM
Classroom:	Clark 234
Prerequisites:	ME114 or Equivalent

Canvas and Course Messaging

Copies of the course materials such as the syllabus, course notes, assignments, homework solutions, etc. will be posted on the Canvas site for the class. I will be using this system for any communication with the class. This system will also allow you to have discussions or chat with others in the class. This feature may be especially helpful if you need assistance on a homework problem.

To log in, go to the Canvas URL http://sjsu.instructure.com. Log in with your 9-digit SJSU ID and password you use for your SJSUOne account. For questions on the use of Canvas, please check out http://www.sjsu.edu/at/ec/canvas/student_resources/index.html

You are responsible for regularly checking with the messaging system through Canvas. You can set up your Canvas account to forward all email sent to your Canvas account to any other email address you wish.

Course Description

Conduction, convection and radiation heat transfer, including conjugate problems. Numerical methods and use of the computer to solve heat transfer problems.

Course Goals

- To provide an advanced understanding of the basic modes of heat transfer
- To demonstrate different techniques used in solving heat transfer problems
- To teach basics of research and engineering in heat transfer

Student Learning Objectives

- To demonstrate a deep understanding of different modes of heat transfer
- To gain problem solving skills in conduction, convection and radiation heat transfer.
- To learn how to analyze heat transfer problems in engineering applications
- To lean elements of research in heat transfer

Required Texts/Readings

Textbook

- There is no specific textbook for this course.
- Course notes and other relevant references will be provided to supplement the textbook.

Other References

- "Advanced Heat and Mass Transfer", Amir Faghri, Yuwen Zhang and John Howell, Global Digital Press, 2010
- "Fundamentals of Heat and Mass Transfer" by F. Incropera and D. DeWitt.
- "Heat Transfer: Thermal Management of Electronics" by Younes Shabany.
- "Conduction Heat Transfer" by Vedat S. Arpaci
- "Heat Conduction" by M. Necati Ozisik
- "Convection Heat Transfer", by Adrian Bejan
- "Convection Heat Transfer" by Verdat S. Arpaci and Poul S. Larsen
- "Convective Heat and Mass Transfer" by W. M. Kays, M. E. Crawford and B. Weigand
- "Thermal Radiation Heat Transfer" by Robert Siegel and John Howell
- "Radiation Heat Transfer" by Michael F. Modest

Classroom Protocol

- Class attendance and arriving on time are necessary.
- Participation in class discussions is encouraged.
- No cell phone or computer use is allowed during the lecture.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc.

- Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html.
- Add/drop deadlines can be found on the current academic calendar web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/.
- The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/**.** Students should be aware of the current deadlines and penalties for dropping classes.
- Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.

Assignments

- Individual and team homework assignments will be given.
- Homework assignments will challenge students' problem-solving capability and may require using computer tools such as Excel.
- Homework sets have to be turned in before the lecture starts on the date they are due.
- Every student can submit up to 2 homework sets with a maximum of one-week delay, and 10% penalty on the total grade of those homework sets.
- Homework shall be professional, neat and easy to follow.
- In addition to homework assignments, each student will do one term project.

Grading Policy

Homework:	30%
Midterm:	**20% (Wednesday, March 11, Class Time)**
Term Project or paper:	**30% (Due Date: Wednesday, April 29, Class Time)**
Final:	**20% (Wednesday, May 13, 7:45 – 10:00 PM)**

- The dates for midterm and final exams are final and will not change.
- All students shall plan to take the midterm and final tests on these dates.
- If you can not take either the midterm or the final test on these dates, only due to circumstances beyond your control, please let me know two weeks in advance to make alternative arrangements.

Term Project or Paper Requirements

- Choose an engineering problem or a research paper in the area of heat transfer and send your selected topic to me for approval.
  - The topics must be defined by **February 19, 2020**.
- Understand
  - how was the engineering problem solved or how will it be solved?
  - the contents of the research paper and any background information needed to support that research.
- Perform some of the calculations needed to solve the engineering problem or to support the claims in the research paper.
- Write an engineering report or research paper based on your own work.
  - The report or paper should be divided into sections such as Abstract, Objectives, Motivations, Introductions (including literature survey), Main Topics (such as Theory, Experimental Setup, Analytical or Numerical Methods, Results), Conclusions and References.
  - The report or paper must be typed and delivered in hard copy by **April 29, 2020**.
- Prepare a PowerPoint presentation to present your work to the class. This presentation
  - shall have similar sections as the report or paper.
  - shall not take more than 10 minutes.
  - shall not include too many words.
- The project or paper will be graded based on the quality of the work itself, the report, and the presentation.

University Policies

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Tentative Topics and Schedule

Week	Date	Topic	Course Note	Reference 1 Reading
1	January 27 January 29	Conservation Equations Conservation of Mass Conservation of Momentum Conservation of Energy	1	2.2.1 – 2.2.3 2.3.1 – 2.3.3
2	February 3 February 5	Heat Conduction Heat Conduction Equation Steady State and Transient Heat Conduction Boundary and Initial Conditions Numerical Solution of Heat Conduction Equation Steady State and Transient Heat Conduction Solution Techniques	2 3	3.1 3.4
3	February 10 February 12	Boundary-Layer Approximations and Analogies Two-Dimensional Conservation Equations Boundary Layer Approximations Normalized Boundary Layer Equations Reynolds Analogy	4	4.1 – 4.5 4.10
4	February 17 **February 19**	Introduction to Turbulent Flows Nature of Turbulence Time-Averaged Governing Equations Closure Problem and Turbulence Modeling Turbulent Shear Stress and Turbulent Heat Flux Prandtl Mixing Length Model Velocity and Temperature Distribution Near a Wall k-ε Model **Last Day to Define Project**	5	2.5 4.11.1 4.11.2 4.11.3
5	February 24 February 26	Integral Method Forced Convection External Heat Transfer Laminar Flow over a Flat Plate, Similarity Solution Turbulent Flow over a Flat Plate, Reynolds Analogy	6 7	4.7 4.6.1 4.11.4
6	March 2 March 4	Forced Convection Internal Heat Transfer Laminar and Turbulent Fully-Developed Flows Friction Factor and Convection Heat Transfer Coefficient for Laminar and Turbulent Flows	8	5.1 5.2 5.3 5.9
7	March 9	Natural Convection Heat Transfer Natural Convection Boundary Layer Equations Laminar Flow over a Vertical Plate, Similarity Solution and Integral Method Turbulent Flow over a Vertical Plate, Integral Method Natural Convection over Inclined and Horizontal Plates Natural Convection over Cylinders and Spheres Natural Convection in Enclosures	9	6.1 6.2.2 6.2.3 6.4.1 - 6.4.4 6.5.1 6.5.2

	March 11	**Midterm Exam**		
8	March 16 March 18	Boiling Heat Transfer Boiling Convection Coefficient Boiling Modes Pool Boiling Regimes; Free Convection, Nucleate, Transition and Film Boiling Critical Heat Flux, Minimum Heat Flux Forced Convection Boiling	10	8.1 8.2 8.3 8.4 8.5 8.6.1
9	March 23 March 25	Condensation Heat Transfer Modes of Condensation Film Condensation Dropwise Condensation	11	7.1 7.2 7.3.1 7.3.3
10	**March 30** **April 1**	**Spring Break**		
11	April 6 April 8	Radiation Heat Transfer in Non-Participating Media Radiation Intensity Emissive Power, Irradiation and Radiosity Black Body Radiation Real Surface Radiation; emissivity, absorptivity, reflectivity and transmissivity	12	9.1 9.2 9.3.1 9.3.2
12	April 13 April 15	Radiation Heat Transfer in Non-Participating Media Kirchhoff's Law and its Application Solar and Atmospheric Radiation View Factors Radiation between Surfaces	12	10.1 10.2
13	April 20 April 22	Radiation Heat Transfer in Participating Media Participating Medium; Absorption, Scattering and Emission The Equation of Radiation Transfer Radiation Heat Flux Vector, Conservation of Radiation Molecular Internal Energy; Rotational, Vibrational and Rotational-Vibrational Spectra Total Emissivity and Absorptivity of H_2O and CO_2	13	10.5
14	April 27 **April 29**	Microscale and Nanoscale Heat Transfer Microscale and Nanoscale Transport Phenomena Microscale Heat Conduction Forced Convection in Microchannels **Project Reports Due**	14	1.4.3 3.6.1 5.8.1 5.8.2
15	May 4 May 6	Project Presentations		
16	May 11 **May 13**	Review **Final Exam**		