EML 6155 - Convection Heat Transfer – Spring 2020

Instructor: Dr. Saeed Moghaddam
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Class Hours & Place: M-W-F, Period 7th (1:55PM to 2:45PM), CSE E118

Office Hours:

Monday and Wednesday 3:00-4:00PM
Friday 12:45PM to 1:45PM
Note: These are the proposed office hours and can be changed upon request

Teaching Assistants:

Rohit Bhagwat rbhagwat@ufl.edu
Tuesday: 1:00 PM to 2:30 PM, NEB 109
Thursday: 1:00PM to 2:30 PM, NEB 109

Course Website: https://ufl.instructure.com

Books:
1- Text: Convection Heat Transfer by A. Bejan, 3rd Ed., John Wiley & Sons, 2004
2- Text: Convective Heat and Mass Transfer by W. M. Kays et al., 4th Ed., McGraw-Hill, 2009
3- Convective Heat Transfer by Burmeister, 2nd Ed., John Wiley & Sons, 1993
4- Boundary Layer Theory by Schlichting, 7th Ed., McGraw-Hill, 1979

Course Objective: to provide a fundamental treatment of fluid flows controlled by viscous or turbulent stress gradients and the subsequent heat transfer between fluids and solid surfaces. Analytical solutions to the momentum and energy conservation equations for both laminar and turbulent flows will be considered. Students will be expected to derive appropriate transport equations, apply transport equations to convective transport problems, and evaluate appropriate transport properties such as friction factors, Nusselt numbers, Sherwood numbers, and Stanton numbers. The fundamental conservation principles covered in this course provide a solid foundation for the engineering practitioner engaged in single phase convective thermal transport; a solid foundation is also provided for further studies in multiphase convective transport.

Course Outline:
1. Introduction
2. Fundamental principles
   a. Mass conservation

  b. Force balances (Momentum equations)
  c. Energy equations
  d. A simple case: Couette flow
  e. Scale analysis
3. Laminar boundary layer flow
  a. The fundamental problem in convection heat transfer
  b. The concept of boundary layer
  c. Velocity and thermal boundary layer thicknesses
4. Laminar momentum and heat transfer in ducts
  a. Entry region
  b. Fully developed flow
  c. Flow and heat transfer in circular and non-circular cross-section ducts
  d. Nusselt number at different wall thermal conditions
5. Laminar momentum and heat transfer in external boundary layers
  a. Potential flow solutions to velocity field
  b. Self similar boundary layers
  c. Similarity transformations
  d. Flow over a flat plate solutions
  e. Displacement thickness, momentum thickness
  f. Integral momentum equation and approximate solutions
  g. Thermal boundary layer similarity transformation and solution
  h. Integral energy equation and approximate solutions
6. Natural convection boundary layers
  a. Boundary layer equations
  b. Boussinesq approximation
  c. Nusslet number (laminar flow)
7. Turbulence fundamentals
  a. Transition to turbulent
  b. Reynolds decomposition
  c. Averaging properties
  d. Turbulent (Reynolds) stress and turbulent (eddy) thermal diffusivity
  e. Prandtl mixing length model
  f. Turbulent Prandtl number
8. Turbulent fluid flow
  a. Law of the wall
  b. Universal velocity profile for external flow
  c. Friction coefficient
  d. Internal flow
9. Turbulent thermal transport
  a. External flow
  b. Law of the wall
  c. Internal flow

Grading:
1. Grading Basis:

Homework	15%
Mid-term Exam I	25%
Mid-term Exam II	25%
Final Exam	35%
Total	100%

2. Homework: Homework assignments weekly to biweekly.
   Show all work, mark all answers, and be neat.

3. Exams:
   Mid-term Exam I   Wednesday, February 12th, 8:20pm to 10:20pm, FLG 0245
   Mid-term Exam II   Wednesday, March 25th, 8:20pm to 10:20pm, FLG 0245
   Final Exam   Thursday, April 30th, 3:00pm to 5:00pm
   No make-up exams will be given unless there is a valid reason consistent with University policy.

4. Grading scale:
   A 10-point scale will be used as a **starting point** (i.e. A$\geq$90%, B$\geq$80%, etc.).

Holidays:
   UF Recognized Holidays (no class):
   Monday, January 20th (Martin Luther King Jr. Day)
   M-W-F, March 2nd-6th (Spring Break)

Class Policies:
1. Regular class attendance is expected and encouraged. Each student is responsible for all of the material presented in class and in the reading assignments. Exams will emphasize treatment of material covered in lectures.

2. All homework assignments are to be turned in at the beginning of the designated class period.

3. All homework assignments and projects are to be turned in at the beginning of the designated class period. In general, no late assignments will be accepted or makeup exams given. Exceptions will be made for a valid excuse consistent with University Policy. Exceptions may also be made if deemed appropriate, but please contact me ahead of time.

4. SOME collaboration is allowable on homework, but each student is responsible for performing the bulk of his or her own homework assignment. The copying of solutions from the Solutions Manual (or copies from) is considered cheating, and is not allowed.

5.   **NO collaboration is allowed on exams**.

6.   Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

7.   Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation. This process must be completed in advance.

8.   UF Counseling Services – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include: University Counseling Center, 301 Peabody Hall, 392-1575; SHCC Mental Health, Student Health Care Center, 392-1171; Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161. Career Resource Center, Reitz Union, 392-1601, for career development assistance and counseling.

9.   Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.