

**MAE 708 ADVANCED CONVECTION HEAT TRANSFER**

Credits: 3

Time: TH 11:45 am - 1:00 pm

Place: 136 MRC  
(Monteith  
Engineering  
Research  
Center) or  
Online Delivery  
(for 601  
section)

**1.1. Instructor's name, office address, telephone number, e-mail address, regularly scheduled class meeting times, and office hours for out-of-class consultation.**

Instructor: Professor Andrey V. Kuznetsov

Office: EBIII 3258

Phone: 515-5292

E-mail: [avkuznet@ncsu.edu](mailto:avkuznet@ncsu.edu)

Office hours: Tue/Thu 1:15 PM – 2:30 PM or by appointment, ending on April 23, 2024 (the last day of classes)

Zoom link for office hours (for EOL students):

<https://ncsu.zoom.us/j/94189559126?pwd=K3hGUUhPWE0vbzU5TnVPUUt3L3A3QT09>

Meeting ID: 941 8955 9126

Passcode: 738924

**If you would like to attend office hours via zoom, please send me an email at the latest in the evening the day before, and please tell me when you approximately would like to come in the 1:15 PM – 2:30 PM window, to make sure that I turned my zoom on**

The course URL: <https://wolfware.ncsu.edu/courses/my-wolfware/>

Classroom content folder URL (to view the recorded lectures):

<https://ncsu.hosted.panopto.com/Panopto/Pages/Sessions/List.aspx#folderID=519b24bd-c265-4ae4-ad53-b0d501765ac4>Course website is located in Moodle and accessible at <https://wolfware.ncsu.edu/courses/my-wolfware/>**1.2. Course prerequisites or restrictive statements.**

Prerequisites: Undergraduate course in convective heat transfer and fluid flow or consent of instructor.

**1.3. Course Motivation.**

This course is designed to be the core graduate course in convection heat transfer. Advanced topics in steady and transient, natural and forced convective heat transfer for laminar and turbulent flow through

conduits and over surfaces. Mass transfer in laminar and turbulent flow. Inclusion of topics on biological flow and mass transfer.

#### 1.4. Designation of course as a General Education Requirement (GER). N/A

#### 1.5. All required Textbook(s), title(s), date(s), price(s), Calculators, price(s)

**Text:** A. Bejan (2013) Convection Heat Transfer, 4<sup>th</sup> ed., John Wiley & Sons, NY  
ISBN-13: 978-0470900376

#### **Add'l. References (optional):**

J.C. Slattery (1999) Advanced Transport Phenomena, Cambridge University Press, NY  
W.M. Kays and M.E. Crawford (1993) Convective Heat and Mass Transfer, 3rd edition, McGraw Hill, NY  
H. Schlichting (1979) Boundary-Layer Theory, McGraw Hill, NY  
C. Kleinstreuer (1996) Engineering Fluid Dynamics, Cambridge University Press, NY

**Consult:** Heat Transfer and Fluid Mechanics Journals, Heat Transfer Conference Proceedings, etc.

#### 1.6. Course organization and scope.

##### **Topics:**

##### ***Fundamental Principles (1 week)***

Study Chapter 1

##### ***Laminar Boundary-Layer Flow (3 weeks)***

- Velocity and Thermal Boundary Layers
- Similarity Solutions
- Integral Solutions

Study Chapter 2

##### ***Laminar Duct Flow (3 weeks)***

- Heat Transfer to Fully Developed Duct Flow
- Heat Transfer to Developing Duct Flow

Study Chapter 3

***Natural Convection (3 weeks)***

- External Natural Convection
- Internal Natural Convection

Study Chapters 4 and 5

***Turbulent Boundary Layer Flow and Duct Flow (2 weeks)***

- The time-averaged Equations
- The mixing length model
- Turbulent Boundary Layer Solutions
- Turbulent Duct Flow Solutions

Study Chapters 7 and 8

**1.7. Projected schedule of quizzes and tests (everything take home).**

1<sup>st</sup> Exam 2/29/24 (Thursday) (tentative)

2<sup>nd</sup> Exam 4/11/24 (Thursday) (tentative)

Course Project is due 04/26/24 (Friday) by 11:59 PM

**Course Project** will be assigned later during the semester. An individual or group (if students choose to work in groups) course project report will be required. **No more than 3 students in a group.** The project report must be delivered electronically (via e-mail) in MS Word format.

**Project Presentation.** Every student (or a group of students working on the same project) must prepare a presentation on his/her (or their) research project that will be assigned during the semester. The presentation must be prepared professionally, using the PowerPoint software, and given in class during last two weeks of semester. Students are encouraged to demonstrate simulations, animations, and visualizations in their presentations (make their presentations as illustrative as possible).

The quality of presentation will be graded out of 100 points and will be 20% in the grade. The duration of the presentation should be approximately 20 minutes plus 5 minutes for questions.

The presentation (a power point file) and project report (prepared professionally using MS Word) must be e-mailed to the instructor electronically.

**Students' evaluations of % of participation in the group project**

Each student must send an e-mail to the instructor indicating % of participation of other students in the group (do not evaluate yourself). Assign each student a % of participation, which is a number between 0 and 100%. For example, if there are 4 students in the group in addition to yourself, you should send something like this: student A – 100%, student B – 80%, student C – 50%, student D – 0% (implying

that student D did not do anything). This information will NOT be reported to other students and will be kept confidential.

You may work in groups on the required homework - in fact, you are encouraged to do so. However, individual solutions must be handed in (no photo copies will be accepted).

### **1.8. Course grades are determined as follows:**

The grading components are 2 Exams 50%; Course Project Report 30%, Course Project Presentation 20%. No incompletes are accepted for this course without verifiable, written doctor's note indicating more than one week's incapacitation.

The final grade will be based on the final average and determined as follows:

90 and above A

80 and < 90 B

70 and < 80 C

60 and < 70 D

Below 60 F

Plus/minus grades will be used for those border line cases where there is excellent attendance, excellent class participation, and improvement in test and exam grades.

### **GENERAL COURSE POLICIES**

Below are the main policies adopted in this class. *Please read them carefully.*

#### **Policy on Attendance and Late Work**

Any absences and missed deadlines will be handled in accordance with the university **Attendance Regulation (NCSU REG02.20.03)** <https://policies.ncsu.edu/regulation/reg-02-20-03>

If you are in quarantine, have been notified that you may have been exposed to COVID-19, or have a personal or family situation related to COVID-19 that prevents you from attending the class in person, please get in touch with me to discuss the available options and make alternative plans, as necessary.

Late assignments will only be accepted in the case of documented excuses and/or emergencies. Please consult the Policy linked above for details about what absences could be excused and the kind of documentation needed for granting an extension.

Please note that whether an absence is excused or not, you are responsible for all missed information, which should be obtained from other members of the class who were present the meeting in question.

#### **Academic Integrity**

In all course work, students are bound by the Pack Pledge. ["I have neither given nor received unauthorized aid on this test or assignment"]. Violations of academic integrity will be handled in accordance with the Student Discipline Procedures (NCSU REG 11.35.02). A recommendation of a zero/F for at least the affected assignment will be made; a failing grade for the course may be imposed as may other penalties such as suspension or expulsion. See the **Code of Student Conduct policy (NCSU POL11.35.1)** <https://policies.ncsu.edu/policy/pol-11-35-01>

**Disability Accommodations**

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, 2751 Cates Avenue, Campus Box 7509, 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG 02.20.01) <https://policies.ncsu.edu/regulation/reg-02-20-01/>

**Privacy: Electronic Course Components**

Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

**Additional NC State Rules and Regulations**

Students are responsible for reviewing the NC State University (PRRs) which pertains to their course rights and responsibilities, including those referenced both below and above in this syllabus:

- Equal Opportunity and Non-Discrimination Policy Statement <https://policies.ncsu.edu/policy/pol-04-25-05> with additional references at <https://oied.ncsu.edu/divweb/policies/>
- Code of Student Conduct <https://policies.ncsu.edu/policy/pol-11-35-01>
- Audits <https://policies.ncsu.edu/regulation/reg-02-20-04>
- Incompletes (IN) <https://policies.ncsu.edu/regulation/reg-02-50-03>

**Restriction on Sharing Content of Course Materials**

Copying, distributing, downloading, and uploading information on the Internet may infringe the copyright for that information. Even an innocent, unintentional infringement violates the law. Violations of copyright law that occur on or over the university's networks or other computer resources may create liability for the university as well as the computer user. <https://policies.ncsu.edu/regulation/reg-01-25-02>

Accordingly, repeat infringers will have their computer account and other access privileges terminated by NC State. By accessing e-reserve and course web site material you agree to the following statement: "I acknowledge that all documents<sup>1</sup> made available to me for the course PHI 302 taught at NC State University in the current term are copyrighted and intended only for my personal use. By logging into the PHI 302 web site, you certify that you will not share any content of the class PHI 302 NC State University website with a third party<sup>2</sup> without written permission from the course instructor, Professor Marina F. Bykova.

**Recording Lectures and Discussions**

Students may not use recording devices in the classroom without explicit prior permission of the instructor. If permission is granted, there must also be no member of the class who objects. Instructor and class permission is not required when an accommodation notification from the Disability Resource Office (DRO) has been received by the instructor, which identifies a student that requires the use of a recording device. However, the instructor may consult with the DRO about prohibiting the use of any recording device when it would inhibit free discussion and free exchange of ideas in the classroom.

<https://policies.ncsu.edu/regulation/reg-02-20-11>

**Students of Concern**

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<sup>1</sup> Both electronic and hard-copy, including (but not limited to), copies of lecture notes, exams, answers to exam questions, or any handouts provided by the Instructor.

<sup>2</sup> Any person not signed up for the course, a personal, public, or commercial website, or any other news or advertising media.

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you, either for the classmate's well-being or yours. When this is the case, you are encouraged you to report this behavior to the NC State's Students of Concern website: <https://prevention.dasa.ncsu.edu/nc-state-cares/about/>. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.

The Student Ombuds is a confidential resource (to the extent allowable by law), that provides a sounding board to discuss concerns related to your university experience - be they academic, personal or interpersonal, if it is important to you, it is an issue you can discuss with the Ombuds. The Student Ombuds provides information, discusses university policies and procedures, and helps students navigate their time at NC State. You can learn more about Student Ombuds Services and schedule an appointment by visiting <https://ombuds.dasa.ncsu.edu/>.

### **Class Evaluations**

Online class evaluations will be available for students to complete during the last two weeks of the semester, becoming unavailable at 8:00 AM on the first day of finals. Students will receive an email message directing them to a website where they can login using their Unity ID and complete evaluations. All evaluations are confidential; instructors will not know how any one student responded to any question, and students will not know the ratings for any instructors.

Evaluation website: <http://go.ncsu.edu/cesurvey>

Student help desk: [classeval@ncsu.edu](mailto:classeval@ncsu.edu)

More information about ClassEval: <https://isa.ncsu.edu/for-the-pack/classeval/for-students/>