

## COURSE INFORMATION

- Instructor:** **Dr. Igor A. Bolotnov**  
2153 Burlington Engineering Laboratories; **(518) 542-8939**  
e-mail (typical response within 12 hours): [igor\\_bolotnov@ncsu.edu](mailto:igor_bolotnov@ncsu.edu)  
*Office hours:* Wednesday, 12:15pm – 1:15pm (BU 2153)  
*EOL students:* Monday, 5pm-6pm, <https://ncsu.zoom.us/j/7162243108>  
*or by appointment (use e-mail to set it up)*

- Schedule:** Monday, Wednesday: 1:30pm – 2:45pm; 327 111 Lampe Dr.

**Homework:** Homework will be assigned periodically throughout the semester (typically 3-4 assignments). The last homework assignment may be due during the last week of classes. Homework assignments to be submitted via Moodle-provided link (to be checked through Turn-it-in software).

**Late Assignments:** Unless stated otherwise, assignments are due at the beginning of class on the designated due date. Assignments turned in within 24 hours of this time are considered LATE and will be assessed a 25% penalty. Assignments turned in after 24 hours will be marked and returned to the student, but no credit will be assigned. To allow for unforeseen circumstances, students are granted a one time exemption if an assignment is turned in by 5:00 PM on the designated due date. Exceptions to this policy may be granted for documented medical or family emergencies.

- Captured Lectures:** This on campus course will be captured and distributed via the Internet and/or electronic media as part of the **Engineering Online** (EOL) program for the distance students. These video recordings *may contain an image of you entering the classroom, asking a question or being a part of the studio class*. Please notify Dr. Linda Krute, Director of EOL, at [ldkrute@ncsu.edu](mailto:ldkrute@ncsu.edu) if you DO NOT want your image to be included in the lecture presentation. If EOL does not hear from you after the first week of the class, we will assume that you are in agreement with this procedure.
- Attendance:** Required; Active class participation is strongly encouraged. University policy on definition of excused absences: <http://policies.ncsu.edu/regulation/reg-02-20-03>
- Class Evaluations:** Schedule: Online class evaluations will be available for students to complete during the last 2 weeks of the semester.  
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 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: <http://oirp.ncsu.edu/eval/clev>
- Selected References** (not required, extra reading)

1. *NUCLEAR SYSTEMS I: THERMAL HYDRAULIC FUNDAMENTALS*, N. E. Todreas and M. S. Kazimi
2. *THE THERMAL-HYDRAULICS OF A BOILING WATER NUCLEAR REACTOR*, R. T. Lahey and F. J. Moody

3. *THERMAL ANALYSIS OF PRESSURIZED WATER REACTORS*, L. S. Tong and J. Weisman
4. *THERMOHYDRAULICS OF TWO-PHASE SYSTEMS FOR INDUSTRIAL DESIGN AND NUCLEAR ENGINEERING*, J. M. Delhaye, M. Giot and M. L. Riethmuller
5. *CONVECTIVE BOILING AND CONDENSATION*, J. G. Collier
6. *ONE-DIMENSIONAL TWO-PHASE FLOW*, G. B. Wallis
7. *NUCLEAR HEAT TRANSPORT*, M. M. El-Wakil
8. *NUMERICAL METHODS*, R. W. Hornbeck
9. *APPLIED NUMERICAL METHODS*, Carnahan, Luther, and Wilkes
10. *NUCLEAR THERMAL-HYDRAULIC FUNDAMENTALS*, J. Michael Doster

7. **Grading:**

<b>A+*</b> > 96%	<b>B+</b> 86 – 88%	<b>C+</b> 76 – 78%	<b>D+</b> 65 – 67%	
<b>A</b> 92 – 96%	<b>B</b> 82 – 85%	<b>C</b> 71 – 75%	<b>D</b> 61 – 64%	<b>F</b> < 58%
<b>A-</b> 89 – 91%	<b>B-</b> 79 – 81%	<b>C-</b> 68 – 70%	<b>D-</b> 58 – 60%	

All course deliverables contribute equally at 50% to your total grade (Homework and Course Projects).

*\*Only top 5% of students may earn "A+" grade (1 top student may earn it in class of less than 20).*

**Audit:** Students who audit the class are exempt from the exams. Attendance, homework and project are required. 70% performance on these items is needed to get an "AU" record.

8. **Academic Integrity:**

- a. University policy on academic integrity: [Code of Student Conduct Policy \( POL11.35.01\)](http://policies.ncsu.edu/policy/pol-11-35-01) (<http://policies.ncsu.edu/policy/pol-11-35-01>)
  - b. The unauthorized posting of any lecture notes, homework answers, exams, or any other course materials on third-party websites constitutes a **violation** of copyright as described in section 8.2 (f) of the Code of Student Conduct. Students posting such materials will be immediately referred to the Office of Student Conduct.
  - c. By signing your name on either test or homework for this course every student implies the following statement: "*I have neither given nor received unauthorized aid on this test or assignment*"
  - d. Absolutely no collaboration is permitted during the tests. All the tests are closed book.
  - e. Each homework assignment must be completely your own. Zero grade will be assigned for particular homework for the first offence. Second offense will be reported to the *Office of Student Conduct*
9. **Supporting Fellow Students in Distress:** 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 safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you. When this is the case, I would encourage you to report this behavior to the NC State Students of Concern website: <http://studentsofconcern.ncsu.edu/>. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.
10. **Students with Disabilities:** Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 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 (REG02.20.1).  
(<http://policies.ncsu.edu/regulation/reg-02-20-1>)

11. **Electronic devices in class:** Cell phones are to be turned OFF prior to entering the class room. No exceptions. Use of laptops/tablets during the class is only allowed to follow the lecture notes.

## COURSE TOPICS

### 1. General Balance Equation (weeks 1-5)

- a. Application to the Heat Conduction Equation
- b. Spatial Discretization Techniques
- c. Steady State Numerical Solutions
  - i. Linear Problems
  - ii. Generalized Newton-Raphson Method for Non-Linear Problems
- d. Time Dependent Numerical Solutions
  - i. Time Differencing Schemes
  - ii. Von Neuman Stability Analysis
  - iii. Applications to Simple Convective Systems

### 2. Single-phase flow (week 6-9)

- a. Derivation of the Single-Phase Fluid Conservation Equations
- b. Area averaged equations
- c. Volume averaged equations
- d. Applications

- i. Loop Momentum Balances
- ii. Solution of Time Dependent Single Phase Flow Networks (Systems Analysis)

### 3. Two-phase flow (weeks 10-15)

- a. Derivation of the Area Averaged Two Phase Flow Equations
- b. Multi-Phase Flow Models
  - i. Six Equation Models
  - ii. Mixture Equations
- c. Mixture Equations
  - i. Five Equation Models
  - ii. Four Equation Models
  - iii. Three Equation Models
- d. Numerical Solution of Time Dependent Two-Phase Flow Networks
  - i. Application to Three Equation Mixture Model
  - ii. Loop Momentum Balance
  - iii. Global Compressibility

## COURSE PROJECTS

Details on the projects timeline, assignment and deliverables to be provided during first weeks of classes.