

# Course Syllabus

## Power Plant Simulation

ENU 4110/6937 ; Class # : 29668/24908 ; Sections : PPSU/PPSG

Class Periods: M|Period 6, W,F|Period 6-7 (12:50 PM - 2:45 PM)

Location : M,W,F|BLK 0415 ; Fall 2024

## Welcome to the Course

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### Instructor:

Dr. Justin Watson  
178 Rhines Hall  
Phone: 352-273-0241  
Email: [justin.watson@ufl.edu](mailto:justin.watson@ufl.edu)  
Office Hours: Tuesday 3:00 pm - 5:00 pm, or by Appointment

### Course Teaching Assistant (TA):

None

## Course Description

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(Official catalog version) Instruction and practical experience in the operation and interpretation of results from major nuclear reactor simulation codes such as TRACE, RELAP5, RETRAN, CATHARE, and SAM.

[What former students have said about the class.](#)

## Statement Related to Policy for Co-Listed Graduate/Undergraduate Courses

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Students enrolled in the graduate course (ENU 6937) will have the following requirements imposed on them in addition to those present for the undergraduate course (ENU 4110):

- Additional complexity in the form of more involved and additional cases to consider for modeling and simulation problems.
- Graduate students will have additional problems and/or more challenging problems on assigned homework, quizzes, and exams.

- Graduate students will be responsible for learning and implementing advanced simulation and modeling methods to solve problems in assigned projects, homework, and exams.
- Graduate students will be assessed on more demanding performance criteria on individual assignments (i.e., implement advanced modeling methods and professional document preparation) as well as for the overall course outcomes.

## Key Course Elements

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### Course Objective

- Develop engineering skills to the construction of best estimate power plant simulations, and interpretation of their results.
- Develop and understanding of the methods used to model two-phase flow and heat conduction in a nuclear reactor.
- Develop a familiarity with basic methods and assumptions used to develop the finite difference formulations of the two fluid Navier-Stokes equations.
- Develop a familiarity with different temporal and spatial differentiation techniques, their impact on numerical solutions and associated error.
- Understand and apply thermodynamics and heat transfer principles to the analysis of nuclear power components and systems subject to performance, economic and safety constraints.
- Demonstrate the ability to use modern engineering tools to design and analyze engineering systems.
- Demonstrate an ability to document the calculations necessary to build a model, mesh sensitivity analysis, steady-state and transient solutions (Project).

## Relation to Program Outcomes (ABET)

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| Outcome   | Coverage* |
|---|-----------|
| 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics  | H         |
| 2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors |           |
| 3. An ability to communicate effectively with a range of audiences  | M         |

|   |   |
|---|---|
| 4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts |   |
| 5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives   | H |
| 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions  |   |
| 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies   | H |

## Course Structure

### Course Pre-Requisites/Co-Requisites:

Undergraduate : ENU 4103 (Pre-Requisite), ENU 4134 (Co-Requisite)

Graduate: EML 4140 or ENU 4133 or ENU 4134 or ENU 6135 or ENU 6136 or ENU 5005

### Materials and Supply Fees:

None

### Required Textbook and Software:

- J. Watson, "Power Plant Simulation," 2023
- TRACE(USNRC), SNAP and APTPlot(USNRC)

### Recommended Materials:

- Neil E. Todreas and Mujid S. Kazimi, "Nuclear Systems I," CRC Press, Third Edition, 2021 (978-1138492448).

**Lecture Material:**

Lectures will be given synchronously at during the assigned class time. On occasion, asynchronous lectures, example problem solutions, or other course material may be provided. Students are expected to attend all lectures.

**Required Computer:**

UF student computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>

**Course Schedule:**

|         |  |
|---------|--|
| Week 1: | <i>Introduction and Syllabus</i><br><i>ResVault Tutorial</i>   |
| Week 2: | <i>Introduction to SNAP and APTPlot</i><br><i>The Basics of Two-Phase Flow</i><br><i>Basic Model Equations</i><br>Homework 1 : Checking Pressure Loss Results  |
| Week 3: | <i>Labor Day (9/2/2024) No Class</i><br><i>Introduction to Finite Volume and Finite Difference Methods</i><br>Homework 2 : Two-Phase Flow<br><i>Conservative Finite Volume Equations</i><br><i>Error Analysis for Difference Equations</i> |
| Week 4: | Homework 3 : Finite Volume Methods<br><i>Solving the Difference Equations</i><br><i>Verification and Validation</i><br>Homework 4 : Error Analysis   |

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| Week 5:  | <p><b><i>Heated Flow Exercise</i></b></p> <p><b><i>Modeling Pumps; The TEE and its Relatives; Momentum Conservation</i></b></p> <p>Homework 5: Temperature Transient and Heated Flow</p>  |
| Week 6:  | <p><b><i>Building Control Systems</i></b></p>   |
|          | <p>Homework 6 : Richardson Based Error Analysis</p> <p><b><i>Control Theory in One Hour</i></b></p>   |
| Week 7:  | <p>Homework 7 : PI Controller for Water Level</p> <p>10/4/2023 Exam 1</p> <p><b><i>Introduction to Restart Calculations</i></b></p> <p><b><i>Active Control of Pumped Flow</i></b></p>  |
| Week 8:  | <p>Homework 8 : Pump Loop Controller</p> <p><b><i>Heat Transfer; A Simple Heat Transfer Experiment</i></b></p> <p><b><i>Core Heat Conduction Calculation</i></b></p>  |
| Week 9:  | <p>Homework 9 : Bennet Tube Experiment</p> <p><b><i>Heat Conduction Limited Boiling Model; Subcooled Boiling; and More on Heat Conduction</i></b></p> <p><b><i>Simple Core Model with TRACE</i></b></p> <p><b><i>Steam Generators</i></b></p> <p>Homework 10: Simple Core Heat Transfer Model</p> <p><b><i>Homecoming (10/18/2024) No Class</i></b></p> |
| Week 10: | <p><b><i>Modeling a Turbine</i></b></p> <p><b><i>Parameter Selection with Secant Method</i></b></p> <p><b><i>Introduction to Requirements for the Final Project</i></b></p>   |
| Week 11: | <p><b><i>Laboratory Work on Final Project</i></b></p> <p>Homework 11: Secant Method</p>   |

|          |  |
|----------|--|
| Week 12: | <i>Laboratory Work on Final Project</i><br>11/8/2023 Exam 2  |
| Week 13: | <i>Laboratory Work on Final Project</i><br>Steam Generator Model<br><b>Veterans Day Observed (11/11/2024) No Class</b>       |
| Week 14: | <i>Laboratory Work on Final Project</i><br>Vessel and Core Model   |
| Week 15: | <i>Laboratory Work on Final Project</i><br>Base Steady-State<br><b>Thanksgiving Break (11/28/2024 - 11/29/2024) No Class</b> |
| Week 16: | <i>Laboratory Work on Final Project</i><br>Final Project Due   |

See [Modules](#) page for additional information.

## Expectations and Evaluation

### Attendance:

Attendance is mandatory. 3 excused absences are allowed without penalty. For every absence beyond the 3 excused absence, your final grade will be reduced by 1%. There will be a one hour lab class on Thursday from 4:05 pm - 4:55 pm in addition to the 3, 50 minute lectures. This time slot is considered to be part of the office hours for the class and is an ideal time to begin your assignments and learn how to use the computer software while under supervision. **YOU WILL NEED HELP! SHOW UP AND USE THIS TIME TO YOUR ADVANTAGE!**

You will be attempting to solve relatively complex problems, with a very complex and too frequently fallible tool (welcome to the real world). As a result you will be required to work in teams to cross-check each other's work. Individual written descriptions are required for all work, but team members should generally submit input decks and computational results as a common group product. Because of the possibility of code problems beyond your control, you should contact me quickly when you believe that you have hit a brick wall.

The use of cell phones is prohibited during the lectures. Laptops/tablets can be used for taking notes.

Excused absences must be in compliance with university policies in the Undergraduate <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/> and Graduate Catalog Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://gradcatalog.ufl.edu/graduate/regulations/>

### **Grading Policy:**

No curve is applied to the final set of scores when determining the final grade. Extra credit is possible and will be discussed in class. Final grades will be determined approximately as follows:

- (11) Homework = 20%
- (2) Exams = 30%
- (4) Projects = 50%

Grades will be assigned according to the following scale:

| Grade | Percent  | Grade Points |
|-------|----------|--------------|
| A     | 100 - 92 | 4.00         |
| A-    | <92 - 88 | 3.67         |
| B+    | <88 - 85 | 3.33         |
| B     | <85 - 81 | 3.00         |
| B-    | <81 - 78 | 2.67         |
| C+    | <78 - 75 | 2.33         |
| C     | <75 - 71 | 2.00         |
| C-    | <71 - 68 | 1.67         |
| D+    | <68 - 65 | 1.33         |
| D     | <65 - 61 | 1.00         |
| D-    | <61 - 58 | 0.67         |
| E     | <58 - 0  | 0.00         |

More information on UF grading policy for Undergraduates may be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

For Graduates:

[UF Graduate Catalog](#)  
[Grades and Grading Policies](#)

Homework handed in up to 12 hours late will receive 30% off, homework handed in up to 24 hours late will receive 50% off. No homework will be accepted after 24 hours. All assignments will be submitted via Canvas, all results for your homework and the final project must be

submitted via drop boxes provided on Canvas. The full results of any homework assignment must be time stamped no later than 11:59 PM of the assigned due date. Homework should be submitted in **one typed file as a pdf**.

- I will not accept any homework that is submitted in multiple files unless specifically requested!
- I will also not accept any photos of handwritten homework.

### Homework Requirements

Requests for re-grading of any course document should be submitted as a written request within one week of the graded document being returned. After one week, re-grading requests will no longer be considered.

Final Exam:

None

### **Students Requiring Accommodations:**

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### **Course Evaluation:**

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### **In-Class Recording:**

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions,



student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### **University Honesty Policy:**

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### **Commitment to a Safe and Inclusive Learning Environment:**

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, [student-support-hr@eng.ufl.edu](mailto:student-support-hr@eng.ufl.edu)
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, [pld@ufl.edu](mailto:pld@ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### **Software Use**

All faculty, staff, and students 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.

### **Student Privacy**

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

## **Health and Wellness**

### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

### **Counseling and Wellness Center:**

<https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

### **Sexual Discrimination, Harassment, Assault, or Violence:**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

### **Sexual Assault Recovery Services (SARS):**

Student Health Care Center, 392-1161.

### **University Police Department:**

At 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

## Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

**Writing Studio**, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus**: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

**On-Line Students Complaints**: <http://www.distance.ufl.edu/student-complaint-process>.

## About Your Instructor

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JUSTIN C. KYLE WATSON, PHD, ASSOCIATE PROFESSOR, received his B.S., M.S. and Ph.D. degrees in Nuclear Engineering from the Pennsylvania State University. Before joining the Department of Materials Science and Engineering, Nuclear Engineering Program at the University of Florida in September of 2018, he was the Department Head of the Computational Methods Development Department at the Applied Research Laboratory, the Pennsylvania State University (PSU) and had dual title with the Nuclear

Engineering Department at PSU. He has had a long history with developing numerical methods, modeling and simulations, and coupled physics solvers for design scale applications.

Research Group: [FAMMoS](#)