Course Syllabus

Power Plant Simulation

ENU 4930 ; Class # : 26040 ; Sections : PAF2

Class Periods: T,R|Period 8-9 (3:00 PM - 4:55 PM)

Location : T|WEIM 1094; R|WEIM 1092 ; Spring 2022

Welcome to the Course

(Official catalog version) Special courses covering selected topics in nuclear engineering.

Most individuals entering a career in the nuclear power industry or in regulation of nuclear power (USNRC), will on numerous occasions be asked to simulate an accident scenario in a nuclear power plant or make decisions based on transient simulations performed by others. This course consists of a series of lectures and exercises designed to provide the basic knowledge necessary for intelligent interpretation of results from major reactor simulation codes such as TRACE, RELAP5, RETRAN, and CATHARE. The nature of the material covered will result in some abrupt transitions between lecture topics. However, the common thread of power system simulation runs through everything, and the course is structured to systematically prepare you for the successful completion of the final project.

What former students have said about the class.

Key Course Elements

Course Objective

The primary objective of this course is to teach application of engineering skills to construction of best estimate power plant simulations, and interpretation of the their results. In the process students will:

1. Develop and understanding of the methods used to model two-phase flow and heat conduction in a nuclear reactor.
2. Develop a familiarity with basic methods and assumptions used to develop the finite difference formulations of the two fluid Navier-Stokes equations.
3. Develop a familiarity with different temporal and spatial differentiation techniques, their impact on numerical solutions and associated error.
4. Understand and apply thermodynamics and heat transfer principles to the analysis of nuclear power components and systems subject to performance, economic and safety constraints.

5. Demonstrate the ability to use modern engineering tools to design and analyze engineering systems.
6. Demonstrate an ability to document the calculations necessary to build a model, mesh sensitivity analysis, steady-state and transient solutions (Project).

Course Structure

Instructor:

Dr. Justin Watson
178 Rhines Hall
Phone: 352-273-0241
Email: justin.watson@ufl.edu
Office Hours: Wednesday 3:00 pm - 4:00 pm, or by Appointment

Course Teaching Assistant (TA):

None

Course Pre-Requisites/Co-Requisites:

None

Materials and Supply Fees:

None

Required Textbook and Software:

- Power Plant Simulation
- Justin K. Watson
- 2019
- 0-471-22363-8

Recommended Materials:

- Nuclear Reactor Physics
- Weston M. Stacey
- 2018, Third Revised Edition
- 978-527-41366-9

Lecture Materials:

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.

Course Schedule:

Week 1:	***Introduction and Syllabus*** ***ResVault Tutorial***
Week 2:	***Introduction to SNAP and APTPlot*** ***The Basics of Two-Phase Flow*** ***Basic Model Equations*** Homework 1 : Checking Pressure Loss Results
Week 3:	***Introduction to Finite Volume and Finite Difference Methods*** Homework 2 : Two-Phase Flow ***Conservative Finite Volume Equations*** ***Error Analysis for Difference Equations***
Week 4:	Homework 3 : Finite Volume Methods ***Solving the Difference Equations*** ***Verification and Validation*** Homework 4 : Error Analysis
Week 5:	***Heated Flow Exercise*** ***Modeling Pumps; The TEE and its Relatives; Momentum Conservation*** Homework 5: Temperature Transient and Heated Flow
Week 6:	***Building Control Systems*** Homework 6 : Richardson Based Error Analysis ***Control Theory in One Hour***
Week 7:	Homework 7 : PI Controller for Water Level 2/15/2022 Exam 1

	Introduction to Restart Calculations ***Active Control of Pumped Flow***
Week 8:	Homework 8 : Pump Loop Controller ***Heat Transfer; A Simple Heat Transfer Experiment*** ***Core Heat Conduction Calculation***
Week 9:	Homework 9 : Bennet Tube Experiment ***Heat Conduction Limited Boiling Model; Subcooled Boiling; and More on Heat Conduction*** ***Simple Core Model with TRACE*** ***Steam Generators*** Homework 10: Simple Core Heat Transfer Model
Week 10:	***Spring Break (3/7/2022 - 3/13/2022) No Class***
Week 11:	***Modeling a Turbine*** ***Parameter Selection with Secant Method*** ***Introduction to Requirements for the Final Project*** Homework 11: Secant Method
Week 12:	***Laboratory Work on Final Project*** 3/24/2022 Exam 2
Week 13:	***Laboratory Work on Final Project*** Steam Generator Model
Week 14:	***Laboratory Work on Final Project*** Vessel and Core Model
Week 15:	***Laboratory Work on Final Project*** Base Steady-State

Week 16:	***Laboratory Work on Final Project*** 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 Graduate Catalog (http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance (Links to an external site.)) and require appropriate documentation.

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 = 40%
(1) Final Project = 40%

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

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.
In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: A B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. More information on UF grading policy may be found at: http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades (Links to an external site.)

Final Exam:

Final Exam: 12/15/2021 @ 3:00 PM - 5:00 PM

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
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, 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 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

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/.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical suppor*t*, 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

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