NUCL 50200 Nuclear Engineering Systems

School of Nuclear Engineering, Purdue University, West Lafayette, IN 47907

Course Information

- Course number and title: **NUCL 50200 Nuclear Engineering Systems**
- CRN: 23808, 31655 (Sections WANG and EPZ)
- Course credit hours: 3 Credits hours
- Meeting time *: MWF 9:30am-10:20am.*
- Lecture: Virtual Class Online – Zoom Meeting

https://purdue-edu.zoom.us/j/94302019183?pwd=dkpmU0xhRjlNNzVUVDladjdUMDQ2Zz09
Meeting ID: 943 0201 9183
Passcode: 970089

- Pre-requisite: NUCL 501 or equivalent or instructor permission
  Co-requisite: None
- Course Brightspace page :

Instructor(s) Contact Information

- Name of the instructor(s): **Prof. Shripad T. Revankar**
- Office Location: WANG Room 4085,
- Phone number: 765-496-1782
- Purdue Email Address: shripad@purdue.edu
- Office hours, times and location *:* The meeting is virtual meeting on zoom/webex an Thursday 10:30:00pm-12:00pm. Virtual Office Hours are a synchronous session to discuss questions related to course.. The virtual meeting link is announced each week a day ahead. If student wants a face-to face meeting, Please let me know prefetably one week ahead to make appropriate meeting place arrangement. The preferred method of contact is email.
- How to reach the instructors remotely -- via Brightspace, Purdue email, or dedicated student contact hours.

Course Description

For overall understanding of the nuclear power plants, total system study is required that covers, reactor types, designs, operational and future designs, reactor components, reactor kinetics, control, radiation and shielding, materials, heat removal, safety, and economics, and environmental impact. This course provide this knowledge and prepare graduate students with ability to look holistically the nuclear powers system.

The course cover the basic science and detailed theory behind each topic at graduate level. It reviews state-of the art on each topics to update advances made in this technology. The student mastery of the subject is assessed through homework, closed book tests, and individual student project where each will research new topic other than course topics and writes a report as a project report. The advanced topics covered will highlight possible challenges in technology and hence exposes graduate level research opportunities.

Course Goals:

a. To acquire knowledge on nuclear power plant components and systems, designs, principle of operation, control and safety. Develop understanding of the engineering and physical principles of a reactor including neutron transport, kinetics, thermodynamics, thermalhydraulics, materials, fuels, radiation, shielding and safety. To overview nuclear fuel cycle and waste management.
b. To apply knowledge of mathematics and physics to the design of nuclear power plant engineering systems. To understand the design principles of nuclear power reactors and related systems. To develop a quantitative and qualitative foundation of nuclear reactor control, fuel cycles, radiation protection, shielding, and safety. To perform groups based term project in the area of nuclear system

Learning Resources, Technology & Texts

Because the material is very broad, in addition to the main texts (T&K and L&B) additional references are used. Class slides and additional notes will be posted on time to time on various topics. Please note that the copies of course slides/note are for this course individual use only. The content of these material should not be traferred or given to others.

Text Books:

1. N. E. Todreas and M. S. Kazimi, "Nuclear Systems I - Thermal Hydraulic Fundamentals," 2nd Edition, CRC Press, Taylor & Francis Group, 2011, ISBN 978-1-4398-0887-0
2. J. R. Lamarsh, and A. J. Baratta "Introduction to Nuclear Engineering,"4th Edition, (January 19, 2017) Pearson Publication, ; 4 edition, ISBN-10: 0134570057, ISBN-13: 978-0134570051

Additional References

1. S. Glasstone and A. Sesonske, "Nuclear Reactor Engineering," Chapman and Hall, 1994.
2. A. Sesonske, " Nuclear Power Plant Design Analysis," Technical Information Center, Office of Information Services, U.S. Atomic Energy Commission, 1973. (Available for download at: https://www.osti.gov/biblio/4417437-nuclear-power-plant-design-analysis or at: https://inis.iaea.org/collection/NCLCollectionStore/_Public/05/110/5110875.pdf)

Brightspace page

You can access the course via Brightspace. It is strongly suggested that you explore and become familiar not only with the site navigation, but with content and resources available for this course. See the Help tab for resources.

For examinations will make use of a proctoring tool Respondus. Details on this will be given as we near the first Test.

Learning Outcomes:

1. Student able to apply knowledge of mathematics, science and engineering. Demonstrate an ability to solve typical nuclear reactor calculations: Develop a quantitative foundation of nuclear reactor safety, radiation protection and shielding. Apply knowledge of mathematics and physics to the design of nuclear power reactor systems
2. Students able to design a reactor system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3. Student model engineering issues in nuclear reactor safety, radiation protection and shielding quantitatively and draw appropriate inferences:
4. Student able to use the techniques, skills, and modern engineering tools necessary for nuclear reactor systems through a project

Assignments

The course evaluations consists of Home work assignments, 3 tests and One individual project.

Homework:

Homework problems should be submitted on the before the deadline and the due dates are on the class schedule. Use the Brightspace for submission of your homework. They will be graded and returned as soon as possible.

Missed or Late Work :

Problems turned in one day late will be graded on a one-half credit basis. Two days late will get ¼ credit and any later day submission will get zero credit. Since these problems are intended to show the application of lecture material and provide preparation for tests, individual work is essential. Solutions should make the approach followed clear to the grader with each step used in arriving at solution. Partial credits may be given. Collaboration on homework is limited to general discussion of the problems and approaches. Each student must independently complete their own written solution to each homework problem. Copying another person's homework or using old or other existing solutions is considered plagiarism. Each homework problem must contain the following header information on each page:

Last name, First name ***NUCL 402, Hwk Assignment #***

Examinations:

All exams will be closed notes and closed book. Depending on exam if required formula sheets/figures will be provided with the exams. No materials other than the formula sheets provided are to be used during exams. A score of zero will be recorded for a missed exam. Exams will be conducted in Brightspace using Respondus.with lockdown browser and video monitor. Details on use of Respondus will be given later.

Term Project

Each student complete a project on the topic chosen related reactor systems or component, writes and submits a formal report. The project can be on any topic in Nuclear Engineering. It should contain at least two key areas covered such as reactor physics, reactor kinetics, reactor control, reactor components, radiation, doses, shielding, thermalhydraulics, fuel and fuel cycle, fuel management, nuclear materials, and reactor safety. Guidelines for the term project report will be provided.

Course Grading Policy

A	85% - 100%
B	75% - 84%
C	65% - 74%
D	50% - 64%
F	< 49%

Weighting:

Homework	20%
Tests (3)	65%
Project	15%

Incompletes

A grade of incomplete (I) will be given only in unusual circumstances. To receive an "I" grade, a written request must be submitted prior to December 1, and approved by the instructor. The request must describe the circumstances, along with a proposed timeline for completing the course work. Submitting a request does not ensure that an incomplete grade will be granted. If granted, you will be required to fill out and sign an "Incomplete Contract" form that will be turned in with the course grades. Any requests made after the course is completed will not be considered for an incomplete grade.

Teaching Philosophy

As an instructor, it is my responsibility to maximize opportunities for every student in the class to learn, grow, and succeed in reaching both my own outcomes for the course and their personal goals and desires related to the class. To meet this responsibility, I draw on theory, frameworks, and practices rooted in principles of collaborative learning and student-faculty partnership.

Academic Guidance in the Event a Student is Quarantined/Isolated

If any student is in quarantine or in isolation and need resources or absence documentation, please contact Office of the Dean of Students, odos@purdue.edu. If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager can be reached at acmq@purdue.edu and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

When a student is in quarantined the you can aceess the video of the class presentation recorded through boilercast in the brightspace. Class slides and all required materials are available in the brightspace. Accomodations will be made for late homework submission, substitute tests/exams, and project report.

Course Syllabus

Nuclear Power Plants: Introduction, Power reactors, LWR : PWR, BWR, HTGR, LMFBR CANDU, SMR, GEN IV Reactors, Micro Reactors, Accelerator Based subcritical reactors

Reactor Operation: Reactor control-Kinetics review, Power Excursion, Temperature, void coefficients, Fission product poisoning

Radiation and Shielding : Radiation protection, Radiation dose rate**,** Radiation dose calculations**,** Reactor shielding **,** Shielding design

Material of Construction and Nuclear Materials: Reactor Vessel, Primary and secondary systems, Containment, Fuels and properties, Fuel Cycle, Spent fuel processing, radioactive waste management

Reactor Heat Removal: Reactor heat generation, Shutdown, decay power, Thermal design and limits Fuel thermal analysis, Temperature distribution, Thermal resistance, Thermodynamics of nuclear plant Simplified PWR system, Power plant PWR system, Reactor thermal analysis, Single & Two phase heat transfer, Two phase pressure drop

Reactor Safety: Safety and Emergency Systems, Reactor Accidents TMI, Cherobyl Reactor Accidents Fukushima

Economics of Nuclear Power Plant: Electric utility economics, plant investment costs, fuel costs, operation and maintenance cost, power supply economics

Environmental Impact: Radiation hazard, waste from nuclear plant, environmental issues.

Course Logistics

- *All course material is in the Brightspace.*
- *All students are expected attend the each class.*
- *Homework are due each week except Test or exam week.*
- *A*ll assignments are due by 10:00 a.m. ET on the due date listed in the course schedule. *Please follow directions for home work given above.*
- Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline. Due dates and delivery time deadlines are defined as that used in West Lafayette, Indiana).
- Use the Brightspace for submission of your homework.
- *Regular accouncements will be made on Brightspace for additional instructions.*

Copyright

Brightspace includes a link to the University policy on the Use of Copyrighted Materials. Online educational environments, like all learning environments, should provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students enrolled in and instructors working in online courses are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes (Visit Purdue University Copyright Office). Students may not copy, reproduce or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s).

Netiquette

Your instructor and fellow students wish to foster a safe online learning environment. All opinions and experiences, no matter how different or controversial they may be perceived, must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea, but you are not to attack an individual. Our differences, some of which are outlined in the University's nondiscrimination statement below, will add richness to this learning experience. Please consider that sarcasm and humor can be misconstrued in online interactions and generate unintended disruptions. Working as a community of learners, we can build a polite and respectful course ambience. Please read the Netiquette rules for this course:

- Do not dominate any discussion. Give other students the opportunity to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language. This could possibly lead to misinterpretation.
- Keep an “open-mind” and be willing to express even your minority opinion.
- Think and edit before you push the “Send” button.
- Do not hesitate to ask for feedback.

Violent Behavior Policy

The Brightspace shell includes a link to Purdue’s policy prohibiting violent behavior under University

Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See our course Brightspace under University Policies for a link to the full Violent Behavior Policy.

Diversity & Inclusion Statement

In our discussions, structured and unstructured, we will explore a variety of challenging issues, which can help us enhance our understanding of different experiences and perspectives. This can be challenging, but in overcoming these challenges we find the greatest rewards. While we will design guidelines as a group, everyone should remember the following points:

- We are all in the process of learning about others and their experiences. Please speak with me, anonymously if needed, if something has made you uncomfortable.
- Intention and impact are not always aligned, and we should respect the impact something may have on someone even if it was not the speaker’s intention.
- We all come to the class with a variety of experiences and a range of expertise, we should respect these in others while critically examining them in ourselves.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students from 8:00 – 5:00, Monday through Friday.

In spring 2020, ODOS updated its website to include more details on its Critical Need Fund related to COVID-19. If you are teaching under COVID-19 restrictions, you might include the following. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency funds. For details and the request form use link: https://www.purdue.edu/odos/resources/critical-need-fund.html.

Course Evaluation

During the last two weeks of the semester, you will be provided with an opportunity to give feedback on this course and your instructor. Purdue uses an online course evaluation system. You will receive an official email from evaluation administrators with a link to the online evaluation site. You will have up to 10 days to complete this evaluation. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Student Help and Success

Brightspace course shell includes links to the following student resources under the Student Help and Success content.

- *Registrar*
- *Financial Aid*
- *Academic Advising*
- *Veterans Success Center*
- *Student Employment*
- *Center for Career Opportunities.*

Disclaimer

This syllabus is subject to change. Describe how you will announce and share changes made to the syllabus.

Attendance Policy during COVID-19
Students should stay home and contact the Protect Purdue Health Center (496-INFO) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflict, when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via emailto:odos@purdue.edu or phone at 765-494-1747. Our course Brightspace includes a link on Attendance and Grief Absence policies under the University Policies menu.

Academic Integrity
Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Nondiscrimination Statement
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. More details are available on our course Brightspace table of contents, under University Policies.

Mental Health Statement
If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack (https://purdue.welltrack.com/). Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students (http://www.purdue.edu/odos). Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Appendix A - Guidelines for Academic Integrity

In a society that increasingly questions the value of higher education, upholding academic integrity takes on added significance. The time and effort necessary to champion high expectations of academic integrity are well understood, and the University is in full support of faculty and instructors who uphold these standards. Please consider these five steps for your class.

1. Define academic dishonesty for your class in your syllabus and emphasize it on the first day of class. The OSRR website offers a faculty guide on responding to academic dishonesty. Revisit your expectations at key junctures of the semester (e.g., before an exam or term project).
2. Provide greater clarity to students about what is acceptable and unacceptable. Some classes routinely use team assignments and encourage collaboration for projects, labs, or homework. Yet at other times of the term, students are expected to work independently. Be very clear about your expectations for each assignment.
3. Students should be told prior to – and as part of – the instructions on each test what is acceptable in terms of notes, phones, calculators, etc. From class to class our practices vary widely so, here again, it's important to be very clear in your expectations.
4. Define penalties that will be enforced for academic dishonesty. One example might be:

   > "Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered."

5. At a minimum, if you penalize a student's grade by deducting points, report the instance of scholastic dishonesty using the OSRR reporting form. Reporting all incidents helps to ensure consistent treatment both at the course level and across the institution. Staff members from OSRR are available to consult on an individual basis. Their office is in B50 of Schleman Hall, and their phone is 765-494-1250.
6. While faculty and instructors have raised concerns about student academic integrity, students have indicated that some instructors appear reluctant to uphold academic standards. Be clear in your syllabus on the steps you will take in your class to uphold academic integrity.

Appendix B: Emergency Preparedness face-to-face

1) As we begin this semester, I want to take a few minutes and discuss emergency preparedness. While COVID-19 is currently a major focus of our campus health and safety preparations, we must also take time to be prepared for other possible emergencies as we would in any semester. Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a "safety briefing" each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter-in-place incidents. Our preparedness will be critical IF an unexpected event occurs!
2) Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let's review the following procedure

- For any emergency text or call 911. 

- There are more than 300 Emergency Telephones (aka blue lights) throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected right away.
- If we hear a fire alarm, we will immediately evacuate the building and proceed to_ east side of RHPH.
- Do not use the elevator. Go over the evacuation route (see specific Building Emergency Plan).
- If we are notified of a Shelter in Place requirement for a tornado warning we will stop classroom or research activities and shelter in the lowest level of this building away from windows and doors. Our preferred location is _ Basement rooms and hallways _.
- If we are notified of a Shelter in Place requirement for a hazardous materials release, we will shelter in our classroom shutting any open doors and windows.
- If we are notified of a Shelter in Place requirement for an active threat such as a shooting, we will shelter in a room that is securable preferably without windows. Our preferred location is _____.
- **(NOTE: Each building will have different evacuation & shelter locations. The specific Building Emergency Plan will provide specific locations and procedures)**

EMERGENCY RESPONSE PROCEDURES:

- Review the **Emergency Procedures Guidelines** https://www.purdue.edu/emergency_preparedness/flipchart/index.html
- Review the **Building Emergency Plan** for Hampton Hall at: https://www.purdue.edu/ehps/emergency_preparedness/bep/HAMP-bep.html for:
  - evacuation routes, exit points, and emergency assembly area
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.

EMERGENCY PREPAREDNESS AWARENESS VIDEOS

- "Shots Fired on Campus: When Lightning Strikes," is a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See: http://www.purdue.edu/securePurdue/news/2010/emergency-preparedness-shots-fired-on-campus-video.cfm (Link is also located on the EP website)
- All Hazards Online Awareness training video (on Webcert & Blackboard.) A 30 minute computer based training video that provides safety and emergency preparedness information. See the EP website for sign up instructions.

MORE INFORMATION

Reference the Emergency Preparedness web site for additional information: https://www.purdue.edu/ehps/emergency_preparedness/