NUCL 410, Introduction to Reactor Theory and Applications

1. **3 Credit Hours:**
   Class Time: M, W, F 12:30-1:20 – Classroom GRIS 118

2. **Instructor:**
   Hany Abdel-Khalik, Ph.: 69718, abdelkhalik@purdue.edu
   Office hours: By appointments only.

3. **Textbook(s):**
   J. Duderstadt and L. Hamilton, Nuclear Reactor Analysis, Wiley, 1976

4. **Course Description:**
   Intermediate treatment of reactor theory and its relevance to routine design engineering calculations, including introduction to transport theory, criticality evaluation, multi-group theory, isotopic depletion, and concludes with short overview of multi-level reactor design calculations, critical experiments, and treatment of neutronic uncertainties.

   List of Topics: Derivation of Boltzmann transport equation, and its reduction to steady state and time dependent diffusion equation. Introduction to multi-group theory, and evaluation of group parameters in both wide and narrow resonance approximations. Introduction to homogenization theory, and evaluation of lattice parameters. Evaluation of criticality condition for bare and reflected reactor geometries. Development of discretization techniques for the time-dependent multi-group diffusion theory equation. Reactor kinetics, reactivity coefficients and reactivity balance equation. Flowchart of multi-level reactor design calculations. Introduction to critical experiments and startup reactor physics test. Sources and treatment of uncertainties in reactor calculations.

5. **Prerequisites:**
   NUCL 310, or any equivalent introductory course in reactor physics.
   If you don't meet prerequisites, please see me after class.

6. **Required tools:**
   Students may need to **MATLAB** for this course. Purdue University MATLAB Portal

7. **Classification:**
   Required

8. **Learning Objectives:**
   a. Students expected to develop an understanding of reactor physics value for engineering design calculations, and to learn how it is applied to make engineering design decision regarding material choice, composition, type, and operating conditions to sustain and control chain reactor over reactor operating horizon.
   b. Students to learn how to develop a computer code to solve a reactor physics problem.

9. ABET Student Outcomes:

An ability to identify, formulate, and solve complex engineering problems by applying principles of Nuclear engineering, science, and mathematics.

Grading: Mid-term examination: 25%, Final Examination: 25%, Assignments/Projects: 30%;
Classroom interactions: 10%, Oral Examination: 10%, Bonus Assignments: 10%.
No makeup assignments, and No grade curving. Following Code of Integrity (PASS or FAIL).

Grades: A+>=96, A>=90, B>=80, C>=70, D>=60, F<60

Exams: All exams are take-home, one mid-term exam, and one final-term exam (during the exams week).

Assignments: Excluding the two exams, all assignments/projects/bonuses are to be typed electronically and submitted via Brightspace. Hand-written assignments will receive **ZERO** grade. Don't send me your assignments electronically unless I request/approve that (**PDF format only**).

Class Structure: The class will adopt a hybrid model, wherein some classes will be in-person and some will be given in an online mode. By default, all classes will be in-person unless otherwise instructed, adapting to the evolving/uncertain pandemic-related circumstances. Should a class be scheduled in an online mode, students will be provided with a 24-hr-notification. All in-person classes will be captured in audio/video for students electing to receive the instructions in an online only mode.

Each class consists of three segments, revision of previous class material (be ready for quizzes), new material will be presented following a problem-based learning approach (students discussion/interactions required), and wrap-up on material presented and directions for next class.

Disability: If you have disability requiring special attention, please notify me immediately to take appropriate measures

Expectations: All assignments, including exams, projects, and bonuses, should state clearly any references you may have used. **No references cited implies the work is your OWN**. Return assignments on time. Late assignments will be subjected to 20% penalty for each day after due date without a valid excuse (up to two days only). **Cheating/Copying/Plagiarism will be severely punished**. Any assignment (including HW, projects, exams, etc.) containing a SINGLE cheating incident will receive zero grade for entire assignment. More than two cheating incidents will be reported to your academic advisor and student conduct office and will receive an F grade in the course. Take pride in your work. SILENCE your cell phones and other electronics while you are in class and when you come see me in the office.

Class Material: The required text for this class is "Nuclear Reactor Analysis" by J. Duderstadt and L. Hamilton. The class notes, assignments, class schedule, examinations, etc. will be posted via Brightspace. You will receive emails from Brightspace system automatically when announcements are made. Make sure your spam-filter is functioning properly. 'My-email-is-not-working', or 'I-have-not-received-this-email' type excuses will not be accepted. Check your Brightspace regularly.

Questions: Post your questions on **Piazza.** Link to the course Piazza, NUCL410 piazza