NUCL 460
Introduction to Controlled Thermonuclear Fusion

Spring 2018 8 January 2018

Course Outline: Fusion energy is the energy of the future. This course is designed for advanced undergraduate students or beginning graduate students in engineering or physical sciences to study the fundamentals and an overview of the thermonuclear fusion energy researches in the U. S. and abroad.

Topics:

1. Review of fusion vs. fission and survey of the world energy resources.
2. Introduction to fusion problems: Thermonuclear reactions, reaction rates, and power density.
3. Introduction to basic plasma physics, Coulomb collisions, and review of the Maxwell's equations.
4. Plasma heating and the requirements for fusion ignition.
5. Energy balance: Radiation losses and impurity control, energy breakeven Lawson criterion, and the direct- and indirect-energy conversion to electric power production.
6. Plasma confinement: Toroidal and linear fusion reactor devices.
7. Stability configurations: Plasma equilibrium and the control of plasma instabilities.
8. Review of current magnetic-confinement fusion energy (MFE) approaches to fusion reactor: Concepts such as tokamak, mirror, field-reversed compact torus, pinch, bumpy torus, mirror cusp, spheromak, spherical tokamak, stellarator, etc.
9. Current inertial-confinement fusion energy (IFE) approaches to fusion reactor: Laser, heavy- and light-ion beams, magnetized target driver concepts, and IFE target design characteristics.

Textbooks:

Required: **U. Inan and M. Golkowski**, *Principles of Plasma Physics for Engineers and Scientists*, Cambridge Univ. Press (2011). ISBN: 978-0-521-19372-6;
J. Bobin, *Controlled Thermonuclear Fusion*, World Scientific (2014). ISBN: 978-981-4590-68-6;
T. Dolan, *Fusion Research*, Vol. I (Principles), Pergamon Press (1982). ISBN: 0-08-025566-3.
https://uofi.box.com/s/gixqw1wspu6uokws6d0m [Free down loadable];

Recommended: **F. Chen**, *Introduction to Plasma Physics and Controlled Fusion*, 3rd/ed., Springer Nature/Science (2016). ISBN: 978-3-319-22308-7. www.link.springer.com → Search & download;
F. Chen, *An Indispensable Truth: How Fusion Power Can Save the Planet*, Springer Nature/ Science (2011). ISBN: 978-1-4419-7819-6. www.link.springer.com → Search & download [free];
M. **Kikuchi**, et al. (Ed.), *Fusion Physics*, IAEA (2012). ISBN:978-92-0-130410-0 [Free access].

Instructor: Prof. Chan K. Choi, choi@purdue.edu.
Office Hours: MWF 2:30 – 3:20 PM @NUCL 112B, or by Appointment

Course Grading: Homework (30%), Midterm Exams (2) (40%), and Final Exam (30%);
$85\% \le A \le 100\%$, $70\% \le B < 85\%$, $55\% \le C < 70\%$, $40\% \le D < 55\%$,
and not passing below 40%; unexcused absences over 2 weeks = not passing.

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If you hear a **fire alarm** during class, we will immediately suspend the class, evacuate the building, and proceed outdoors. Do not use the elevator.

If we are notified during class of a **Shelter in Place requirement for a tornado** warning, we will suspend the class and shelter in [the basement].

If we are notified during class of a **Shelter in Place requirement for a hazardous materials release, or a civil disturbance,** including a shooting or other use of weapons, we will suspend the class and shelter in the classroom, shutting the door and turning off the lights.

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Campus Emergency: 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. Information about the changes in this course in such emergencies would be obtainable from the course instructor and/or the university provost office.

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