NUCL 560
INTRODUCTION TO FUSION TECHNOLOGY

Fall, 2025

Course Outline:

This course covers the fundamental plasma engineering governing fusion reactor plasmas, discusses issues in fusion reactor engineering/technology, and summarizes the state-of-the-art designs for both magnetic and inertial confinement fusion devices.

Topics:

1. Introduction to Plasma Confinement and Reviews of Magnetic Mirrors and Cusps; Pinches and Compact Toroids; Tokamaks, Stellarators and Elmo Bumpy Torus; Glass and Gas Lasers, and Electron- and Ion-Beam Devices
2. Fusion Engineering Problems and Technology Issues
3. Magnets – water cooled, pulsed, and superconducting
4. Plasma Heating and Refueling
5. First Wall, Blankets and Shield
6. Control Systems
7. Materials Issues for Fusion Reactors
8. Vacuum and Cryogenic Systems
9. Plasma Diagnostic Systems
10. Power Plant Designs
11. Fusion-Fission Hybrids
12. Safety and Environment
13. Progress on current Toroidal-devices (ITER tokamak and stellarator) and Laser-driven NIF

Textbooks: T. Dolan, Magnetic Fusion Technology, Springer-Verlag (2013). [Required, e/Free]
[Note: www.link.springer.com → Search & free download pdf (from campus PC)]
E. Morse, Nuclear Fusion, Springer (2018), ISBN 978-3-319-98170-3 [Recmm, e/Free]
J. Freidberg, Plasma Physics and Fusion Energy, Cambridge U. Press (2010).[Recmm.]

References:

1. Fundamentals of Magnetic Fusion Technology, International Atomic Energy Agency (IAEA) (Sept. 2023) Pp. 778, <https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1945_web.pdf>
2. IAEA World Fusion Outlook 2023 (Oct. 17, 2023), IAEA World Fusion Outlook 2023 | IAEA
3. F. F. Chen, Plasma Physics & Controlled Fusion, Springer, 3/e (2016), ISBN 978-3-319-22308-7
4. M. Kikuchi, K. Lackner, and M. Tran (Eds.), Fusion Physics, IAEA (2012). pp.1129.
   [A comprehensive reference book for advanced students on magnetic and inertial confinement. Free electronic copy is available:< http://www-pub.iaea.org/books/IAEABooks/8879/Fusion-Physics>]
5. National Research Council, Inertial Confinement Fusion, National Academic Press (2013)
6. Plasma Physics and Technology Aspects of the Deuterium-Tritium Fuel Cycle for Fusion Energy, IAEA (June 2024), IAEA-TECDOC-2049, ISBN: 978-92-0-110124-2, pp. 73. [e/free].

Grading:

Homework & Attendance – 30%, Examinations (2) - 40%, Final Examination - 30%

[HW-25%; Att.-5% // 2-week absence = No Att. Credit]
[A = 85% - 100%; B = 70 % - < 85%; C = 55% - < 70%;
D = 40% - <55%; Below 40% = Not Passing.]