National Cheng Kung University
Modular Course 2020 Summer Program

工程電漿物理
Plasma Physics for Engineers

Instructor	Affiliation	Graduation (Ph.d.)
Yasutaro Nishimura	**NCKU Institute of Space and Plasma Sciences**	**UW-Madison Wisconsin**

Course Type	Course Credit	Student Size (Maximum)
Lecture + Recitation	**1**	**35**

Student Background

- **A freshmen level, basic knowledge of calculus and general physics.**
- **College of Science、Institute of Technology、College of Life Science、College of Electrical Engineering and Computer Science、College of Medical**

Format of The Course

Lecture 100%

Grading Policy

Exam：70 %，The exam will be a 90 minutes written exam on the last day.
2 Homework sets：30%，in forms of recitation in classes.

Code of Conduct for The Course

None

Course Description

Plasma physics, one branch of physics, is a field to study statistical behavior of charged particles and its collective behavior (here, the term collective is used antithetically to randomness). Besides its strong link to nuclear fusion research and space science research, plasma discharge techniques have been successfully applied in various industrial applications such as plasma etching of semiconductors (which is now being controlled at nano-scales) and Plasma-immersion ion implantation (PIII) which is a surface modification of materials. From plasma physics point of view, the success in the industrial application is specifically linked to "sheath dynamics" at the plasma-material boundary. The sheath dynamics manifest itself as "anisotropy" (in plasma etching, ions bombard the material surfaces perpendicularly) and "conformality" in PIII. The introductory key concepts of plasma physics are discussed in the five days course.

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Timetable and Syllabus

Period	Timetable	Syllabus
8/31(MON)	14:00-17:35	Phase space dynamics and velocity distribution function
9/1(TUE)	14:00-17:35	Debye Hückel theory and sheath dynamics in plasmas
9/2(WED)	14:00-17:35	Collisions in plasma based on Rutherford scattering model, collisions with neutrals
9/3(THU)	14:00-17:35	Plasma oscillation and collective behavior in plasmas
9/4(FRI)	14:00-17:40	Demonstration: Particle-in-Cell (PIC) simulation of capacitively coupled plasma. 90 minutes final exam.

Goal of The Course

1. **Let students understand the basic theory of plasma.**
2. **Let students see different ways of generating plasma.**
3. **Let students see various applications of plasma.**

The Importance, Cross-Over Disciplinary and Contemporary of The Curriculum

[Interdisciplinary nature of the course]
Plasma physics, one specific field of physics to study statistical behavior of charged particles, shares common interest in various fields of engineering, space science, chemistry, or biomedical science, to name a few.
Theoretical plasma physics has been one of the major drives for modern applied mathematics.
[Importance of the course contents] Though plasmas (as listed above) is applied in surprisingly many scientific disciplines, often it is seen as a charged gas as a lump. For an effective advance in students' upcoming research, the course plans to convey the compact/minimum idea of plasma physics (the idea of plasma being more than just an ambient ionized gas) with an emphasis in its practical application.

Remarks

Reference:
Introduction to Plasma Theory, D.W.Nicholson (Krieger 1992).