课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	**MEE5305/**等离子体原理与应用 **MEE5305/**Fundamentals and applications of plasma
2.	**课程性质** **Compulsory/Elective**	专业课**/Elective**
3.	**课程学分/学时** **Course Credit/Hours**	3/48
4.	**授课语言** **Teaching Language**	中文和英文 Chinese and English
5.	**授课教师** **Instructor(s)**	邓辉/助理教授 机械与能源工程系 Hui DENG / Assistant professor Department of Mechanical and Energy Engineering Email: dengh@sustc.edu.cn
6.	**是否面向本科生开放** **Open to undergraduates or not**	是 Yes
7.	**先修要求** **Pre-requisites**	研究生：无 本科生：ME302 机械制造基础 Fundamentals of Manufacturing
8.	**教学目标** **Course Objectives**	
	等离子体是物质的第四态，它在人们的生活以及生产过程中扮演着非常重要的角色。在精密制造领域，等离子体已经发展成为一种非常重要的技术手段。作为一门交叉学科，等离子体涉及到物理、化学、表面科学以及工程应用等诸多内容。 本课程的教学目标是使学生掌握等离子体放电的基本原理并对等离子体的相关应用有清晰的了解。本课程的第一部分将从物理的角度对等离子体放电过程进行分析；第二部分将阐述等离子体的化学动力学过程；第三部分介绍各种等离子体的激发过程及特性；第四部分会对等离子体的典型应用进行介绍。 As the fourth state of mater, plasma plays an very important role in our daily life as well as industry production. Especially in precision manufacturing, plasma has become an useful approach. To understand the principles and applications of plasma, theoretical knowledge, such as plasma physics, chemical kinetics, surface science and engineering is indispensable. The objective of this course is to give an overall introduction to the principles of plasma discharge and offer the students with the knowledge of plasma applications. In the first part, the physical fundamentals about plasma discharge will be introduced. In the second part, chemical kinetics of plasma will be introduced. In the third part, the properties of various plasma sources will be introduced. Finally, some typical applications of plasma will be discussed. The students will be cultivated with the ability to understand the principles and applications of plasma and conduct related researches.	
9.	**教学方法** **Teaching Methods**	
	课堂教学	

10.	**教学内容（需要写到 section 16）** **Course Contents**	
	Section 1	课程介绍（2 学时）：对这个课程的预期目标、讲授内容、评价标准以及课堂要求作简要介绍。 Course orientation (2 credit hours): give the students an overall introduction about the course including the contents and assessment.
	Section 2	等离子体的基本方程（2 学时）：这一章主要介绍麦克斯韦方程组、玻尔兹曼方程、粒子数/动量/能量守恒方程，并介绍等离子体平衡态的性质。 Basic plasma equations (2 credit hours): Maxwell's equations, Boltzmann equation and conservation equations will be introduced as well as the properties of plasma at equilibrium level.
	Section 3	原子碰撞（4 学时）：这一章介绍弹性和非弹性碰撞，包括原子能级、电偶极辐射、亚稳态、碰撞截面、电荷转移和碰撞电离等。 Atomic collisions (4 credit hours): elastic and inelastic collisions in plasma will be introduced, including atomic level, electric dipole irradiation, metastable level, collision cross section, charge transfer and collision ionization.
	Section 4	直流鞘层（2 学时）：这一章会介绍鞘层的基本概念、玻姆鞘层判据、鞘层形成的广义判据以及静电探针诊断技术。 Direct current sheaths (2 credit hours): in this chapter, the definition of sheath will be introduced. The Bohm criterion of sheath, the general criterion of the formation of sheath will be explained. Electrostatic probe diagnosis will be introduced.
	Section 5	化学反应和平衡（4 学时）：这一章主要介绍一些概念，如能量、焓、熵、吉布斯自由能等。然后会对化学平衡以及异相平衡进行学习。 Chemical reactions and equilibrium (4 credit hours): in this chapter, some concepts, like energy, enthalpy, entropy, Gibbs free energy will be introduced. Then, we will learn some fundamentals about chemical equilibrium and heterogeneous equilibrium.
	Section 6	分子碰撞（2 学时）：这一章首先介绍分子结构，然后对电子-分子碰撞反应、重粒子间的碰撞、反应速率以及细致平衡、发射光谱法和光化线强度测定等分别进行介绍。 Molecular collisions (2 credit hours): in this chapter, molecular structures will first be introduced. Then, electron-molecule collisions and collisions between heavy particles will be introduced. Finally, we will learn the reaction efficiency, detailed equilibrium and emission spectroscopy will be introduced.

Section 7	化学动力学和表面过程（2 学时）：这一章包含四个内容：基元反应、气相动力学、表面过程和表面动力学。 Chemical kinetics and surface processes (2 credit hours): this chapter includes 4 parts, elementary reaction, gas phase kinetics, surface process and surface kinetics.
Section 8	容性放电与感性放电（8 学时）：这一章将对分别对容性放电和感性放电进行介绍。关于容性放电，将主要介绍其均匀和非均匀放电模型，实验以及数值模拟，匹配网络和功率测量。感性放电则主要介绍高密度低气压等离子体、盘香型线圈等离子体和螺旋共振器放电。 Capacitive discharges and inductive discharges (8 credit hours): in this chapter, capacitive discharges and inductive discharges will be introduced respectively. For capacitive discharge, equilibrium and nonequilibrium discharge models, experimental and numerical simulation, matching network and power measurement will be introduced. For inductive discharge, high density and low pressure discharge, incense coil discharge and helical resonator discharge will be introduced.
Section 9	波加热的气体放电（2 学时）：这一章包含以下三个内容：电子回旋共振等离子体、螺旋波放电以及表面波放电 Wave-heated discharges (2 credit hours): this chapter includes 3 parts: electron cyclotron resonance plasma, helical wave discharge and surface wave discharge.
Section 10	直流放电（2 学时）：这一章会介绍辉光放电的定性描述、正柱区分析、阴极鞘层分析、平面磁控放电等。 Direct current discharges (2 credit hours): in this chapter, we will learn the qualitative description of glow discharge, analysis of positive column, cathode sheath analysis and magnetic plane discharge.
Section 11	刻蚀（上）：介绍一些常见的刻蚀工艺，包括刻蚀的要求和工艺过程和刻蚀反应动力学等。 Etching (I): some typical etching processes will be introduced including the requirements and processes of etching and etching dynamics.
Section 12	刻蚀（下）：介绍一些常见的刻蚀工艺，包括用卤素原子刻蚀硅、其他刻蚀系统、衬底上的电荷积累等。 Etching (II): some typical etching processes will be introduced including silicon etching and charge up of substrate and so forth.
Section 13	沉积（上）：介绍一些典型的等离子体沉积工艺，如等离子体增强化学气相沉积。 Deposition (I) : some plasma related deposition processes will

		be introduced including plasma enhanced chemical vapor deposition (PE-CVD).
	Section 14	沉积（下）：介绍一些典型的等离子体沉积工艺，如溅射沉积等。 Deposition (II) : some plasma related deposition processes will be introduced including sputtering deposition and so on.
	Section 15	表面改性（上）：这一章会对等离子体表面改性工艺进行介绍，包括表面改性的一些概念和等离子体表面改性的原理。 Surface functionalization (I): plasma surface modification process will be introduced including some concepts and modification mechanisms.
	Section 16	表面改性（上）：介绍树脂材料的表面改性、金属材料的表面改性以及陶瓷材料的表面改性。 Surface functionalization (II): introduce the plasma surface modification process of polymers, metals and ceramics.
11.	**课程考核** **Course Assessment**	
	出勤（10%）+ 课堂表现（20%）+ 期末报告（70%） Attendance(10%) + Class Performance (20%) + Final Presentation (70%)	
12.	**教材及其它参考资料** **Textbook and Supplementary Readings**	
	Principles of Plasma Discharges and Materials Processing, Michael A. Lieberman, Alan J. Lichtenberg, John Wiley & Sons, 8 Apr 2005	