

## 课程详述

### COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	<b>课程名称 Course Title</b>	光学材料与器件 Optical Materials and Devices
2.	<b>授课院系 Originating Department</b>	材料科学与工程系 Department of Materials Science and Engineering
3.	<b>课程编号 Course Code</b>	MSE339
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业核心课 Major Core Courses
6.	<b>授课学期 Semester</b>	春季 Spring
7.	<b>授课语言 Teaching Language</b>	中英双语 English & Chinese
8.	<b>授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation &amp; Contact (For team teaching, please list all instructors)</b>	李贵新，教授，材料科学与工程系 Guixin Li, Professor, Department of Materials Science and Engineering ligx@sustech.edu.cn
9.	<b>实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact</b>	待公布 To be announced
10.	<b>选课人数限额(可不填) Maximum Enrolment (Optional)</b>	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
学时数 Credit Hours	48				48
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	大学物理 General Physics				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite					
14. 其它要求修读本课程的学系 Cross-listing Dept.					

### 教学大纲及教学日历 SYLLABUS

#### 15. 教学目标 Course Objectives

The objective of this course is to introduce the fundamental knowledge of Maxwell's equations and the nature of light-matter interaction in both homogenous and artificial materials, and concept of how to apply the theory of electromagnetism to a range of applications. Topics cover includes the propagation of light, the vectorial nature of light, coherence, interference and diffractions of light, optical properties of solids, photonic crystals, plasmonics, metamaterials and metasurfaces.

本课程的目的是通过学习麦克斯韦方程，理解光在均匀介质和人工结构材料中光与物质相互作用的原理，以及电磁理论的相关应用。课程内容涵盖光的传播、光的矢量性质、光的相干性、干涉和衍射、固体的光学特性、光子晶体、等离激元学、光学超构材料和光学超构表面。

#### 16. 预达学习成果 Learning Outcomes

##### Knowledge:

1. Introduce the fundamental knowledge of Maxwell's equations; 介绍麦克斯韦方程的基础知识;
2. Understand the vectorial nature of light, and the coherence, interference and diffraction phenomena of light; 理解光的矢量性质，以及光的相干性、干涉和衍射现象;
3. Understand the theory and applications of the optical properties of solids; 理解固体光学特性的理论和应用;
4. Understand the physical concepts of photonic crystal, metamaterials, metasurfaces and their applications. 理解光子晶体、超构材料、超构表面的物理概念及其应用。

##### Skills:

1. Apply Maxwell's equations in the propagation of light in both homogenous and artificial materials; 在均匀介质和人工材料中应用麦克斯韦方程描述光的传播特性;
2. Design the advanced optical devices, and control the multiple degrees of freedom of light fields. 设计先进的光学器件，控制光场的多个自由度。

#### 17. 课程内容及教学日历 (如授课语言以英文为主，则课程内容介绍可以用英文; 如团队教学或模块教学，教学日历须注明主讲人)

**Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

I. The Propagation of Light (4 Credit hours) 光的传播 (4 学分)

- 1.1 Maxwell's equations 麦克斯韦方程
- 1.2 The speed of light 光速
- 1.3 Plane harmonic waves 平面波

**II. The vectorial Nature of Light (6 Credit hours) 光的矢量性质 (6 学分)**

- 2.1 Energy flow and the Poynting vector 能流和坡印廷矢量
- 2.2 Polarized light 偏振光
- 2.3 Jones vector and matrix representation 琼斯矢量和矩阵表示
- 2.4 Reflection and refraction at a plane boundary 光的反射和折射

**III. Coherence, Interference and Diffraction (10 Credit hours) 相干、干涉和衍射 (10 学分)**

- 3.1 The principle of linear superposition 线性叠加原理
- 3.2 Young's experiment 杨氏实验
- 3.3 Coherence time and coherence length 相干时间和相干长度
- 3.4 Interference with multiple beams 多光束干涉
- 3.5 The Fabry-Perot interferometer 法布里-珀罗干涉仪
- 3.6 Diffraction of light 光的衍射
- 3.7 Optical holography 光学全息

**IV. Optics of Solids (6 Credit hours) 固体的光学性质 (6 学分)**

- 4.1 Propagation of light in isotropic dielectrics 均匀介质中的光传播
- 4.2 Propagation of light in conducting media 导电介质中的光传播
- 4.3 Propagation of light in crystals 晶体中的光传播
- 4.4 Double refraction and optical activity 双折射和旋光性

**V. Thermal radiation, lasers (6 Credit hours) 热辐射与激光 (6 学分)**

- 5.1 Blackbody radiation 黑体辐射
- 5.2 Modes of electromagnetic radiation in cavity 腔体中电磁辐射模式
- 5.3 Stimulated emission 受激辐射
- 5.4 Methods of producing a population inversion 产生粒子数反转的方法
- 5.5 Laser oscillation and optical resonator theory 激光振荡和光学谐振腔理论

**VI. Ray Optics (4 Credit hours) 光线光学 (4 学分)**

- 6.1 Reflection and refraction at a spherical surface 球面的反射和折射
- 6.2 Ray equations 几何光学方程
- 6.3 Ray matrices and ray vectors 光线矩阵和光线矢量

**VII. Photonic Crystals (4 Credit hours) 光子晶体 (4 学分)**

- 7.1 Electromagnetism as an eigenvalue problem 电磁波的特征值问题

- 7.2 One dimensional photonic crystals 一维光子晶体
- 7.3 Fabrication of photonic crystals 光子晶体的制备
- 7.4 Applications of photonic crystals 光子晶体的应用

**VIII. Plasmonics: Theory and Applications (4 Credit hours) 等离激元学：理论与应用（4 学分）**

- 8.1 Plasmon 等离激元
- 8.2 Surface plasmons 表面等离激元
- 8.3 Plasmonic devices and applications 等离激元器件与应用

**IX. Metamaterials and Metasurfaces (4 Credit hours) 超构材料和超构表面（4 学分）**

- 9.1 Optical metamaterials 光学超构材料
- 9.2 Negative refraction 负折射
- 9.3 Photonic metasurfaces 光学超构表面
- 9.4 Manipulation of the light fields with metasurfaces 基于超构表面的光场操控

**18. 教材及其它参考资料 Textbook and Supplementary Readings**

- 1. Introduction to Modern Optics, Grant R. Fowles.
- 2. Optical Metamaterials: Fundamentals and Applications, Cai Wenshan, Shalaev Vladimir.

**课程评估 ASSESSMENT**

19. 评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		10		
期中考试 Mid-Term Test		30		
期末考试 Final Exam		50		
期末报告 Final Presentation				
其它（可根据需要 改写以上评估方 式） Others (The above may be modified as necessary)				



20. 记分方式 **grading system**

- A. 十三级等级制 **Letter Grading**  
 B. 二级记分制 (通过/不通过) **Pass/Fail Grading**

课程审批 **Review and Approval**

21. 本课程设置已经过以下责任人/委员会审议通过  
**This Course has been approved by the following person or committee of authority**

