南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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.	**课程名称 Course Title**	**液晶光电子学** **Liquid crystal optoelectronics**
2.	**授课院系** **Originating Department**	电子与电气工程系 Department of Electrical & Electronic Engineering
3.	**课程编号** **Course Code**	EE335
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业选修课 Major Elective Courses
6.	**授课学期** **Semester**	秋季 Fall
7.	**授课语言** **Teaching Language**	中文 Chinese
8.	**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& Contact** **（For team teaching, please list all instructors）**	刘言军，副教授，电子与电气工程系 办公室：第二科研楼 523 室 Email：yjliu@sustc.edu.cn 电话：0755-8801-8520 LIU Yanjun, Assoc. Prof., Department of Electrical and Electronic Engineering Office: Room No. 523, Faculty Research Building 2 Email: yjliu@sustc.edu.cn Telephone: 0755-8801-8520
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	李珂，研究助理，电子与电气工程系 Email：lik@mail.sustc.edu.cn LI Ke, Research Assistant, Department of Electrical and Electronic Engineering Email：lik@mail.sustc.edu.cn
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	20

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	32		32		64

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	EE210 光学基础 EE210 Fundamentals of Optics
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.	无 None

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

本课程目标是训练学生理论与实践相结合，学习液晶光电子学的基础知识，掌握液晶器件的制作工艺、光电特性的表征与测试。

This course aims to train the students with lectures combined with lab practice. Through this training, students will learn the basic knowledge of liquid crystal optoelectronics and master the basics of fabrication processes, characterization and performance testing of liquid crystal optoelectronic devices.

16. **预达学习成果 Learning Outcomes**

通过本课程的学习，学生将掌握液晶光电子学的基础知识，掌握液晶器件的制作工艺，光电特性的表征与测试手段，深入理解液晶相关概念，为今后从事光信息技术科研及开发工作打下良好的专业基础。

Through this course, students will master the basic knowledge of liquid crystal optoelectronics and the basics of fabrication processes, characterization and performance testing of liquid crystal optoelectronic devices. Students will have in-depth understanding of liquid crystal related physical concepts. It is essential for students to engage in research and development of optical information technology in the future.

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.)

课程将讲授液晶光电子学理论并结合工艺实践，理论课程主要讲述：1）光的偏振（4 学时），2）液晶的基础知识（6 学时），3）光在各向异性介质中的传播和散射（6 学时），4）液晶连续体弹性形变理论（4 学时），5）液晶光场调控技术（4 学时）， 6）液晶材料与显示器（4 学时）， 7）液晶等离激元光子学（4 学时）等；

This course will introduce the basics of liquid crystal optoelectronics and lab practice on the fabrication process, characterization and performance testing of liquid crystal devices. The basics of liquid crystal optoelectronics includes: 1) polarization of optical waves (4 hrs), 2) basics of liquid crystals (6 hrs), 3) light propagation and scattering in anisotropic materials (6 hrs), 4) theory of elastic deformation of liquid crystals (4 hrs), 5）liquid crystal based optical field modulation technologies (4 hrs), 6) liquid crystal materials and displays (4 hrs), 7) liquid crystal plasmonics (4 hrs), etc.

理论课程大纲：

第 1 章光的偏振（4 学时）

介绍光的偏振的基础知识，主要包括光的线偏振、椭圆偏振、以及圆偏振，以及判断光的偏振的基本方法。

Chapter 1 Light polarization (4 credit hours)

This chapter introduces the basic knowledge of the light polarization including linear polarization, elliptical polarization, and circular polarization. The technical differentiation methods of different light polarizations will be also introduced.

第 2 章液晶的基础知识（6 学时）

介绍液晶的基础知识，主要包括液晶的概念和分类， 液晶的基本物理和光学特性以及各种液晶的物理和光学特性的差异。

Chapter 2 Introduction of liquid crystals (6 credit hours)

This chapter introduces the basic knowledge of the liquid crystals including the concept and classifications of liquid crystals, the unique physical and optical properties of liquid crystals, the differences among the different types of liquid crystals.

第 3 章光在各向异性介质中的传播和散射（6 学时）

本章主要介绍从麦克斯韦方程出发，介绍光在各向异性介质中的传播和散射，包括单轴晶体和双轴晶体，介绍利用琼斯矩阵的方法描述光在各向异性介质中的传播。

Chapter 3 Light propagation and scattering in anisotropic media (6 credit hours)

This chapter starts from Maxwell equations to introduce the light propagation and scattering in anisotropic media including uniaxial and biaxial liquid crystals. We will also introduce the utilization of Jones Matrix method to describe the light propagation and scattering in anisotropic media.

第 4 章液晶连续体弹性形变理论（4 学时）

本章主要介绍液晶在外场作用下的弹性形变以及在去除外场作用下的弹性恢复形变，这个弹性形变主要由欧欣—夫兰克（Oseen-Frank）连续体理论描述。这一理论是唯象的研究液晶在外场作用下发生畸变的经典理论，是研究液晶显示行为的理论基础。

Chapter 4 Elastic deformation theory of continuous media (4 credit hours)

This chapter introduces the elastic deformation of liquid crystals under an external field and their relaxation to the original

states after the removal of the externa field. This elastic deformation can be well described by the classical Oseen-Frank theory, which lays the theoretical foundation of the liquid crystal display behaviours.

第 5 章液晶光场调控技术（4 学时）

利用液晶的光学各向异性特性来调制入射光的振幅、相位和偏振特性，属于空域调控，即所谓的液晶光场调控技术。比如具有螺旋相位的涡旋光场、偏振态非均匀分布的矢量光场、振幅和相位随空间变化的艾里（Airy）光场和贝塞尔（Bessel）光场等性质新颖独特的结构光场，是目前液晶光场调控技术的主要研究领域。

Chapter 5 Optical field modulation technologies (4 credit hours)

This chapter introduces how to modulation the amplitude, phase and polarization of the incident light utilizing the unique anisotropic optical properties of liquid crystals. We will list several examples about this modulation technology, like vortex beam generation, nonuniform distributed polarized vectorial optical field generation, Airy and Bessel beam generation, etc.

第 6 章液晶材料与显示器（4 学时）

本章介绍用于显示的几种常用的液晶材料，包括向列相、胆甾相、以及蓝相液晶材料。同时介绍液晶显示的基础知识以及常见的液晶显示类型。

Chapter 6 Liquid crystal materials and displays (4 credit hours)

This chapter introduces several widely used types of liquid crystals including nematic, cholesteric, and blue phase liquid crystals. Meanwhile, we will also introduce the basic knowledge of liquid crystal displays and those widely used types of liquid crystal displays.

第 7 章液晶等离激元光子学（4 学时）

本章主要总结介绍液晶等离激元光子学研究领域的最新进展。该领域是将液晶与金属纳米结构相结合，设计下一代可调谐/可重构的等离激元光子学器件，诸如开关，调制器，滤色器，吸收器等各种有源微纳光子学器件。

Chapter 7 Liquid crystal plasmonics (4 credit hours)

This chapter summarizes the most recent progress of the liquid crystal based active plasmonics. This field is to combine the liquid crystals and plasmonic nanoparticles/nanostructures to design and realize the next generation tunable/reconfigurable nanoplasmonic devices, such as active plasmonic switch, modulator, color filters, absorbers, etc.

实验课程为制作小型器件及其工作性能表征及测试。主要内容包括：1）液晶盒制作及盒厚控制（10 学时），2）液晶可调焦光学透镜的制作、表征和测试（12 学时），3）液晶可调光栅的制作、表征和测试（10 学时）。

The lab practice includes: 1) fabrication of liquid crystal cells and cell thickness control (10 hrs), 2) fabrication, characterization and test of tunable liquid crystal lenses (12 hrs), 3) fabrication, characterization and test of tunable liquid crystal gratings (10 hrs).

实验课程大纲：

实验 1: 液晶盒制作及盒厚控制（10 学时，第 9 周-第 11 周）

根据液晶器件基本原理，制备所需液晶盒；熟练掌握 TN 液晶盒制备工艺；学会判断液晶盒质量。

第 9 周：实验室日常使用基本培训并测试。

第 10 周：学会制备液晶盒；熟练掌握 TN 液晶盒制备工艺；

第 11 周：学会判断液晶盒质量，并能完成盒厚的测试。

Lab 1: Liquid crystal cell fabrication and the control of the cell thickness（10 credit hours, week 9-11）

Based on the basic working principle of liquid crystal displays, students will learn how to fabricate the liquid crystal cells, and the quality judegement of the liquid crystal cells.

Week 9：Basic training of the general lab practice and every student should pass the test of the lab training.

Week 10：Students will learn how to fabricate the liquid crystal cells and practice the fabrication of a TN cell.

Week 11：Students will learn how to judge the quality of the fabricated cells and perform the measurement of the cell thickness experimentally.

实验 2: 液晶可调焦光学透镜的制作、表征和测试（12 学时，第 11 周-第 14 周），

设计和制备液晶可调微透镜；熟练掌握液晶微透镜制备工艺、表征和测试。

第 11 周：设计和制备液晶可调微透镜；讲解可调微透镜的工作原理。

第 12 周：学习并熟练掌握液晶可调微透镜制备工艺。

第 13 周：讲解可调微透镜的基本性能测试原理，学生自己完成可调微透镜的光学表征和测试。

第 14 周：鼓励学生探索可调微透镜的在成像方面的应用和实践。

Lab 2: Liquid crystal tunable microlens fabrication, characterization and testing（12 credit hours, week 11-14）

Students will learn how to design, fabricate, characterize, and test the liquid crystal tunable microlenses.

Week 11：Students will learn the basic working principle of the liquid crystal tunable microlenses and learn how to design them. Finish training and operation of the relevant equipment.

Week 12：Students will learn how to fabricate the liquid crystal tunable microlenses.

Week 13：Explain the measurement principle about the liquid crystal tunable microlenses; Students perform the optical characterization and testing of the liquid crystal tunable microlenses by themselves.

Week 14：Encourage the students to explore the imaging applications of the liquid crystal tunable microlenses and do more practice.

实验 3: 液晶可调光栅的制作、表征和测试（10 学时，第 14 周-第 16 周），

设计和制备液晶可调光栅；熟练掌握液晶可调光栅制备工艺、表征和测试。测量液晶可调光栅随外部电场变化的衍射效率

以及响应时间等。

第 14 周：设计和制备液晶可调光栅；熟练掌握液晶可调光栅制备工艺。

第 15 周：讲解液晶光栅的衍射效率和响应时间的测试原理，以及液晶器件电光测试设备培训和操作。

第 16 周：液晶可调光栅的光学表征、衍射效率以及响应时间的测试。

Lab 3: Liquid crystal tunable grating fabrication, characterization and testing（10 credit hours, week 14-16）

Students will learn how to design, fabricate, characterize, and test the liquid crystal tunable gratings. The diffraction efficiency and response time will be measured under different external electric field.

Week 14：Students will learn how to design and fabricate the liquid crystal tunable gratings.

Week 15：Explain the measurement principle about the diffraction efficiency and response time; Train the students how to use the electro-optical testing equipments.

Week 16：Students will test and measure the diffraction efficiency and response time of the liquid crystal tunable gratings.

教学日历安排

1-16 周，理论课，每周 2 小时，由刘言军主讲。

9-16 周，工艺实践课，每周 4 小时，安排一整个下午，由刘言军主讲，李珂助教带领学生实验。

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

《Optics of Liquid Crystal Displays》 Pochi Yeh and Claire Gu, John Wiley & Sons, Inc., ISBN: 047118201X

《液晶光子学》罗丹等著，电子工业出版社,ISBN：9787121342554

《液晶器件工艺基础》范志新著，北京邮电大学出版社，ISBN：9787563504503

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		30		
小测验 Quiz				
课程项目 Projects		40		
平时作业 Assignments				
期中考试 Mid-Term Test				

期末考试 **Final Exam**				
期末报告 **Final Presentation**		20		
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