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**	光纤通信原理与技术 Fiber Communication Principles and Techniques
2.	**授课院系 Originating Department**	电子与电气工程 Electrical and Electronic Engineering
3.	**课程编号 Course Code**	EE308
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**	春季 Spring
7.	**授课语言 Teaching Language**	中英双语 English & 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）**	罗 丹 副教授 电子与电气工程系 第二科研楼 525 电话： +86-755-88018552 电邮: luo.d@sustc.edu.cn Dr. Dan Luo Associate Professor Department of Electrical and Electronic Engineering, Faculty Research Building 2, room 525 Tel: +86-755-88018552 Email: luo.d@sustc.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	徐琳琳，教学工程师，电子与电气工程系 xull@sustc.edu.cn 15338737651 Linlin Xu, Teaching Engineer, Department of Electrical and Electronic Engineering xull@sustc.edu.cn 15338737651
10.	**选课人数限额(可不填) Maximum Enrolment （Optional）**	50

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		16		48

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	无
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	本课程为光电子和通信专业选修课；其它非光电子和通信专业学生如果想学习光纤通信方面的知识，也可选修本课程。 This course is optional subject for optoelectronics and communications major; other non-optoelectronics and non-communications majors can also select it, if you want to learn fiber optic communications.
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**

本课程适合光电子、通信专业本科三年级。通过该课程的学习，学生将掌握光纤通信的基本原理和技术，了解光纤通信相关的各种器件。了解从光纤结构、光源、光功率发射与耦合、光检测接收到波分复用、光放大器以及非线性效应等知识。

This course is suitable for optoelectronics , communications undergraduate year 3 undergraduate. Through this course, students will master the basic principles and techniques of optical fiber communication , understanding the various components related to optical fiber communication. Learn from the fiber structure , light source, optical power transmission and coupling, optical detector receives, WDM , optical amplifiers, and nonlinear effects of such knowledge .

16. **预达学习成果 Learning Outcomes**

通过该课程的学习，学生将全面的了解和掌握光纤通信的基本知识构架，具备初步的光纤通信基础知识和实验动手能力，能够将理论与实际相结合，具备一定的分析能力，和动手能力。

Through this course , students will fully understand and master the basics of fiber optical communication architecture, and fiber optical communications infrastructure with preliminary knowledge and practical ability , the ability to combine theory and practice , with some analytical skills, and ability.

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.)

Chapter 1: Overview of Optical Fiber Communications

1.1 Basic Network Information Rates
1.2 The Evolution of Fiber Optic Systems
1.3 Elements of an Optical Fiber Transmission Link
1.4 Simulation and Modeling Tools
1.4.1 Characteristics of Simulation and Modeling Tools
1.4.2 Programming Languages
1.4.3 Sample Simulation and Modeling Tool
1.5 Use and Extension of the Book
1.5.1 References
1.5.2 Simulation Program on a CD-ROM
1.5.3 Photonics Laboratory

Chapter 2: Optical Fibers: Structures, Waveguiding, and Fabrication

2.1 The Nature of Light
2.1.1 Linear Polarization
2.1.2 Elliptical and Circular Polarization
2.1.3 The Quantum Nature of Light
2.2 Basic Optical Laws and Definitions
2.3 Optical Fiber Modes and Configurations
2.3.1 Fiber Types
2.3.2 Rays and Modes
2.3.3 Step-Index Fiber Structure
2.3.4 Ray Optics Representation
2.3.5 Wave Representation in a Dielectric Slab Waveguide
2.4 Mode Theory for Circular Waveguides
2.4.1 Overview of Modes
2.4.2 Summary of Key Modal Concepts
2.4.3 Maxwell's Equations
2.4.4 Waveguide Equations
2.4.5 Wave Equations for Step-Index Fibers
2.4.6 Modal Equation
2.4.7 Modes in Step-Index Fibers
2.4.8 Linearly Polarized Modes
2.4.9 Power Flow in Step-Index Fibers
2.5 Single-Mode Fibers
2.5.1 Mode Field Diameter
2.5.2 Propagation Modes in Single-Mode Fibers
2.6 Graded-Index Fiber Structure
2.7 Fiber Materials
2.7.1 Glass Fibers
2.7.2 Halide Glass Fibers
2.7.3 Active Glass Fibers
2.7.4 Chalgenide Glass Fibers
2.7.5 Plastic Optical Fibers
2.8 Fiber Fabrication
2.8.1 Outside Vapor Phase Oxidation
2.8.2 Vapor Phase Axial Deposition
2.8.3 Modified Chemical Vapor Depositionosition
2.8.5 Double-Crucible Method
2.9 Mechanical Properties of Fibers
2.10 Fiber Optic Cables

Chapter 3: Signal Degradation in Optical Fibers

3.1 Attenuation
3.1.1 Attenuation Units
3.1.2 Absorption
3.1.3 Scattering Losses
3.1.4 Bending Losses
3.1.5 Core and Cladding Losses
3.2 Signal Distortion in Optical Waveguides

3.2.1 Information Capacity Determination
3.2.2 Group Delay
3.2.3 Material Dispersion
3.2.4 Waveguide Dispersion
3.2.5 Signal Distortion in Single-Mode Fibers
3.2.6 Polarization-Mode Dispersion
3.2.7 Intermodal Distortion
3.3 Pulse Broadening in Graded-Index Waveguides
3.4 Mode Coupling
3.5 Design Optimization of Single-Mode Fibers
3.5.1 Refractive-Index Profiles
3.5.2 Cutoff Wavelength
3.5.3 Dispersion Calculations
3.5.4 Mode-Field Diameter
3.5.5 Bending Loss

Chapter 4: Optical Sources

4.1 Topics From Semiconductor Physics
4.1.1 Energy Bands
4.1.2 Intrinsic and Extrinsic Material
4.1.3 The pn Junctions
4.1.4 Direct and Indirect Bandgaps
4.1.5 Semiconductor Device Fabrication
4.2 Light-Emitting Diodes (LEDs)
4.2.1 LED Structures
4.2.2 Light Source Materials
4.2.3 Quantum Efficiency and LED Power
4.2.4 Modulation of an LED
4.3 Laser Diodes
4.3.1 Laser Diode Modes and Threshold Conditions
4.3.2 Laser Diode Rate Equations
4.3.3 External Quantum Efficiency
4.3.4 Resonant Frequencies
4.3.5 Laser Diode Structures and Radiation Patterns
4.3.6 Single-Mode Lasers
4.3.7 Modulation of Laser Diodes
4.3.8 Temperature Effects
4.4 Light Source Linearity
4.5 Modal, Partition, and Reflection Noise
4.6 Reliability Considerations

Chapter 5: Power Launching and Coupling

5.1 Source-to-Fiber Power Launching
5.1.1 Source Output Pattern
5.1.2 Power-Coupling Calculation
5.1.3 Power Launching versus Wavelength
5.1.4 Equilibrium Numerical Aperture
5.2 Lensing Schemes for Coupling Improvement
5.2.1 Nonimaging Microsphere
5.2.2 Laser Diode-to-Fiber Coupling
5.3 Fiber-to-Fiber Joints
5.3.1 Mechanical Misalignment
5.3.2 Fiber-Related Losses
5.3.3 Fiber End Face Preparation
5.4 LED Coupling to Single-Mode Fibers
5.5 Fiber Splicing
5.5.1 Splicing Techniques
5.5.2 Splicing Single-Mode Fibers
5.6 Optical Fiber Connectors
5.6.1 Connector Types
5.6.2 Single-Mode Fiber Connectors
5.6.3 Connector Return Loss

Chapter 6: Photodetectors

6.1 Physical Principles of Photodiodes
6.1.1 The pin Photodetector
6.1.2 Avalanche Photodiodes
6.2 Photodetector Noise
6.2.1 Noise Sources
6.2.2 Signal-to-Noise Ratio
6.3 Detector Response Time
6.3.1 Depletion Layer Photocurrent
6.3.2 Response Time
6.4 Avalanche Multiplication Noise
6.5 Structures for InGaAs APDs
6.6 Temperature Effect on Avalanche Gain
6.7 Comparison of Photodetectors

Chapter 7: Optical Receiver Operation

7.1 Fundamental Receiver Operation
7.1.1 Digital Signal Transmission
7.1.2 Error sources
7.1.3 Receiver Configuration
7.1.4 Fourier Transform Representation
7.2 Digital Receiver Performance
7.2.1 Probability of Error
7.2.2 The Quantum Limit
7.3 Detailed Performance Calculation
7.3.1 Receiver Noises
7.3.2 Shot Noise
7.3.3 Receiver Sensitivity Calculation
7.3.4 Performance Curves
7.3.5 Nonzero Extinction ratio
7.4 Preamplifier Types
7.4.1 High-Impedance FET Amplifiers
7.4.2 High-Impedance Bipolar Transistor Amplifiers
7.4.3 Transimpedance Amplifier
7.4.4 High-Speed Circuits
7.5 Analog receivers

Chapter 8: WDM Concepts and Components

8.1 Operational Principles of WDM
8.2 Passive Components
8.2.1 The 2 X 2 Fiber Coupler
8.2.2 Scattering Matrix Representation
8.2.3 The 2 X 2 Waveguide Coupler
8.2.4 Star Couplers
8.2.5 Mach-Zehnder Interferometer Multiplexers
8.2.6 Fiber Grating Filters
8.2.7 Phased-Array-Based WDM Devices
8.3 Tunable Sources
8.4 Tunable Filters
8.4.1 System Considerations
8.4.2 Tunable Filter Types
Problems
References

Chapter 9 - Optical Amplifiers

9.1 Basic Applications and Types of Optical Amplifiers
9.1.1 General Applications

9.1.2 Amplifier Types
9.2 Semiconductor Optical Amplifiers
9.2.1 External Pumping
9.2.2 Amplifier Gain
9.3 Erbium-Doped Fiber Amplifiers
9.3.1 Amplification Mechanism
9.3.2 EDFA Architecture
9.3.3 EDFA Power-Conversion Efficiency and Gain
9.4 Amplifier Noise
9.5 System Applications
9.5.1 Power Amplifiers
9.5.2 In-Line Amplifiers
9.5.3 Preamplifiers
9.5.4 Multichannel Operation
9.5.5 In-Line Amplifier Gain Control
9.6 Wavelength Converters
9.6.1 Optical Gating Wavelength Converters
9.6.2 Wave-Mixing Wavelength Converters

Chapter 10r -Nonlinear Effects

10.1 Nonlinear effects
10.2 Effective length and the effective area of
10.3 Stimulated Raman Scattering
10.4 Stimulated Brillouin Scattering
10.5 Self-phase modulation
10.6 Cross-phase modulation
10.7 FWM
10.8 Reduce FWM
10.9 Wavelength conversion
10.9.1 Optical gate wavelength converter
10.9.2 Wave mixing wavelength converter
10.10 Soliton

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

推荐教材 Textbook：

Gerd Keiser，光纤通讯 （Optical Fiber Communications）,第四版， 电子工业出版社。

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		0%		
课堂表现 Class Performance		0%		
小测验 Quiz		0%		
课程项目 Projects		20%		
平时作业 Assignments		10%		
期中考试 Mid-Term Test				
期末考试		50%		

Final Exam				
期末报告 Final Presentation		**0%**		
实验 Experiments		**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