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	通信原理 Communication Principles
2.	授课院系 **Originating Department**	电子与电气工程系 Department of Electrical and Electronic Engineering
3.	课程编号 **Course Code**	EE206
4.	课程学分 Credit Value	3
5.	课程类别 **Course Type**	专业基础课 Major Foundational 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**）	贡毅教授，电子与电气工程系 Professor GONG Yi, Department of Electrical and Electronic Engineering 第二科研楼 515 室 Rm 515, Faculty Research Building 2 Email: gong.y@sustc.edu.cn Tel: 0755-88018518
9.	实验员/助教、所属学系、联系方式 **Tutor/TA(s), Contact**	吴光，电子与电气工程系 Dr. Guang Wu, Department of Electrical and Electronic Engineering Email: wug@sustech.edu.cn
10.	选课人数限额(可不填) **Maximum Enrolment** （**Optional**）	

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	EE 205 信号与系统 EE 205 Signals and Systems
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	EE 313 无线通信 EE 313 Wireless Communications
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

本课程介绍基本的模拟与数字通信技术，包括模拟幅度调制、模拟频率调制、模拟相位调制、基带和带通数字信号的传输，基本的信噪比分析等。

To introduce the basic concepts in analog and digital communications, including the analog amplitude modulation, analog frequency modulation, analog phase modulation, baseband digital signal transmission and band-pass digital signal transmission, basic analysis of signal-to-noise ratio and etc.

16.   预达学习成果 Learning Outcomes

通过课程的学习，学生将具备如下能力：

1. 理解和掌握模拟通信和数字通信的一些基本概念，包括：幅度调制，频率调制，脉冲模拟调制，采样，量化，数字信号的基带和带通调制。

2. 对上述的通信技术进行信噪比分析。

3. 进行幅度调制，频率调制，脉冲幅度调制，移相键控，频移键控等收发机的若干基础模块的设计。

4. 进一步开展通信工程领域的学习。

After completing this course, the students will be able to

1. Understand the basic concepts and fundamentals of analog and digital communications, including amplitude modulation, frequency modulation, pulse analog modulation, sampling, quantization, bandband and bandpass modulations of digital signals.

2. Conduct the SNR analysis of the above basic communication technologies.

3. Conduct the design of some components in both transmitter and receiver of amplitude modulation, frequency modulation, pulse amplitude modulation, phase shift keying, frequency shift keying and etc.

4. Continue further study on communication engineering.

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.)

Introduction and Revision: Analog vs. digital messages, What is communication? Elements of a communication system, Channel impairments, Definition and purposes of modulation, Types of modulation, Fourier transform, Filters, Signal power.

Amplitude Modulation (AM): Types of AM, Conventional AM, Envelope detection, Spectrum, Single-tone AM, Double-Sideband Suppressed Carrier (DSBSC) AM, Coherent/synchronous demodulation.

AM Related Systems and Applications: Frequency translation, Mixing, Multiplexing, Frequency Domain Multiplexing, De-multiplexing, Quadrature Amplitude Modulation (QAM), QAM modulation and detection.

Noise Performance of AM Signals: Parameters of noise, Power spectral density (PSD), Signal-to-noise ratio (SNR),White noise, bandpass noise, AM receiver model, DSBSC AM with coherent detection, Conventional AM with envelope detection, Threshold effect of envelope detection, Noise analysis.

Basics of Angle Modulation: Angle-Angular frequency-Frequency, Definition of Frequency Modulation (FM), Definition of Phase Modulation (PM), Single-tone modulation, Modulation index of FM, Modulation index of PM, Instantaneous frequency deviation, Instantaneous phase deviation.

Narrow-Band and Wideband FM: Narrow-band FM, Phasor diagram, Wideband FM, Double-sided amplitude spectrum, Properties of $J_n(\beta)$, Bandwidth of FM signals, 1% rule, Carson's rule, Bandwidth of arbitrary FM signals.

FM signals: Generation of Narrow-band FM signals, Generation of Wideband FM signals, Armstrong method, Frequency multiplier, Frequency converter, Direct generation of wideband FM signals，Phase-Lock Loop (PLL), Frequency discrimination, Limiter, DM demodulator model, FM receiver model, PM signal demodulation.

Noise Performance of FM Signals: Capture effect, Demodulated signal power, Demodulated noise power, Noise quieting, Output SNR derivation, FM receiver threshold phenomenon.

Pulse Analog Modulation: Introduction to digital communications, Sampling, Reconstruction, Pulse-amplitude modulation, PAM noise analysis, Time-division multiplexing, Pulse-width modulation, Pulse-position modulation, PPM generation, PPM detection, PPM noise analysis.

Digital Representation of Analog Signal: Quantization, Quantization noise, Pulse code modulation, Line code, Delta modulation.

Baseband Transmission of Digital Signal: Energy signal, Power signal, Gaussian process, Additive white Gaussian noise, Match filter, Probability of error, Bit error rate, Q-function, Inter-symbol interference, Eye pattern, Nyquist's criterion for distortionless transmission, M-ary PAM, tapped-delay-line equalization.

Band-Pass Transmission of Digital Signal: Band-pass transmission model, Phase-shift keying, Frequency-shift keying, Coherent detection of FSK and PSK, M-ary Modulation.

Laboratory：

Lab1: LabVIEW Programming for Communication systems: **1.** Introduction to LabVIEW, **2.** LabVIEW programming (New VI, Data types, Case structure, Loop structure, Waveform display, Modulation Tool Kit, Help documents), **3.** Universal Software Radio Peripheral (USRP) platform.

Lab2: Amplitude Modulation: 1. Pre-Lab (Sampling theory, Spectrum measurement, Wireless channel, Low-pass filter, Interpolation and decimation), **2.** Amplitude Modulation (AM model, AM block diagram, Over modulation), **3.** Amplitude Demodulation (Amplitude demodulation Model, Envelope demodulation block diagram, Power and spectrum efficiency analysis).

Lab3: DSB & SSB Modulation: 1. DSB Modulation (DSB Model, Carrier recover, DSB block diagram, DSB spectrum

analysis), **2.** SSB Modulation (SSB Model, Hilbert transform, SSB block diagram, Comparison with AM and DSB), **3.** SSB Walkie-Talkie Design (SSB Walkie-Talkie model, Performance evaluation).

Lab4: Frequency Modulation: **1.** Pre-Lab (Voltage-Controlled Oscillator, Phase-Locked Loop, Frequency deviation, Carson bandwidth rule), **2.** NBFM/WBFM Modulation (NBFM/WBFM Model, NBFM/WBFM block diagram, Bandwidth Analysis, Noise performance analysis).

Project1: Implementation of FM transceiver using USRP: 1. Introduction to USRP (Most-used USRP functions, Basic Sine Generation VI, RF signal analyzer), **2.** Implementation of FM transceiver (FM complex signal, Resample Waveforms, Numeric Integral, Unwrap Phase, Numeric derivative, Rational resample, Performance evaluation).

Lab5: Pulse Amplitude Modulation: 1. Pre-Lab (A/D Converter, Sampling theory, Aliasing, Flat-Top sampling, Uniform quantization, quantization noise), **2.** Pulse Amplitude Modulation (PAM model, PAM block diagram, Spectrum analysis). **3.** Implementation of PAM with a recorded speech signal.

Lab6: Eye Pattern: 1. Pre-Lab (Inter Symbol Interference (ISI), Pulse shaping filter, Raised cosine function), **2.** Eye Pattern (Sinc Pattern with different raised cosine function factor, Bandwidth and ISI analysis).

Lab7: ASK Modulation: 1. Pre-Lab **(**2-ASK/4-ASK/OOK modulation/demodulation), **2.** 2-ASK/4-ASK (2-ASK/4-ASK model and block diagram, Bit-Error-Rate analysis for different values of SNR).

Lab8: M-PSK Modulation: 1. Pre-Lab **(**Band-Pass transmission system, Phase Shift Keying (PSK), BPSK/QPSK modulation and demodulation, Constellation), **2.** BPSK/QPSK (BPSK/QPSK modulation and demodulation model and block diagram, Bit-Error-Rate analysis for different values of EbNo, Constellation analysis).

Project2: Text/Image transmission using USRP: 1. Pre-Lab (Digital transceiver system, Packet format, Text Coding). 2. Implementation (Design 4-PSK/8-PSK/16-PSK modulation and demodulation block diagrams using modulation toolkit, Verification using USRP, Bit-Error-Rate analysis for different values of EbNo, Constellation analysis).

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

Simon Haykin and Michael Moher , Communication Systems （International Student Version）, 5th Edition, John Wiley & Sons, ISBN: 978-0-470-16996-4.

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**				

课堂表现 **Class Performance**			
小测验 **Quiz**			
课程项目 **Projects**	30		Lab
平时作业 **Assignments**	10		
期中考试 **Mid-Term Test**	25		
期末考试 **Final Exam**	35		
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**

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课程审批 **REVIEW AND APPROVAL**

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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