

## 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>	信号分析与数据处理 Signal Analysis and Data Processing
2.	<b>授课院系 Originating Department</b>	地球与空间科学系 Department of Earth and Space Sciences
3.	<b>课程编号 Course Code</b>	ESS405
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业选修课 Major Elective 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>	韩鹏, 地球与空间科学系 邮箱: hanp@sustech.edu.cn 电话: 0755-88015515 办公室: 创园 9 栋 307 Peng Han, Department of Earth and Space Sciences Email: hanp@sustech.edu.cn Tel: 0755-88015515 Office: Innovation Park #9-307
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	MA101B 高等数学(上) A、MA103A 线性代数 I-A MA101B Calculus I A and MA103A Linear Algebra I-A				
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

本课程主要讲授数字信号采集、处理的基本理论、方法以及观测数据的去噪、时频分析等，并对前沿的数据处理方法进行介绍。为本专业学生了解地球物理数据的采集过程、原理及地球物理专业数据分析提供基础知识和理论储备。

This is a specialized course for students in Geophysics or other related areas. This course mainly focuses on the fundamental theory of signal acquisition and processing, denoising, time-frequency analysis. It also introduces frontier data analysis methods. Students are expected to gain insights into the theory of signal processing, and abilities to apply them to specific problems in Geophysical or other related areas, particularly know how to conduct time-frequency analysis and filtering to improve SNR.

#### 16. 预达学习成果 Learning Outcomes

学生完成本课程后，将会掌握以下知识：

1. 离散时间信号与系统的基本概念和理论；
2. Fourier-变换，Z-变换，Laplace-变换；
3. 采样定理，频率混叠与泄露；
4. 滤波器的原理及特征；
5. 时频分析方法（短时傅里叶变换，Gabor 变换，小波变换等）；
6. 相关性分析及功率谱估计；
7. 主成分分析、独立成分分析。

Upon completing the course, students will be able to:

1. Understand the fundamental theory of discrete time signals and systems;
2. Understand Fourier transforms, z-transforms, and Laplace transforms;
3. Know sampling theorem, aliasing, and leakage;
4. Understand the principle and characteristics of digital filters;
5. Apply time-frequency analysis method (STFT, Gabor transform, Wavelet transform, HHT, etc.);
6. Correlation analysis and power spectrum estimation;

7. Know about frontier of data processing such as PCA, ICA, and compressed sensing.

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.)**

**第一章：引言（2 学时）**

介绍课程的讲授内容、目的及这门课的学习方法。讲授信号处理发展历史。

**第二章：信号与系统（4 学时）**

基本信号类型，信号与系统的表示，系统的分类。

**第三章：差分方程与卷积（6 学时）**

系统的差分方程、脉冲响应，卷积定理，系统的输出计算。

**第四章：Laplace 变换（4 学时）**

Laplace 变换及反变换，Laplace 变换的性质，使用 Laplace 变换求解差分方程。

**第五章：Z 变换（4 学时）**

Z 变换及反变换，Z 变换的性质及收敛域，Z 变换的零点和奇点，系统的传递函数。

**第六章：Fourier 变换（6 学时）**

Fourier 级数，Fourier 变换及反变换，Fourier 变换的性质，信号调制与解调，系统的频率响应，快速 Fourier 变换的实现。

**第七章：采样定理（4 学时）**

采样定理，频率混叠与泄露，加窗 Fourier 变换。

**第八章：滤波器的原理及特征（4 学时）**

有限冲激响应滤波器与无限冲激响应滤波器，滤波器的 matlab 实现。

**第九章：时频分析（6 学时）**

短时傅里叶变换，Gabor 变换，小波变换原理及其 matlab 实现。

**第十章：相关性分析及功率谱估计（4 学时）**

相关系数，自相关，互相关，自功率谱密度，互功率谱密度。

**第十一章：多元统计分析及压缩感知（4 学时）**

主成分分析、独立成分分析、压缩感知基本原理及应用。

**Chapter 1: Introduction(2 hours)**

The contents and objectives of this course, study method, history of signal processing.

**Chapter 2: Signal and system (4 hours)**

Basic concepts and types of signals and systems, their representation.

**Chapter 3: Difference equation and convolution (6 hours)**

System difference equation, impulse response, convolution theorem, computation of system outputs.

**Chapter 4: Laplace transform (4 hours)**

Laplace transform and inverse transform, properties, solve difference equations using Laplace transform.

**Chapter 5: Z transform (4 hours)**

Z transform and inverse transform, properties, region of convergence, zeros and poles, system transfer function.

**Chapter 6: Fourier transform (6 hours)**

Fourier series, Fourier transform and inverse transform, properties, signal modulation and demodulation, frequency response, fast Fourier transform.

**Chapter 7: Sampling theorem (4 hours)**

Sampling theorem, aliasing and leakage, windowed Fourier transform.

**Chapter 8: Principle and characteristics of filter (4 hours)**

Finite impulse response filter (FIR) and infinite impulse response filter (IIR), realization of filters by MATLAB.

**Chapter 9: Time-frequency analysis (6 hours)**

Short-term Fourier transform, Gabor transform, Wavelet transform and their realization by MATLAB.

**Chapter 10: Correlation analysis and power spectrum estimation (4 hours)**

Correlation coefficient, autocorrelation, cross correlation, auto-power spectral density, cross power spectral density.

**Chapter 11: Multivariate statistical analysis and compressed sensing (4 hours)**

Principle component analysis (PCA), Independent component analysis (ICA), basic principle and application of compressed sensing.

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

1. Oppenheim, Alan V., Ronald W. Schaffer, and John R. Buck. Discrete-Time Signal Processing. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1999. ISBN: 9780137549207.
2. 程佩青. 《数字信号处理教程》. 第三版. 北京: 清华大学出版社, 2007.
3. 万永革. 《数字信号处理的 MATLAB 实现》. 第二版. 北京: 科学出版社, 2012.

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		30		
平时作业 Assignments		20		
期中考试 Mid-Term Test				
期末考试 Final Exam		40		
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)				

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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