

数字信号处理 教学大纲

Digital Signal Processing Subject Syllabus

一、课程信息 Subject Information

课程编号: Subject ID	3100113013	开课学期: Semester	2
课程分类: Category	公共基础 GF	所属课群: Section	专业基础 MF
课程学分: Credit Points	2.5	总学时/周: Total Hours/Weeks	40
理论学时: LECT. Hours	32	实验学时: EXP. Hours	8
PBL 学时: PBL Hours	0	实践学时/周: PRAC. Hours/Weeks	0
开课学院: College	东北大学 悉尼智能科技学院	适用专业: Stream	通信工程 CE
课程属性: Pattern	必修 Compulsory	课程模式: Mode	自建 NEU
中方课程协调人: NEU Coordinator	刘健 Liu Jian	成绩记载方式: Result Type	百分制 Marks
先修课程: Requisites	复变函数、信号与系统 Complex change function, Signal and System		
英文参考教材: EN Textbooks	Cheng Peiqing, digital Signal Processing Course (fifth edition), Tsinghua University University Press, 2017		
中文参考教材: CN Textbooks	Cheng Peiqing, digital Signal Processing Course (fifth edition), Tsinghua University University Press, 2017 程佩青著,《数字信号处 理教程》(第五版),清华大学大学出版社, 2017		
教学资源: Resources	程佩青:《数字信号处理教程》(第三版),清华大学出版社,2008 程佩青:《数字信号处理教程》(第四版),清华大学出版社,2013 丁玉美,高西全:《数字信号处理(第三版)》,西安电子科技大学 出版社,2009		
课程负责人(撰写人): Subject Director	刘健 Liu Jian	提交日期: Submitted Date	4/1/2023
任课教师(含负责人): Taught by	刘健, 曹亚丽 Liu Jian, Cao Yali		
审核人: Checked by	韩鹏	批准人: Approved by	史闻博
		批准日期: Approved Date	9/1/2023

二、教学目标 Subject Learning Objectives (SLOs)

注：毕业要求及指标点可参照悉尼学院本科生培养方案，可根据实际情况增减行数

Note: GA and index can be referred from undergraduate program in SSTC website. Please add/reduce lines based on subject.

<p>整体目标: Overall Objective</p>	<p>本课程是大学本科通信工程专业必修的专业基础课程。通过本课程的学习，一方面加深对“信号与系统”课程的理解和扩展其知识领域，另一方面为数字信号处理理论与技术、通信理论与技术、无线电技术、数字图像处理等专业课打下良好的基础。本课程系统地讲授数字信号处理的基本理论、基本分析方法、基本算法和基本实践方法，使学生掌握离散时间信号与系统的基本理论，即离散时间信号与系统、Z 变换及离散傅立叶变换；掌握各种快速傅立叶变换算法；掌握数字滤波器的结构、理论，掌握 IIR 数字滤波器和 FIR 数字滤波器的理论和设计方法。</p> <p>This course is a required professional basic course for the university undergraduate communication engineering major. Through the study of this course, on the one hand, I will deepen my understanding of the "Signal and System" course and expand its knowledge field, on the other hand, I will lay a good foundation for digital signal processing theory and technology, communication theory and technology, radio technology, digital image processing and other professional courses.</p> <p>This course systematically teaches the basic theory, basic analysis method, basic algorithm and basic practice method of digital signal processing, so that students can master the basic theory of discrete time signal and system, namely discrete time signal and system, Z transform and discrete Fourier transform; master various fast Fourier transform algorithms; master the structure and theory of digital filter, and master the theory and design method of IIR digital filter and FIR digital filter.</p>	
<p>(1) 专业目标: Professional Ability</p>	<p>1-1</p>	<p>掌握数字信号处理在人类生活和社会发展中的重要地位和作用，了解数字信号处理发展史以及数字信号处理特点及应用。</p> <p>Master the important position and role of digital signal processing in human life and social development, understand the development history of digital signal processing and the characteristics and application of digital signal processing.</p>
	<p>1-2</p>	<p>系统地掌握有关数字信号处理的基本概念、基本现象、基本规律和基本方法，并牢固掌握离散时间信号与系统的基本理论，即离散时间信号与系统、Z 变换及离散傅立叶变换、各种快速傅立叶变换算法；理解和熟悉数字滤波器的结构、理论，掌握 IIR 数字滤波器和 FIR 数字滤波器的理论和设计方法。</p> <p>Systematically master the basic concepts, basic phenomena, basic laws and basic methods of digital signal processing, and firmly grasp the basic theories of discrete time signal and system, namely, discrete time signal and system, Z transform and discrete Fourier transform, and various fast Fourier transform algorithms; understand and be familiar with the</p>

		structure and theory of digital filter, and master the theory and design methods of IIR digital filter and FIR digital filter.
	1-3	在掌握数字信号处理领域科学基础的同时,通过科学思维方法的训练,培养学生运用科学原理解决实际问题的工程能力,为将来从事数字信号处理系统设计及研发奠定必要的基础。 While mastering the scientific foundation of the field of digital signal processing, students can cultivate the engineering ability of using scientific principles to solve practical problems through the training of scientific thinking methods, so as to lay a necessary foundation for the design and development of digital signal processing system in the future.
(2) 德育目标: Essential Quality	2-1	培养科学与工程应用的意识和素质,逐步培养学生的探索精神和创新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability.
	2-2	能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context..

课程教学目标与毕业要求的对应关系 Matrix of GA & SLOs

毕业要求 GA	指标点 GA Index	教学目标 SLOs
毕业要求 1:掌握数学与自然科学知识,具备较强的数学分析、数值计算能力和分析与解决复杂工程问题的能力。	1-1 掌握数学、自然科学、工程基础和专业知识,并能够将其运用到通信工程相关问题的描述中。	1-1 1-2
	1-2 能够针对实际通信工程问题设计相关方案,并运用数学方法分析解决。	1-2 1-3
毕业要求 2:具有健全的人格、良好的人文素质和道德修养,富有创新精神.	2-3 具备科学的世界观、人生观和价值观。	1-1
毕业要求 4:掌握通信原理、信号与系统分析、通信电子线路等通信领域的基本理论和基本知识,具备通信系统功能模块的设计与开发能力。	4-2 掌握本专业的工程实践中涉及的重要工程技术指标,具备通信系统设计与开发的能力。	1-1 1-2 1-3
毕业要求 8:具有较强工程实践能力,能在通信工程、电子与计算机应用技术等领域	8-1 熟悉相通信工程、电子与计算机应用技术等领域的工程指标。	1-1 1-2

域，从事工程设计、设备研发、技术创新和科学研究的能力。	8-2 具备工程实践和科学研究的能力。	1-3 2-1
毕业要求 10: 具有良好的团队协作意识、组织管理能力和社会适应能力。	10-2 能够理解团队合作对于项目的意义，积极在团队中发挥作用、体现能力。	2-1 2-2

三、教学内容 Content (Topics)

注：以中英文填写，各部分内容的表格可根据实际知识单元数量进行复制、扩展或缩减

Note: Filled in both CN and EN, extend or reduce based on the actual numbers of knowledge unit

(1) 理论教学 Lecture

知识单元序号: Knowledge Unit No.	1	支撑教学目标: SLOs Supported	1-1
知识单元名称 Unit Title	绪论 Introduction		
知识点: Knowledge Delivery	数字信号处理基本组成 Basic composition of digital signal processing		
	数字信号处理的特点及其应用 Characteristics of digital signal processing and their applications		
学习目标: Learning Objectives	了解: Recognize	了解信号的分类 Recognize the classification of signals	
	理解: Understand	理解数字信号处理组成及其每部分的作用。 Understand the composition of digital signal processing and the role of each part.	
德育目标 Moral Objectives	培养科学与工程应用的意识和素质，逐步培养学生的探索精神和创新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability. 能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context..		
重点: Key Points	数字信号处理基本组成框图及每部分的作用 The basic composition of digital signal processing block diagram and the function of each part		
难点: Focal points	数字信号处理基本组成框图 Basic composition block diagram of digital signal processing		

知识单元序号: Knowledge Unit No.	2	支撑教学目标: SLOs Supported	1-2 1-3
知识单元名称 Unit Title	离散时间信号与系统 Discrete-time signals with the system		
知识点: Knowledge Delivery	序列的基本运算 The basic operation of the sequence		
	线性移不变系统的判定 Judgment of the linear shift-invariant system		
	常系数线性差分方程的迭代求解法—求单位抽样响应 Iterative solution of linear difference equation with constant coefficient- -find unit sampling response		
	连续时间信号的抽样 Sampling of the continuous-time signals		
学习目标: Learning Objectives	了解: Recognize	连续时间信号的理想抽样 Ideal sampling of the continuous-time signal	
	理解: Understand	序列的运算 The operation of the sequence	
	掌握: Master	深入理解系统的线性、移不变、因果、稳定的判定； 熟练常系数线性差分方程的迭代求解法—求单位抽样响应。 Understand linear, shift, causality and stability of linear difference equation- -unit sampling response.	
德育目标 Moral Objectives	培养科学与工程应用的意识和素质，逐步培养学生的探索精神和创新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability. 能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context..		
重点: Key Points	序列的基本运算；系统线性、移不变、因果稳定的判定；抽样定理。 Basic operation of sequence; determination of system linear, shifting and causal stability; sampling theorem.		
难点: Focal points	序列线性卷积和运算；系统因果稳定的判定 Sequence linear convolution and operation; determination of system causal stability		

知识单元序号: Knowledge Unit No.	3	支撑教学目标: SLOs Supported	1-2,1-3
知识单元名称 Unit Title	z 变换与离散时间傅里叶变换 Z-transform with a discrete-time Fourier transform		
知识点: Knowledge Delivery	序列的 z 变换与连续信号拉氏变换和傅里叶变换的关系 Z-transformation of the sequence versus the continuous signal Lazherian and Fourier transforms		
	序列 z 变换及收敛域; z 变换的基本性质和定理 Sequence z-transformation and convergence domain; basic properties and theorems of z-transform		
	序列的傅里叶变换 The Fourier transform of the sequence		
	离散系统的系统函数、系统的频率响应 System function of the discrete system, the frequency response of the system		
学习目标: Learning Objectives	了解: Recognize	z 变换与离散时间傅里叶变换 Z-transform with a discrete-time Fourier transform	
	理解: Understand	序列的 Z 变换与连续信号的拉普拉斯变换、傅立叶变 换的关系 The relation of the Z transform of the sequence to the Laplace transform, the Fourier transform of the continuous signal	
	掌握: Master	序列的傅立叶变换和变换性质; 掌握离散系统的系统 函数、系统的频率响应 Fourier transform and transform properties of sequence; master the system function and frequency response of discrete system	
德育目标 Moral Objectives	培养科学与工程应用的意识和素质, 逐步培养学生的探索精神和创 新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability. 能够在多学科背景下的团队中承担个体、团队成员以及负责人的角 色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context		
重点: Key Points	序列 z 变换及其收敛域的求解; 序列的 Z 变换与连续信号的拉普拉斯变换、傅立叶变换的关系; 序列的傅里叶变换及其性质。 The solution of the sequence z-transformation and its convergence domain; The relationship between the Z transformation of the sequence and the Laplace transform and the Fourier transform of the continuous signal; The Fourier transform of the sequences and their properties.		

难点: Focal points	序列的 Z 变换与连续信号的拉普拉斯变换、傅立叶变换的关系 The Relation of the Z transform of the sequence to the Laplace transform, the Fourier transform of the continuous signal
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知识单元序号: Knowledge Unit No.	4	支撑教学目标: SLOs Supported	1-2,1-3
知识单元名称 Unit Title	离散傅里叶变换(DFT) Discrete Fourier Transform (DFT)		
知识点: Knowledge Delivery	傅立叶变换的几种形式 (傅立叶变换、傅立叶级数、序列的傅立叶变换、离散傅立叶变换) Several forms of the Fourier transform (Fourier transform, Fourier series, Fourier transform of the sequence, discrete Fourier transform)		
	周期序列的离散傅里叶级数及其性质 Discrete Fourier series of the periodic sequences and their properties		
	离散傅里叶变换及其性质 Maximum power transfer for DC circuits		
	利用 DFT 计算模拟信号的 FT 对时会出现的问题 Problems that arise when calculating the FT pairs of simulated signals using the DFT		
学习目标: Learning Objectives	理解: Understand	理解周期序列的频谱特点, 能用 DFS 和 DFT 分析周期序列的频谱, 会画频谱图; 理解非周期序列的频谱特点, 能用 DTFT 和 DFT 分析非周期信号的频谱, 会画频谱图; 理解 DFT 的意义和应用; 理解和掌握圆周运算; 理解和掌握 DFT 变换对逼近连续时间信号及其频谱的基本方法、出现的问题和解决方法; 理解和掌握序列的 DTFT、DFS、DFT、z 变换的含义和关系。 Understand the spectrum characteristics of periodic sequence, be able to analyze the spectrum spectrum with DFS and DFT, understand the spectrum characteristics of aperiodic sequence, analyze the spectrum of Aperiodic signal with DTFT and DFT, draw the spectrum map; understand the meaning and application of DFT, understand and master the circular operation; understand and master DFT transform to approximate the continuous time signal and the problem and solve the spectrum; understand and master the meaning and relationship of DTFT, DFS, DFT and z transformation.	
德育目标 Moral Objectives	培养科学与工程应用的意识和素质, 逐步培养学生的探索精神和创新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability.		

	能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context
重点: Key Points	傅里叶变换的 4 种可能形式; 周期序列与有限长序列的关系; 序列的圆周运算和圆周对称分解; 圆周卷积和与线性卷积和的关系; DFS 和 DFT 的定义、基本性质; 利用 DFT 变换对逼近连续时间信号及其频谱的基本方法及其出现的问题和解决方法。 The 4 possible forms of the Fourier transform; The relation between periodic sequence and finite length sequence; circular operation and symmetric decomposition of circular sequence; the relationship between circular convolution and linear convolution sum; Definition and basic nature of DFS and DFT; Using the DFT transform to approximate the continuous time signal and its frequency spectrum and its emerging problems and solutions.
难点: Focal points	DTFT、DFS、DFT 和 z 变换的意义和相互关系; DFT 变换对的隐含周期性; 圆周运算的基本规则; 连续时间信号及其频谱的近似分析方法。 Meaning and mutual relationship of DTFT, DFS, DFT and z-transform; Implied periodicity of DFT transformation pair; basic rules of circular operation; Approximate analysis method for the continuous-time signal and its frequency spectrum.

知识单元序号: Knowledge Unit No.	5	支撑教学目标: SLOs Supported	1-2,1-3
知识单元名称 Unit Title	快速傅里叶变换(FFT) Fast Fourier transform (FFT)		
知识点: Knowledge Delivery	快速傅立叶变换算法的基本发展思路 Basic development idea of the fast Fourier transform algorithm		
	按时间抽选的基-2 FFT 算法 Base-2 FFT algorithm selected by time		
	按频率抽选的基-2 FFT 算法 Base-2 FFT algorithm selected by frequency		
	离散傅立叶反变换 (IDFT) 的快速计算方法 Fast calculation method of discrete Fourier transform (IDFT)		
学习目标: Learning Objectives	掌握: Master	掌握快速傅立叶变换算法的基本发展思路; 理解按时间抽选的基-2 FFT 算法的特点、流图; 掌握按频率抽	

	<p>选法与按时间抽选法的异同；掌握用圆周卷积代替线性卷积的条件；理解离散傅立叶反变换（IDFT）的快速计算方法。</p> <p>Understand the basic development idea of fast Fourier transform algorithm; understand the characteristics and flow diagram of base-2 FFT algorithm selected by time; master the similarities and differences between frequency selection method and time selection method; master the conditions of replacing linear convolution; and understand the fast calculation method of discrete Fourier reverse transform (IDFT).</p>
<p>德育目标 Moral Objectives</p>	<p>培养科学与工程应用的意识和素质，逐步培养学生的探索精神和创新能力。</p> <p>Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability.</p> <p>能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。</p> <p>Enable to assume roles as individuals, team members and principals in a multidisciplinary context</p>
<p>重点: Key Points</p>	<p>直接计算 DFT 的运算量</p> <p>Calculate the amount of DFT directly</p>
	<p>利用旋转因子的性质减少 DFT 运算量的基本方法</p> <p>Basic method to reduce the amount of DFT operations using the properties of rotation factors</p>
	<p>FFT 的意义</p> <p>The meaning of FFT</p>
	<p>DIT 和 DIF 基-2 FFT 算法原理、基本蝶形运算单元、信号流图、特点和基本规则</p> <p>Principle of DIT and DIF base-2 FFT algorithm, basic butterfly operation unit, signal flow diagram, characteristics and basic rules</p>
	<p>线性卷积的快速算法</p> <p>Fast algorithm for the linear convolution</p>
<p>难点: Focal points</p>	<p>旋转因子的意义及其性质</p> <p>Significance of the rotation factor and its properties</p>
	<p>DIT 和 DIF 基-2 FFT 的算法规则</p> <p>Algorithmic rules for both DIT and DIF-based-2 FFT</p>

知识单元序号: Knowledge Unit No.	6	支撑教学目标: SLOs Supported	1-2,1-3
知识单元名称 Unit Title	数字滤波器的基本结构 Basic structure of the digital filters		
知识点: Knowledge Delivery	数字滤波器结构的表示方法 Representation method of the digital filter structure		
	IIR 滤波器的基本结构 Basic structure of the IIR filter		
	FIR 滤波器的基本结构 Basic structure of the FIR filter		
学习目标: Learning Objectives	掌握: Master	<p>熟悉数字滤波器的方框图和信号流图的表示方法；理解 IIR 和 FIR 数字滤波器的特点；理解并掌握 IIR 和 FIR 数字滤波器的基本结构及其特点，并会画各种结构图；理解线性相位的概念和约束条件。</p> <p>Be familiar with the representation of box diagram and signal flow diagram of digital filters; understand the characteristics of IIR and FIR digital filters; understand and master the basic structure and characteristics of IIR and FIR digital filters, and draw various structural drawings; understand the concepts and constraints of linear phase.</p>	
德育目标 Moral Objectives	<p>培养科学与工程应用的意识和素质，逐步培养学生的探索精神和创新能力。</p> <p>Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability.</p> <p>能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。</p> <p>Enable to assume roles as individuals, team members and principals in a multidisciplinary context</p>		
重点: Key Points	<p>数字滤波器的信号流图； IIR 和 FIR 数字滤波器的差分方程、结构类型、系统函数及其零点极点分布特点； IIR 数字滤波器的直接型、级联型和并联型结构及其特点； FIR 数字滤波器的直接型、级联型、频率抽样型结构和线性相位结构及其特点。</p> <p>Signal flow diagram of the digital filter; Difference equation, structure type, system function and zero-pole distribution characteristics of IIR and FIR digital filters; Direct, cascade and parallel structure of IIR digital filter and its characteristics; Direct type, cascade type, frequency sampling type structure and linear phase structure of FIR digital filter and their characteristics.</p>		

难点: Focal points	IIR 和 FIR 数字滤波器的特点; 线性相位 FIR 数字滤波器的约束条件; IIR 和 FIR 数字滤波器各种结构的特点。 Features of the IIR and FIR digital filters; Constraints for the linear phase FIR digital filter; Features of the various structures of the IIR and FIR digital filters.
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知识单元序号: Knowledge Unit No.	7	支撑教学目标: SLOs Supported	1-2,1-3
知识单元名称 Unit Title	无限长单位冲激响应 (IIR) 数字滤波器的设计方法 Design method of infinite length unit impulse response (IIR) digital filter		
学习目标: Learning Objectives	掌握: Master	掌握最小与最大相位延时系统的特点和系统函数的零极点分布; 理解和掌握全通系统的作用、系统函数及其零极点分布特点; 理解和掌握冲激响应不变法和双线性变换法实现 s 域到 z 域映射的基本思想和特点, 会计算; 了解各种典型类型模拟滤波器的频谱特点和设计方法。 Master the characteristics of the minimum and maximum phase delay systems and the zero pole distribution of system functions; understand and master the functions, system functions and their zero pole distribution characteristics; understand and master the basic ideas and characteristics of s-to-z-field mapping, and understand the spectrum characteristics and design methods of various typical types of analog filters.	
德育目标 Moral Objectives	培养科学与工程应用的意识和素质, 逐步培养学生的探索精神和创新能力。 Cultivate the consciousness and quality of science and engineering application, and gradually cultivate the students' exploration spirit and innovation ability. 能够在多学科背景下的团队中承担个体、团队成员以及负责人的角色。 Enable to assume roles as individuals, team members and principals in a multidisciplinary context		
重点: Key Points	最小与最大相位延时系统及其系统函数零极点的分布特点; 全通系统及其应用; 冲激响应不变法、双线性变换法的映射原理和优缺点。 Distribution characteristics of the minimum and maximum phase delay system and its system function zero pole; All-pass system and its application; Mapping principle and disadvantages of impulse response and bilinear method.		
难点: Focal points	最小与最大相位延时系统的理解; 全通系统及作用的理解; 冲激响应不变法和双线性变换法的特点。		

	Understanding of minimum and maximum phase delay system; understanding of all-pass system and function; Characteristics of impulse response and bilinear transformation method.
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知识单元序号: Knowledge Unit No.	8	支撑教学目标: SLOs Supported	1-2,1-3 2-2-1 2-2
知识单元名称 Unit Title	有限长单位冲激响应 (FIR) 数字滤波器的设计方法 Design method of finite length unit impulse response (FIR) digital filter		
知识点: Knowledge Delivery	线性相位 FIR 滤波器的特点 Magnetic induction and ideal transformers		
	窗函数设计法 Window function design method		
	IIR 和 FIR 数字滤波器的比较 Comparison of the IIR and FIR digital filters		
学习目标: Learning Objectives	掌握: Master	掌握线性相位的概念和线性相位 FIR 数字滤波器的时域约束、系统函数的零点分布特点、频谱的幅度和相位函数的特点, 以及线性相位结构, 会计算和画图; 掌握常用窗函数的特点, 会根据线性相位 FIR 数字滤波器的性能指标要求选择适当的窗函数及其参数, 会计算; 了解 IIR 和 FIR 数字滤波器的异同点。 Master the concept of linear phase and time domain constraints of linear phase FIR digital filter, zero distribution characteristics of system function, amplitude and phase function, and linear phase structure, calculate and draw, select the appropriate window function and its parameters according to the performance index requirements of linear phase FIR digital filter, and understand the similarities and differences of IIR and FIR digital filters.	
德育目标 Moral Objectives	最小与最大相位延时系统及其系统函数零极点的分布特点; 全通系统及其应用; 冲激响应不变法、双线性变换法的映射原理和优缺点。 Distribution characteristics of the minimum and maximum phase delay system and its system function zero pole; All-pass system and its application; Mapping principle and disadvantages of impulse response and bilinear method.		
重点: Key Points	线性相位 FIR 数字滤波器的特点、时域约束; 线性相位 FIR 数字滤波器的幅度函数、相位函数的 4 种情形及其特点; 线性相位 FIR 数字滤波器的 z 域特点; 窗函数设计法; IIR 和 FIR 数字滤波器的比较。		

	<p>Mutual inductance, Principle of transformer</p> <p>Characteristics and time-domain constraints of the linear phase FIR digital filter;</p> <p>Four kinds of amplitude function and phase function of linear phase FIR digital filter;</p> <p>Z-domain characteristics of the linear phase FIR digital filter;</p> <p>Window function design method;</p> <p>Comparison of the IIR and FIR digital filters.</p>
<p>难点: Focal points</p>	<p>线性相位的理解;</p> <p>窗函数设计法的性能分析;</p> <p>窗函数及其参数的选择</p> <p>Understanding of the linear phase;</p> <p>Performance analysis of the window function design method;</p> <p>Selection of the window function and its parameters</p>

(2) 实验教学 Experiments

注：可根据实际情况增减行数。实验类型可分为验证性、设计性、综合性，实验性质可分为选做、必做。

Note: Please add/reduce lines based on subject. The Type contains Verify, Design, and Comprehensive, while the Pattern contains Required and Elective

序号 No.	实验项目名称 Experiment Topic	学时 Hours	每组人数 MPG*	实验类型 Type	实验性质 Pattern
1	时域离散信号的基本运算 Basic operation of the time-domain discrete signals	2	1	综合性 Comp	必做 Elec
2	离散傅里叶变换 discrete Fourier transform	2	1	综合性 Comp	必做 Elec
3	IIR 数字滤波器的设计 Design of the IIR digital filter	2	1	综合性 Comp	必做 Elec
4	FIR 数字滤波器的设计 Design of the FIR digital filter	2	1	综合性 Comp	必做 Elec
	总计 Total	8			

*MPG: Members per group

实验项目序号: Experiment No.	1	支撑教学目标: SLOs Supported	1-1 1-2,1-4
每组成员: Members per Group	1	指导教师: Tutor	曹亚丽
实验名称: Experiment Title	时域离散信号的基本运算 Basic operation of the time-domain discrete signals		
实验内容:	掌握常用的时域离散信号主要有单位抽样序列、单位阶跃序列、实		

Content	指数序列、复指数序列、正（余）弦序列、锯齿波序列、矩形波序列以及随机序列等典型信号。 The commonly used time-domain discrete signals mainly include unit sampling sequence, unit step sequence, real index sequence, complex index sequence, string sequence of positive (residual) sequence, zigzag wave sequence, rectangular wave sequence and random sequence and other typical signals.
学习目标: Learning Objectives	了解常用的时域离散信号及其特点。 掌握 MATLAB 产生常用时域离散信号的方法。 Understand the common time-domain discrete signals and their characteristics. Master the method of MATLAB in generating common time-domain discrete signals.
教学要求: Requirements	达到熟练掌握各种时域离散信号的产生、特点、运算及使用。 To master the production, characteristics, operation and use of various time-domain discrete signals.
实验场地: Location	综合楼 1112; comprehensive building 1112
实验软硬件设备: Software/Hardware	微型计算机 microcomputer

实验项目序号: Experiment No.	2	支撑教学目标: SLOs Supported	1-3,1-4
每组成员: Members per Group	1	指导教师: Tutor	曹亚丽
实验名称: Experiment Title	离散傅里叶变换 discrete Fourier transform		
实验内容: Content	熟练掌握离散时间傅里叶变换的求法和逆变换的求法 Master the search method of discrete time Fourier transform and the inverse transform search method		
	掌握 FFT 的实现及应用 Master the implementation and application of FFT		
学习目标: Learning Objectives	加深对离散傅里叶变换（DFT）基本概念的理解。 了解有限长序列傅里叶变换(DFT)与周期序列傅里叶级数（DFS）、离散时间傅里叶变换（IDFT）的联系。 掌握用 MATLAB 语言进行离散傅里叶变换和逆变换的方法以及 FFT 的程序实现过程。 Deepen the understanding of the basic concepts of discrete Fourier transform (DFT). Understand the connection of finite long sequence Fourier transform (DFT) and periodic sequence Fourier series (DFS), discrete time Fourier transform (IDFT). Master the method of discrete Fourier transform and inverse transform in MATLAB language and the program implementation process of		

	FFT.
教学要求: Requirements	掌握有限长序列和无限长序列的傅里叶变换(DFT)、逆变换(IDFT)和 FFT Master the Fourier transform (DFT), inverse transform (IDFT) and FFT of finite and infinite long sequences
实验场地: Location	综合楼 1112; comprehensive building 1112
实验软硬件设备: Software/Hardware	微型计算机 microcomputer

实验项目序号: Experiment No.	3	支撑教学目标: SLOs Supported	1-2 1-3
每组成员: Members per Group	1	指导教师: Tutor	曹亚丽
实验名称: Experiment Title	IIR 数字滤波器的设计 Design of the IIR digital filter		
实验内容: Content	学会用脉冲响应不变法设计 IIR 数字滤波器 Learn to design IIR digital filters without varying the pulse response		
学习目标: Learning Objectives	<p>加深对脉冲响应不变法设计 IIR 数字滤波器基本方法的了解。 掌握使用模拟滤波器原型进行脉冲响应变换的方法。 了解 MATLAB 有关脉冲响应变换的子函数。</p> <p>Deepen the understanding of the basic method of IIR digital filter design. Master the method of using the analog filter prototype for the pulse response transformation. Understand the subfunctions of MATLAB about impulse response transformations.</p>		
教学要求: Requirements	<p>实验课前认真阅读实验室指导书, 根据实验指导书的要求准备好, 实验中按教师要求的程序和步骤, 参考实验指导书内容, 完成对 IIR 数字滤波器的设计过程。</p> <p>Before the experiment class, read the laboratory instruction carefully and prepare it according to the requirements of the experiment instruction. In the experiment, complete the design process of the IIR digital filter according to the procedures and steps required by the teacher, and refer to the content of the experiment instruction.</p>		
实验场地: Location	综合楼 1112; comprehensive building 1112		
实验软硬件设备: Software/Hardware	微型计算机 microcomputer		

实验项目序号: Experiment No.	4	支撑教学目标: SLOs Supported	1-2 1-3, 2-1,2-2
每组成员: Members per Group	1	指导教师: Tutor	曹亚丽
实验名称: Experiment Title	FIR 数字滤波器的设计 Design of the FIR digital filter		
实验内容: Content	学会用窗函数法和频率抽样法来设计 FIR 数字滤波器 Learn to use the window function method and the frequency sampling method to design the FIR digital filters		
学习目标: Learning Objectives	掌握 FIR 数字滤波器设计的方法 掌握实现滤波器设计过程中 MATLAB 有关函数和程序设计思想。 Master the method of FIR digital filter design Master the functions and programs of MATLAB in the process of filter design.		
教学要求: Requirements	实验课前认真阅读实验室指导书, 根据实验指导书的要求准备好, 实验中按教师要求的程序和步骤, 参考实验指导书内容, 完成对 FIR 数字滤波器的设计过程。 Before the experiment class, read the laboratory instruction carefully and prepare it according to the requirements of the experiment instruction. In the experiment, complete the design process of the FIR digital filter according to the procedures and steps required by the teacher, and refer to the content of the experiment instruction.		
实验场地: Location	综合楼 1112; comprehensive building 1112		
实验软硬件设备: Software/Hardware	微型计算机 microcomputer		

四、教学安排 Teaching Schedule

注: 可根据实际情况增减行数

Note: Please add/reduce lines based on subject.

教学内容 Teaching Content	学时(周) Hour(Week)			
	理论 LECT.	实验 EXP.	课外实践 PBL	实践 PRAC.
绪论 Introduction	1			
离散时间信号与系统 Discrete-time signals with the system	3	2		
z 变换与离散时间傅里叶变换 Z-transform with a discrete-time Fourier transform	6			

离散傅里叶变换(DFT) Discrete Fourier Transform (DFT)	4			
快速傅里叶变换(FFT) Fast Fourier transform (FFT)	6	2		
数字滤波器的基本结构 Basic structure of the digital filters	4			
无限长单位冲激响应(IIR)滤波器的设计 Design of the infinite length unit impulse response (IIR) filter	4	2		
有限长单位冲激响应(FIR)数字滤波器的设计方法 Design method of finite length unit impulse response (FIR) digital filter	4	2		
总计 Total	32	8		

五、教学方法 Teaching Methodology

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

勾选 Check	教学方法与特色 Teaching Methodology & Characters
<input checked="" type="checkbox"/>	多媒体教学：基于信息化设备的课堂教学 Multi-media-based lecturing
<input checked="" type="checkbox"/>	实践能力传授：理论与行业、实际案例相结合 Combining theory with industrial practical problems
<input checked="" type="checkbox"/>	课程思政建设：知识讲授与德育相结合 Knowledge delivery with ethic education
<input checked="" type="checkbox"/>	PBL 教学：问题驱动的分组学习与交流 Problem-based learning
<input type="checkbox"/>	其他:单击或点击此处输入文字。 Other:单击或点击此处输入文字。

六、成绩评定 Assessment

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

考核环节: Assessment Content	平时 Behavior	环节负责人: Director	刘健
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	10
考核方式: Measures	出勤：本门课程的所有环节均要求学生参与并签到，不得缺勤。出勤成绩占总成绩的 5%。每缺勤一次扣 1 分。无故缺勤 4 次及以上者，取消本门课程的考试资格。 作业：本门课程有 2 次课内作业，要求学生必须独立完成并在规定		

	时间提交。作业成绩占总成绩的 5%，每次作业占 2.5%。未按时提交作业或作业有抄袭（雷同）现象的，该次作业成绩按零分计。
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考核环节: Assessment Content	实验 Experiment	环节负责人: Director	曹亚丽
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	20
考核方式: Measures	实验：本门课程设有 4 次实验，要求学生按照实验题目分组完成实验，归纳总结，撰写实验报告。实验成绩占总成绩的 20%，每次实验成绩占 5%；		

考核环节: Assessment Content	期末 Final	环节负责人: Director	刘健
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	70
考核方式: Measures	结课考试占总成绩的 70%		

七、改进机制 Improvement Mechanism

注：未尽事宜以教学团队以及学院教学指导委员会商定为准。

Note: Matters not covered in this file shall be determined by TAB of SSTC, NEU.

教学大纲改进机制 Subject Syllabus Improvement Mechanism			
考核周期(年): Check Period (YR)	4	修订周期(年): Revise Period (YR)	4
改进措施: Measures	课程负责人根据课程教学内容与人才培养目标组织课程团队讨论并修改教学大纲，报分管教学工作副院长审核后由执行院长批准。 The subject coordinator shall be responsible for the syllabus discussion and improvement, and the revised version shall be submitted to deputy dean (teaching affairs) for reviewing then to executive dean for approval		
成绩评定改进机制 Assessment Improvement Mechanism			
考核周期(年): Check Period (YR)	1	修订周期(年): Revise Period (YR)	1
改进措施: Measures	课程负责人根据课程教学内容、课堂教学效果以及成绩分布，对课程教学方法和成绩评定环节进行改进，并同步优化评定办法。 The subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.		