**《生物医学信号与系统-2》课程教学大纲（2020版）**

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| 课程基本信息（Course Information） |
| 课程代码（Course Code） | EI373 | \*学时（Credit Hours） | 32 | \*学分（Credits） | 2 |
| \*课程名称（Course Name） | （中文）生物医学信号与系统-2 |
| （英文）Biomedical Signals and Systems-2 |
| 课程类型 (Course Type) | 专业必修课 |
| 授课对象（Target Audience） | 生物医学工程专业本科三年级学生 |
| 授课语言 (Language of Instruction) | 一个平行班为全外文，一个平行班为全中文 |
| \*开课院系（School） | 生物医学工程学院 |
| 先修课程（Prerequisite） | 基本电路理论、模拟电子、高等数学、工程数学、线性代数、生物医学信号与系统-1 | 后续课程(post） |  |
| \*课程负责人（Instructor） | 李瑶 | 课程网址(Course Webpage) |  |
| \*课程简介（中文）（Description） | 本门课是生物医学工程专业的专业基础课，它是学生完成了高等数学、信号与系统等课程后，进一步为学习专业知识打基础的课程。本课程将通过讲课、课堂练习、上机实验等多种方式，使学生建立”数字信号处理”的基本概念，掌握数字信号处理的基本分析方法和分析工具，为培养和提升学生利用信号处理以及相关数学方法、分析和解决生物医学工程领域的相关问题的能力，具有不可或缺的重要地位。主要教学内容包括时域离散信号及离散系统的时域分析方法、频域分析方法、及时域离散系统的设计方法几个部分。其中，时域分析方法主要包括采样与重建、典型时域离散序列及其表述、序列运算、系统的时域表示、系统特性分析、线性差分方程及其求解；频域分析方法主要包括离散傅里叶变换、快速傅里叶变换算法、Z变换等；系统设计主要包括FIR数字滤波器设计、IIR数字滤波器设计等。教学目标旨在加深学生对数字信号处理的理解，培养学生利用信号处理及相关数学方法来分析和解决生物医学工程领域的相关问题的能力。 |
| \*课程简介（英文）（Description） | （英文300-500字）This course is to teach the basic representation of discrete-time signals and systems andtheory of frequency analysis of discrete-time signals and linear shift invariant (LSI) system. Also, it is to teach the basic processing techniques of discrete-time signals and LSI system. The students will learn basic skills of Matlab-based discrete-time signals description and system designs. We will prepare the students with the ability to present digital signals; to present and describe the linear shift-invariant system; to perform linear convolution; to analyze the spectrum change of analog signal when passing a digital system; to get the Z transform, Fourier series, discrete time Fourier Transform, discrete Fourier transform and their relationships; to use Z transform, discrete Fourier transform to analyze the discrete-time signals; to do fast discrete Fourier transform of a time series and their linear convolution; to realize the digital systems with different structures; to analyze the system properties according to the zeros and poles of the system; to design a digital FIR/IIR filter; to use MATLAB to present digital signals, perform basic operations of digital signals and design digital systems, FIR and IIR filters. |
| 课程目标与内容（Course objectives and contents） |
| \*课程目标 (Course Object) | 1. Ability to present digital signals;[a] (A1,A4,B2,C3,D1)
2. Ability to present and describe the linear shift-invariant system;[a] (A1, A4,B2,C3,D1)
3. Ability to perform linear convolution;[a,e] (A1, A4,B2,C3,D1)
4. Ability to analyze the spectrum change of analog signal when passing a digital system;[a,e] (A1, A4,B2,C3,D1)
5. Ability to get the Z transform, Fourier series, discrete time Fourier Transform, discrete Fourier transform and their relationships;[a,e] (A1, A4,B2,C3,D1)
6. Ability to use Z transform, discrete Fourier transform to analyze the discrete-time signals. [a,e] (A1, A4,B2,C3,D1)
7. Ability to do fast discrete Fourier transform of a time series and their linear convolution;[a,e] (A1, A4,B2,C3,D1)
8. Ability to realize the digital systems with different structures;[ a,c,e] (A1, A4,B2,C3,D1)
9. Ability to analyze the system properties according to the zeros and poles of the system;[a,c,e] (A1,B2,C3,D1)
10. Ability to design a digital FIR/IIR filter; [a,c,e,k] (A1, A3,B2,B4,C3,C5,D1,D2)
11. Ability to use Matlab to present digital signals; [k] (A3,B2,B4,C2,C3,D1)
12. Ability to use Matlab to perform basic operations of digital signals; [k] (A3,B2,B4,C2,C3,D1)
13. Ability to use Matlab to design digital systems, FIR and IIR filters; [c,k] (A3,B2,B4,C2,C3,D1)
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| 毕业要求指标点与课程目标的对应关系 | 课程目标 | 毕业要求指标点 |
| 课程目标1 | 毕业要求1 |
| 课程目标2 | 毕业要求1 |
| 课程目标3 | 毕业要求1,5 |
| 课程目标4 | 毕业要求1,5 |
| 课程目标5 | 毕业要求1,5 |
| 课程目标6 | 毕业要求1,5 |
| 课程目标7 | 毕业要求1,5 |
| 课程目标8 | 毕业要求1,3,5 |
| 课程目标9 | 毕业要求1,3,5 |
| 课程目标10 | 毕业要求1,3,5,11 |
| 课程目标11 | 毕业要求11 |
| 课程目标12 | 毕业要求11 |
| 课程目标13 | 毕业要求3,11 |
| \*教学内容进度安排及对应课程目标 (Class Schedule & Requirements & Course Objectives) | 章节 | 教学内容（要点） | 教学目标 | 学时 | 教学形式 | 作业及考核要求 | 课程思政融入点 | 对应课程目标 |
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| Chapter 1 | Discrete- time signals and Discrete-time System  | T1: Course InfoT2: Course Outline/ IntroductionT3: PrerequisitesT4: Digital Signals and SystemsT5: Digital Signals: Representation | 2 | 讲课 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标1，2 |
| Chapter 2 | Discrete- time signals and Discrete-time System  | T1: Discrete System propertiesT2: ConvolutionT3: Convolution PropertiesT4: Difference EquationsT1: Analog-to-Digital conversion, Digital-to-Analog conversionT5: Quantization; Signal reconstructionT6: Discrete-time processing of analog signals | 4 | 讲课 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标3, 4 |
| Chapter 3 | Z-Trans form | T1: IntroductionT2: Definition of Z-TransformT3: S-plane vs Z-planeT4: Fourier transformT5: Inverse Z-transformT6: Solution of difference equation using z-Transform | 2 | 讲课 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标5, 6 |
| Chapter 4 | Transform Analysis of Systems | T1: Representations of signal and systems in frequency domainT2: Fourier analysis of signalsT3: Fourier seriesT4: Fourier transform T5: Frequency analysis of systemT6: Frequency responseT7: System functionT8: Realization of digital filters | 6 | 讲课, 上机实验 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标5, 6,8,11,12 |
| Chapter 5 | Discrete Fourier Transform | T1: Discrete Fourier seriesT2: Discrete Fourier transform (DFT)T3: DFT propertiesT4:MATLAB example | 2 | 讲课 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标6, 7 |
| Chapter 6 | Fast Fourier Transform | T1: IntroductionT2: Divide and conquer principleT3: Decimation -in-Frequency methodT4: Decimation -in-Time methodT5: FFT algorithmT6: Example of radix-2 FFT | 4 | 讲课 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标 7 |
| Chapter 7 | Finite Impulse Response Filter Design | T1: BackgroundT2: Structure of finite impulse response (FIR) systemT3: Design of FIR filterT4: Frequency sampling designT5: FIR filter design methods in practiceT6: In class exercises | 6 | 讲课, 上机实验 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标 10,13 |
| Chapter 8 | Infinite Impulse Response Filter Design | T1: BackgroundT2: Infinite impulse response (IIR) filter formatT3: Design of IIR filterT4: Digital Butterworth and Chebyshev filter designT5: Higher order IIR filter design using cascade methodT6: IIR Applications  | 6 | 讲课, 上机实验 | 练习题 | 通过学习培养学生一丝不苟、认真严谨的工作作风 | 课程目标10,13 |
| 注1：建议按照教学周周学时编排，以便自动生成教学日历。注2：相应章节的课程思政融入点根据实际情况填写。 |
| 课程目标达成度评价 |  课程目标 考核方式 | 平时作业(20分) | 课程项目 (30分) | 期末考试 （50分） | 课程目标权重 | 课程目标达成度 |
| 见附表 |  |  |  |  |  |
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| \*考核方式 (Grading) | （1）平时作业 30分（2）上机实验 10分 (3) 随堂测验 10分（4）期末考试 50分 |
| \*教材或参考资料 (Textbooks & Other Materials) | 教材：J.G. Proakis，Digital Signal Processing-Principles, Algorithms, and Applications. Third Edition（数字信号处理-原理、算法与应用，第三版，影印版），中国电力出版社，2004，ISBN 0-13-394338-9教学参考书：1． Understanding Digital Signal Processing (3rd Edition), by Richard G. Lyons, ©2010 Prentice Hall, ISBN : 01370274192． Digital Signal Processing: Fundamentals and Applications, by Li Tan and Jean Jiang, ©2013 Academic Press, ISBN-13: 978-01241589313． M.H.Hayes，张建华译，数字信号处理，科学出版社，2002, ISBN: 0-07-027389-8 |
| 其它（More） |  |
| 备注（Notes） |  |
| 备注说明： 1．带\*内容为必填项。  2．课程简介字数为300-500字；课程大纲以表述清楚教学安排为宜，字数不限。 |

附表：课程目标达成度评价

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| **Summary of the Attainment of LOs** |
|  Learning Outcomes  Assignments Weight | LO1 | LO2 | LO3 | LO4 | LO5 |
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| Hws | 20% | 78.3% | 93.3% | 66.7% | 73.3% |  |
| Quizzes | 20% | 83.3% | 76.7% | 100.0% | 100.0% |  |
| Labs | 10% |  |  |  |  | 100.0% |
| Final Exam | 20% | 93.3% | 96.7% | 76.7% | 73.3% |  |
| Total | 70% |  |  |  |  |  |
| Weighted averages | 85.0% | 88.9% | 81.1% | 82.2% | 100.0% |