南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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**	神经工程与脑机接口 Neural Engineering and Brain-computer Interface
2.	**授课院系 Originating Department**	生物医学工程系 Biomedical Engineering
3.	**课程编号 Course Code**	BMEB333
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业核心课 Major Core Courses
6.	**授课学期 Semester**	秋季 Fall
7.	**授课语言 Teaching Language**	英文 English
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）**	肖凯，xiaok3@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced
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	48				48

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MA107A
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 None
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

神经工程与脑机接口是生物医学工程的重要研究方向之一。本课程首先介绍人体神经系统及相应效应器的结构与功能，并通过相应的案例展示其独特的应用意义，然后介绍神经系统传感技术的工作原理，学习神经电生理、功能近红外成像、功能核磁共振、脑磁图等神经信号的采集方法，以及经颅磁刺激、经颅直流电刺激等神经刺激与调控方法；课程进一步介绍神经系统生理信号采集的硬件系统、信号获取方法与理论，介绍脑机接口系统框架，典型应用与范式，并结合具体的应用案例给出神经信号的常见处理算法；最后，课程介绍神经工程领域前沿研究并对其未来发展方向进行开放式讨论。

Neural engineering and brain-computer interface is one of the important research directions in biomedical engineering. This course will firstly introduce the structure and function of the human nervous system and corresponding effectors, and demonstrate their unique application significance through corresponding cases. Then, the acquisition methods of neural signals such as neurophysiology, functional near-infrared imaging, functional magnetic resonance imaging, and magnetoencephalography, as well as neurostimulation and regulation methods such as transcranial magnetic stimulation and transcranial direct current stimulation, and the working principles of the corresponding sensors are introduced. The course further introduces the hardware system, signal acquisition method and theory of physiological signal acquisition of neuromuscular system, and gives common processing algorithms for neural signals in combination with specific application cases; finally, the course introduces the frontier research in the field of neuro-engineering and its future development direction Have an open discussion.

16. 预达学习成果 Learning Outcomes

通过学习，本课程预期达到下列学习成果：

1. 了解人体神经系统；
2. 熟悉神经信号获取与调控技术；
3. 了解神经接口技术发展历史与前沿动态；
4. 掌握神经系统典型传感器的原理、硬件系统、神经信号采集方法与理论；
5. 学习脑机接口实验范式与实验设计方法；
6. 掌握神经信号的常见处理算法；
7. 了解神经工程学的前沿动态。

After one semester of course study, we plan to achieve the following goal:

1. Understand the human nervous system;
2. Familiar with neural signal acquisition and regulation technology;

3. Understand the development history and frontier trends of neural interface technology;
4. Master the sensor technology, hardware systems, signal acquisition methods and theory of neural signals;
5. Learning BCI paradigms and experimental design methods;
6. Master the common processing algorithms of neural signals;
7. Understand the cutting-edge advances of neuro-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.)

Section 1 神经工程概述（2 学时）

Section 1 General introduction to neural engineering

Section 2 人体神经系统概要（4 学时）

扼要介绍人体神经系统基本结构与功能。

Section 2 Fundamentals of neural system

Briefly introduce the basic structure and function of the human neural system.

Section 3 神经系统传感技术 （6 学时）

介绍电生理监测的手段及传感原理。

Section 3 Sensing technologies of neural system

Introduce methods and sensing principle of electrophysiological monitoring.

Section 4 神经信号采集方法理论和仪器系统（6 学时）

介绍神经信号采集方法、理论及仪器系统：脑电、心电、肌点、近红外光谱、功能核磁共振成像等神经系统监测手段。

Section 4 Techniques of neural signal acquisition

Introduction to neural signal acquisition techniques (EEG, ECG, EMG, fMRI, NIRs and other neurological monitoring methods).

Section 5 神经系统调控技术（6 学时）

介绍神经系统刺激与调控技术。

Section 5 Neural regulation technologies

Introduction to neural stimulation and modulation techniques (e.g., TMS, tDCS).

Section 6 脑机接口概述（2 学时）

介绍脑机接口系统框架和典型应用。

Section 6 Introduction to BCI

Introduction to the framework and classical applications of BCI.

Section 7 脑机接口实验范式（4 学时）

介绍脑机接口实验范式：事件相关电位、稳态视觉诱发电位、运动想象。

Section 7 Paradigms of BCI

Introduction to BCI paradigms (e.g., ERP, SSVEP, MI).

Section 8　神经信号处理方法 1（6 学时）

介绍卷积、傅里叶变换、时频分析等神经信号的查看分析方法。

Section 8　Data processing of neural signals – Part 1

Introduces methods for viewing and analyzing neural signals such as convolution, Fourier transform, and time-frequency analysis.

Section 9　神经信号处理方法 2（6 学时）

介绍 FIR/IIR 滤波器及其设计方法、小波变换、独立成分分析等神经信号的常用处理算法。

Section 9　Data processing of neural signals – Part 2

Introduce common processing algorithms for neural signals such as FIR/IIR filters and their design methods, adaptive filtering, independent component analysis, etc.

Section 10　神经信号处理方法 3（4 学时）

介绍神经信号处理中的统计学方法。

Section 10　Data processing of neural signals – Part 3

An introduction to statistical methods in neural signal processing.

Section 11　神经工程与脑机接口前沿讨论（2 学时）

针对神经工程领域前沿思想与技术展开交流讨论。

Section 11　Frontiers in Neuro-engineering and BCI

Open discussion on cutting-edge ideas and technologies of neural engineering.

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

Textbook
None

Supplementary Readings
1. Neural Engineering, He
2. Neuroengineering, DiLorenzo
3. Principles of Neural Science, Kandel
4. Biological Psychology, Kalat
5. Cognitive Neuroscience: the biology of the mind, by Herreras E B.
6. Brain-computer interfaces: Revolutionizing human-computer interaction, by Graimann, B., Allison, B. Z., & Pfurtscheller, G.

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		5%		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		30%		
平时作业 Assignments		25%		

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)				

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

生物医学工程系教学委员会