

# 试验设计与分析 教学大纲

## Design and Analysis of Experiment

## Subject Syllabus

### 一、课程信息 Subject Information

课程编号: Subject ID	<a href="#">3100313013.01</a>	开课学期: Semester	2
课程分类: Category	专业教育 PA	所属课群: Section	专业平台 MT
课程学分: Credit Points	2	总学时/周: Total Hours/Weeks	36
理论学时: LECT. Hours	36	实验学时: EXP. Hours	0
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	应用统计学 AS
课程属性: Pattern	选修 Elective	课程模式: Mode	自建 NEU
中方课程协调人: NEU Coordinator	张琨 Kun Zhang	成绩记载方式: Result Type	百分制 Marks
先修课程: Requisites	数理统计 Mathematical Statistics		
英文参考教材: EN Textbooks	Montgomery D. Design and Analysis of Experiments, Wiley, 2013.		
中文参考教材: CN Textbooks	茆诗松, 周纪芾, 周迎春等. 试验设计, 中国统计出版社, 2020.		
教学资源: Resources	<a href="http://www.lib.uts.edu.au">www.lib.uts.edu.au</a>		
课程负责人(撰写人): Subject Director	张琨 Kun Zhang	提交日期: Submitted Date	4/10/2023
任课教师(含负责人): Taught by	张琨 Kun Zhang		
审核人: Checked by	韩鹏	批准人: Approved by	史闻博
		批准日期: Approved Date	4/10/2023

## 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>试验是包括科学、医学、工程和营销在内的所有领域研究的重要组成部分。关于如何设计好试验的许多想法与应用领域无关，本课程涵盖了适用于所有领域的良好设计标准原则。它涵盖了测试治疗手段假设的标准设计（完全随机、随机完全区组、拉丁方和析因设计），讨论了如何设计试验来研究方差，并讨论了假设检查和转换。</p> <p>本课程旨在让学生较为透彻地理解各种方法的设计思想及其实践过程，并在将来能运用自如，除旧创新。</p> <p>Experiments are an important part of research in all areas including science, medicine, engineering and marketing. Many ideas on how to design a good experiment are independent of the area of application and this subject covers standard principles of good design applicable to all areas. It covers standard designs (completely randomised, randomised complete block, Latin squares and factorial designs) for testing hypotheses about treatment means, discusses how to design experiments to study variances, and discusses assumption checking and transformations.</p> <p>This course aims to enable students to thoroughly understand the design ideas and practical process of various methods, and be able to use them freely in the future.</p>	
<p>(1) 专业目标: Professional Ability</p>	<p>1-1</p>	<p>向技术专家和一些非专业人士提供连贯、清晰的统计论据。 Present a coherent and clear statistical argument to both technical experts and informed lay people.</p>
	<p>1-2</p>	<p>在为不熟悉的情况设计实验时明确需要考虑的约束条件，并为这种情况构建合适的设计。 Identify the constraints that need to be considered when designing an experiment for an unfamiliar situation and to construct an appropriate design for that situation.</p>
	<p>1-3</p>	<p>学会如何在工业和公共政策中使用设计实验，并在这些环境中应用设计实验的概念。 Explain how designed experiments can be used in industry and public policy and apply the concepts of designed experiments in these contexts.</p>
	<p>1-4</p>	<p>采用先进技术，使用行业标准软件解决真实问题。 Implement advanced techniques to solve authentic problems using industry standard software.</p>
	<p>1-5</p>	<p>在设计研究或进行分析时，提出缓解伦理问题的解决方案。 Suggest solutions to mitigate ethical issues when designing a study or presenting analysis. Master parameters and arguments,</p>

		return values.
	1-6	以书面形式向专家和非专家听众提出一个有说服力的论点，其中包括一个实质性的方法论部分。 Present a persuasive argument which includes a substantial methodological component to both expert and non-expert audiences in written form.
	1-7	写一份综合报告，总结一个实质性的研究项目。 Produce a comprehensive report summarizing a substantial research project.
(2) 德育目标: Essential Quality	2-1	培养具有不畏困难、不惧失败、锲而不舍、敢于尝试、迎难而上的精神,并在学习过程中培养自己的细心和耐心的勇气和精神 Cultivate the spirit of not fearing difficulties or failure, perseverance, daring to try, and cultivate their own careful and patient courage and spirit in the process of learning
	2-2	培养服务意识,具有“以人为本”的服务精神 Cultivate service consciousness and have the service spirit of "people-oriented"
	2-3	培养遵守法律、懂规则、守规则的新时代公民 Cultivate citizens of the new era who abide by the law, understand and obey the rules
	2-4	了解主要矛盾和次要矛盾,在面对复杂问题的时候要实事求是、抓住主要矛盾 Understand the main contradiction and secondary contradiction, seek truth from facts and grasp the main contradiction in the face of complex problems
	2-5	培养有条理和计划,做到心中有数、有条不紊、循序渐进地完成一项工作 Cultivate a sense of order and plan, and complete a work in an orderly and gradual manner
<b>课程教学目标与毕业要求的对应关系 Matrix of GA &amp; SLOs</b>		
毕业要求 GA	指标点 GA Index	教学目标 SLOs
<b>3、设计/开发解决方案:</b> 能够设计针对复杂实际问题的解决方案,设计满足特定需求的系统、单元或流程,并能够在设计环节中体现创新意识,考虑社会、健康、安全、法律、文化以及环境等因素 <b>3. Design/Development of Solutions:</b> Design solutions for complex practical problems and design systems,	3-1: 能够设计针对本专业相关复杂实际问题的解决方案 3-1: Capable of designing solutions to complex practical problems related to this major	1-1 到 1-7 2-5
	3-2: 能够对不同设计方案进行比较和优化,在工作各环节中具有创新意识和批判意识,善于发现、分析、系统表述和解决实际问题 3-2: Capable of comparing and optimizing different design schemes, having a sense of innovation and criticism in all aspects of	

<p>components or processes that meet specified needs with appropriate consideration for public health, and safety, cultural, societal and environmental considerations.</p>	<p>work, and be good at discovering, analyzing, systematically elaborating and solving practical problems</p>	
<p><b>4、研究：</b>能够基于科学原理并采用科学方法对复杂实际问题进行研究，包括设计实验、分析与解释数据、并通过信息综合得到合理有效的结论 <b>4. Investigation:</b> Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions</p>	<p>3-3: 能够在设计和开发的各个环节中综合考虑社会、健康、安全、法律、文化以及环境等因素 3-2: Capable of comparing and optimizing different design schemes, having a sense of innovation and criticism in all aspects of work, and be good at discovering, analyzing, systematically elaborating and solving practical problems</p> <p>4-1: 能够基于科学原理并采用科学方法，在本专业相关理论指导下对复杂实际问题设计实验进行研究 4-1: Capable of design experiments on complex problems with scientific knowledge and research methods of this major</p> <p>4-2: 能够结合本专业对实验数据进行分析与解释，设计并优化实验方案，并通过信息综合得到合理有效的结论 4-2: Capable of analyzing and interpreting the experimental data, designing and optimizing the experimental schemer with the knowledge of this major; reasonable and effective conclusions are obtained through information synthesis</p>	<p>1-1 到 1-7 2-4</p>
<p><b>5、使用现代工具：</b>能够针对复杂实际问题，开发、选择与使用恰当的技术、资源、现代信息技术工具，包括对复杂实际问题的预测与模拟，并能够理解其局限性 <b>5. Modern Tool Usage:</b> Create, select and apply appropriate techniques, resources and modern engineering and IT tools,</p>	<p>5-2 熟悉解决本专业相关复杂实际问题所需的技术和资源，能够运用现代信息技术进行文献检索和资料查询，获取专业解决方案 5-2: Familiar with the technology and resources required to solve complex practical problems related to the major, capable of using modern information technology to conduct document retrieval and data query, and obtaining professional solutions</p>	<p>1-1 到 1-7 2-4、2-5</p>

including prediction and modeling, to complex practical problems, with an understanding of the limitations	5-3: 能够针对本专业相关复杂实际问题, 选择与使用恰当的技术、资源、现代信息技术工具 5-3: Capable of selecting and using appropriate technology, resources, and modern information technology tools in response to complex practical problems related to the major	
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### 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、2-1
知识单元名称 Unit Title	介绍 Introduction		
知识点: Knowledge Delivery	试验设计的应用 Some Typical Application of Experimental Design		
	R 语言环境的安装 Installing R		
	统计设计 Statistical Design		
学习目标: Learning Objectives	了解: Recognize	R 语言的起源与发展 A brief history of R and its development	
		R 语言环境的安装 Installing R	
	理解: Understand	R 语言的编程风格 The style of programming with R	
	掌握: Master	R 编程中常见错误 Common errors when programming with R	
德育目标 Moral Objectives	培养具有不畏困难、不惧失败、锲而不舍、敢于尝试、迎难而上的精神，并在学习过程中培养自己的细心和耐心的勇气和精神 Cultivate the spirit of not fearing difficulties or failure, perseverance, daring to try, and cultivate their own careful and patient courage and spirit in the process of learning		
	培养服务意识，具有“以人为本”的服务精神 Cultivate service consciousness and have the service spirit of "people-oriented"		
	培养遵守法律、懂规则、守规则的新时代公民 Cultivate citizens of the new era who abide by the law, understand and obey the rules		

重点: Key Points	统计设计 Statistical Design
	R 语言的编程风格 The style of programming with R
难点: Focal Points	R 语言编程中常见错误 Common errors when programming with R

知识单元序号: Knowledge Unit No.	2	支撑教学目标: SLOs Supported	1-2、2-4
知识单元名称 Unit Title	简单对比试验 Simple Comparative Experiments		
知识点: Knowledge Delivery	基本统计概念 Basic Statistical Concepts		
	抽样和抽样分布 Sampling and Sampling Distributions		
	配对比较设计 Paired Comparison Design		
学习目标: Learning Objectives	了解: Recognize	R 语言 R Language	
	理解: Understand	对比实验 Comparative Experiments	
	掌握: Master	配对比较问题及其设计 Paired Comparison Problem and its Design	
德育目标 Moral Objectives	了解主要矛盾和次要矛盾, 在面对复杂问题的时候要实事求是、抓住主要矛盾 Understand the main contradiction and secondary contradiction, seek truth from facts and grasp the main contradiction in the face of complex problems		
重点: Key Points	简单对比试验的种类 The Kind of Simple Comparative Experiments		
	基本统计概念 Basic Statistical Concepts		
难点: Focal Points	正态分部的方差 The Variances of Normal Distributions		

知识单元序号: Knowledge Unit No.	3	支撑教学目标: SLOs Supported	1-3、2-5
知识单元名称 Unit Title	单因素实验: 方差分析 Experiments with a Single Factor: The Analysis of Variance		
知识点: Knowledge Delivery	方差分析 The Analysis of Variance		
	模型适合性检验 Model Adequacy Checking		
	结果的实用性阐释 Practical Interpretation of Results		

	随机效应模型 The Random Effects Model	
	方差分析的方法 The Methods in the Analysis of Variance	
学习目标: Learning Objectives	了解: Recognize	R 语言中的数据结构 Data Structures in R
		固定效应模型 The Fixed Effects Model
	理解: Understand	常态假设 The Normality Assumption
		正交对比 Orthogonal Contrasts
	掌握: Master	置信区间估计法 Confidence Interval Estimation Method
		单一随机因素 A Single Random Factor
德育目标 Moral Objectives	无 None	
重点: Key Points	随机模型的方差分析 Analysis of Variance for The Random Model	
难点: Focal Points	上机实验 Sample Computer Output	

知识单元序号: Knowledge Unit No.	4	支撑教学目标: SLOs Supported	1-4、2-5
知识单元名称 Unit Title	随机区组、拉丁方和相关设计 Randomized Blocks, Latin Squares and Related Designs		
知识点: Knowledge Delivery	随机完全区组设计 The Randomized Complete Block Design		
	正交设计 The Latin Square Design		
	希腊拉丁正交设计 The Graeco-Latin Square Design		
	平衡不完全区组设计 Balanced Incomplete Block Design		
学习目标: Learning Objectives	了解: Recognize	随机完全区组设计 The Randomized Complete Block Design	
	理解: Understand	正交设计 The Latin Square Design	
	掌握: Master	正交设计 The Latin Square Design	
		平衡不完全区组设计 Balanced Incomplete Block Design	

德育目标 Moral Objectives	培养有条理和计划，做到心中有数、有条不紊、循序渐进地完成一项工作 Cultivate a sense of order and plan, and complete a work in an orderly and gradual manner
重点: Key Points	正交设计 The Latin Square Design
难点: Focal Points	希腊拉丁正交设计 The Graeco-Latin Square Design

知识单元序号: Knowledge Unit No.	5	支撑教学目标: SLOs Supported	1-5
知识单元名称 Unit Title	析因设计简介 Introduction to Factorial Designs		
知识点: Knowledge Delivery	析因设计的基本定义和原则 Basic Definitions and Principles of Factorial Designs		
	双因素析因设计 The Two-Factor Factorial Design		
	一般析因设计 The General Factorial Design		
	析因设计中的阻塞 Blocking in a Factorial Design		
学习目标: Learning Objectives	了解: Recognize	析因设计的基本定义和原则 Basic Definitions and Principles of Factorial Designs	
	理解: Understand	拟合响应曲线和曲面 Fitting Response Curves and Surfaces	
	掌握: Master	双因素析因设计 The Two-Factor Factorial Design	
一般析因设计 The General Factorial Design			
德育目标 Moral Objectives	了解主要矛盾和次要矛盾，在面对复杂问题的时候要实事求是、抓住主要矛盾 Understand the main contradiction and secondary contradiction, seek truth from facts and grasp the main contradiction in the face of complex problems		
重点: Key Points	双因素析因设计 The Two-Factor Factorial Design		
	一般析因设计 The General Factorial Design		
难点: Focal Points	析因设计中的阻塞 Blocking in a Factorial Design		

知识单元序号: Knowledge Unit No.	6	支撑教学目标: SLOs Supported	1-6
知识单元名称 Unit Title	$2^k$ 析因设计 The $2^k$ Factorial Design		



知识点: Knowledge Delivery	2 <sup>k</sup> 析因设计 The 2 <sup>k</sup> Factorial Design	
	2 <sup>k</sup> 设计的单一复制 The Single Replicate of the 2 <sup>k</sup> Design	
	2 <sup>k</sup> 设计的中心点 The Addition of Center Points to the 2 <sup>k</sup> Design	
学习目标: Learning Objectives	了解: Recognize	2 <sup>2</sup> 析因设计 The 2 <sup>2</sup> Factorial Design
	理解: Understand	2 <sup>3</sup> 析因设计 The 2 <sup>3</sup> Factorial Design
	掌握: Master	2 <sup>k</sup> 析因设计 The 2 <sup>k</sup> Factorial Design
		2 <sup>k</sup> 设计的单一复制 The Single Replicate of the 2 <sup>k</sup> Design
德育目标 Moral Objectives	无 None	
重点: Key Points	2 <sup>2</sup> 析因设计 The 2 <sup>2</sup> Factorial Design	
	2 <sup>k</sup> 析因设计 The 2 <sup>k</sup> Factorial Design	
难点: Focal Points	2 <sup>k</sup> 设计的单一复制 The Single Replicate of the 2 <sup>k</sup> Design	

知识单元序号: Knowledge Unit No.	7	支撑教学目标: SLOs Supported	1-7
知识单元名称 Unit Title	2 <sup>k</sup> 析因设计中的阻塞和混淆 Blocking and Confounding in the 2 <sup>k</sup> Factorial Design		
知识点: Knowledge Delivery	阻止复制的 2 <sup>k</sup> 析因设计 Blocking a Replicated 2 <sup>k</sup> Factorial Design		
	2 <sup>k</sup> 析因设计中的混淆 Confounding in the 2 <sup>k</sup> Factorial Design		
	在两个/四个块中混淆 2 <sup>k</sup> 析因设计 Confounding the 2 <sup>k</sup> Factorial Design in Two/Four Blocks		
	部分混杂 Partial Confounding		
学习目标: Learning Objectives	了解: Recognize	2 <sup>k</sup> 析因设计中的混淆 Confounding in the 2 <sup>k</sup> Factorial Design	
	理解: Understand	2 <sup>k</sup> 析因设计中的阻塞 Blocking in the 2 <sup>k</sup> Factorial Design	
	掌握: Master	2 <sup>k</sup> 析因设计中的阻塞和混淆 Blocking and Confounding in the 2 <sup>k</sup> Factorial Design	
		阻止复制的 2 <sup>k</sup> 析因设计 Blocking a Replicated 2 <sup>k</sup> Factorial Design	
	在两个/四个块中混淆 2 <sup>k</sup> 析因设计 Confounding the 2 <sup>k</sup> Factorial Design in Two/Four		

		Blocks
德育目标 Moral Objectives	无 None	
重点: Key Points	2 <sup>k</sup> 析因设计中的混淆 Confounding in the 2 <sup>k</sup> Factorial Design	
	在两个/四个块中混淆 2 <sup>k</sup> 析因设计 Confounding the 2 <sup>k</sup> Factorial Design in Two/Four Blocks	
难点: Focal Points	部分混杂 Partial Confounding	

知识单元序号: Knowledge Unit No.	8	支撑教学目标: SLOs Supported	2-7
知识单元名称 Unit Title	两水平部分析因设计 Two-Level Fractional Factorial Designs		
知识点: Knowledge Delivery	2 <sup>k-1</sup> 设计 The One-Half Fraction of the 2 <sup>k-1</sup> Design		
	2 <sup>k-2</sup> 设计 The One-Quarter Fraction of the 2 <sup>k-2</sup> Design		
	部分析因和其他设计中的别名结构 Alias Structures in Fractional Factorials and other Designs		
	决议 III 设计 Resolution III Designs		
学习目标: Learning Objectives	了解: Recognize	2 <sup>k-1</sup> 设计 The One-Half Fraction of the 2 <sup>k-1</sup> Design	
	理解: Understand	2 <sup>k-p</sup> 设计 The One-Quarter Fraction of the 2 <sup>k-p</sup> Design	
	掌握: Master	2 <sup>k-2</sup> 设计 The One-Quarter Fraction of the 2 <sup>k-2</sup> Design	
		部分析因和其他设计中的别名结构 Alias Structures in Fractional Factorials and other Designs	
		决议 III 设计 Resolution III Designs	
德育目标 Moral Objectives	无 None		
重点: Key Points	2 <sup>k-1</sup> 设计 The One-Half Fraction of the 2 <sup>k-1</sup> Design		
	决议 III 设计 Resolution III Designs		
难点: Focal Points	2 <sup>k-p</sup> 设计 The One-Quarter Fraction of the 2 <sup>k-p</sup> Design		

## (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

无

None

#### 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	集中实践 PRAC.
随机性和设计 Randomization and Design	4			
完全随机设计 Completely Randomized Designs	4			
诊断：假设检验及转换 Diagnostics: Assumptions Tests, Transformations	4			
对比处理 Comparing Treatments	4			
完全随机区组设计与拉丁方 Randomized Complete Block Designs and Latin Squares	4			
双因素设计 Two Factor Designs	4			
完全因子设计 Complete Factorial Designs	4			
析因设计中的阻塞和混淆 Blocking and Confounding in Factorial Designs	4			
部分析因设计与嵌套设计 Fractional Factorial Designs and Nested Designs	4			
总计 Total	36		0	0

#### 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	张琨 Kun Zhang
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	满分 100 分，使用“学习通”进行。出勤，50 分；作业，50 分。 The full score is 100 points. Students' usual classroom performance is recorded by "XueXiTong". 10 points are counted for each attendance, and no score is given for absence. And 10 points are counted for each assignment, no score for plagiarism, plagiarism for others or no assignment. The final total score is not more than 100 points, not less than 0 points		

考核环节: Assessment Content	期末 Final	环节负责人: Director	张琨 Kun Zhang
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	满分 100 分，通过批阅期末考试试卷给出学生成绩。 The full score is 100, and the students' scores are given by marking the final examination papers.		

## 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		
<b>成绩评定改进机制 Assessment Improvement Mechanism</b>			
考核周期(年): Check Period (YR)	1	修订周期(年): Revise Period (YR)	1
改进措施: Measures	<p>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。</p> <p>The subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.</p>		