东北大学秦皇岛分校本科课程教学大纲

一、课程基本信息

<table>
<tr><td>开课单位</td><td colspan="3">悉尼智能科技学院</td><td>课程代码</td><td colspan="5">3100313037</td></tr>
<tr><td>中文名称</td><td colspan="8">随机过程与金融数学</td></tr>
<tr><td>英文名称</td><td colspan="8">Stochastic Processes and Financial Mathematics</td></tr>
<tr><td>总学时</td><td>56</td><td rowspan="2">理论学时</td><td rowspan="2">56</td><td rowspan="2">实验学时</td><td rowspan="2">0</td><td rowspan="2">上机学时</td><td rowspan="2">0</td><td rowspan="2">设计学时</td><td rowspan="2">0</td><td rowspan="2">课外学时</td><td rowspan="2">0</td></tr>
<tr><td>学　分</td><td>3.5</td></tr>
<tr><td>课程类型</td><td colspan="11">☑理论课程　☐理论（含实验）课程　☐实践类课程</td></tr>
<tr><td>课程类别</td><td colspan="11">☐通识类　☐学科基础类　☑专业方向类　☐实践类</td></tr>
<tr><td>适用专业</td><td colspan="11">应用统计学</td></tr>
<tr><td>先修课程</td><td colspan="11">数学分析与建模导论，概率论与随机变量，微分方程</td></tr>
<tr><td>建议开课学期</td><td colspan="11">☐1-1 ☐1-2 ☐2-1 ☐2-2 ☑3-1 ☐3-2
☐4-1 ☐4-2 ☐5-1 ☐5-2 ☐*（代表每学期都开设）</td></tr>
<tr><td>考核方式</td><td colspan="3">☑考试 ☐考查</td><td>成绩分制</td><td colspan="6">☑百分制 ☐五级制 ☐二级制</td></tr>
<tr><td>使用教材</td><td colspan="11">1、 Elements of Stochastic Modelling [Borokov, 2014]
2、 A Benchmark Approach to Quantitative Finance [Platen and Heath, 2006]
3、 Stochastic Calculus for Finance I [Shreve, 2005]
4、 Stochastic Calculus for Finance II [Shreve, 2004] (advanced)
5、 Financial Modelling with Jump Processes [Cont and Tankov, 2004] (advanced)</td></tr>
<tr><td>参考书及教学资源</td><td colspan="11">1、https://lms.cloudcampus.com.cn/login/canvas
2、https://canvas.uts.edu.au/courses/22701/pages/computational-software?module_item_id=862426</td></tr>
<tr><td>其他说明</td><td colspan="11">无</td></tr>
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二、课程简介

中文描述

本门课程为应用统计学专业的选修课程。

通过本课程的学习，逐步培养利用随机过程的理论、技能解决应用概率问题的能力，培养运用随机过程的方法分析问题、解决问题的能力。

English Description

This course is an elective course for applied statistics majors.

Through the study of this course, students acquire the ability to use the theory and skills of stochastic process to solve applied probability problems, and develop the ability to analyze and solve problems by using the method of stochastic process.

三、课程目标

1、知识目标：

1-1：了解概率论历史、随机变量的收敛性。

1-2：频率方法、Kolmogorov 公理化方法、极限定理、随机模拟、虑子、因果性和可逆性、非平稳性、转移密度。

1-3：掌握条件概率与独立事件、随机变量、多元 Gauss 随机变量、随机变量的随机模拟、Gauss 过程、平稳过程、Gauss Markov 过程、Chapman-Kolmogorov 方程、离散时间齐次 Markov 链、连续时间齐次 Markov 链、复合 Poisson 过程、移位算子演算、平稳性、Black-Scholes 模型中的 Kolmogorov 向后方程、关于 Brown 运动的随机积分。

2、能力目标：

2-1：定义并说明概率和随机过程中使用的术语。

2-2：讨论和演示概率中使用的证明技术以及随机过程理论中重要的一些数学推导。

2-3：陈述并应用概率的基本极限定理。

2-4：展示使用数学技术分析各种随机过程行为的能力，尤其是长期或稳态行为。

2-5：制定和解决涉及概率和随机过程的应用和理论问题。

2-6：清楚地传达概率和随机进程主题的知识以及涉及这些主题的问题的解决方案。

3、德育/素养目标：

3-1：自主工作或团队合作，展示对需要应用数学和统计学的现实生活问题的专业和负责任的分析。

3-2：使用各种方法，简洁准确地表达推理和结论，向各种受众传达数学解决方案及其含义。

表 1 课程目标与毕业要求的对应关系

毕业要求	指标点	课程目标	关联 (H/M/L)
1. 具有扎实的数学基础，能够将数学、自然科学和专业知识用于解决复杂实际问题。	1.2 掌握统计调查、统计数据处理、统计分析、计算机与统计软件使用等应用统计学的基本理论、知识与方法，具备采集、处理、分析数据的能力，熟悉预研报告、可行性分析报告、研究方案等文档的撰写规范。	2-1—2-6	M
2. 能够借助应用统计学的基本原理、方法和手段，识别、表达、并通过文献研究分析复杂实际问题，以获得有效结论。	2.1 能够借助应用统计学的基本原理、方法和手段，分析、识别、表达本专业相关的复杂实际问题。	1-1—1.3 2-1—2-6	H
	2.2 能够借助应用统计学的基本原理、方法和手段，针对复杂实际问题设计针对性的方案，并综合运用文献、科学理论和技术手段予以解决。	1-1—1.3 2-1—2-6	H
4. 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。	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。	2-1—2-6 3-1—3-2	M

四、主要教学内容

（一）理论教学

第 1 章：Introduction to axiomatic approach, probability basics（支撑教学目标 1-1、1-2、1-3、2-1、2-2、2-6、3-2）

【1】知识点：

(1) History of probability theory.

(2) Frequency approach to probability.

(3) Kolmogorov's axiomatic approach.

(4) Conditional probability and independent events.

(5) Scalar RVs.

【2】学习目标：

了解：History of probability theory.

理解：Frequency approach to probability; Kolmogorov's axiomatic approach.

掌握：Conditional probability and independent events; Scalar RVs.

【3】重点内容：

(1) Conditional probability and independent events.

(2) Scalar RVsThe programming style and documentation.

【4】难点内容：

(1) Kolmogorov's axiomatic approach.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 2 章：Multivariate Gaussian random variables（支撑教学目标 1-3、2-1、2-2、2-6、3-2）

【1】知识点：

(1) Constructing Gaussian vector RVs.

(2) Affine-linear transform of Gaussian vector RVs.

(3) Theorem on normal correlation.

【2】学习目标：

掌握：Constructing Gaussian vector RVs; Affine-linear transform of Gaussian vector RVs; Theorem on normal correlation.

【3】重点内容：

(1) Constructing Gaussian vector RVs.

(2) Affine-linear transform of Gaussian vector RVs.

(3) Theorem on normal correlation.

【4】难点内容：

(1) Theorem on normal correlation.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 3 章：Methods of stochastic simulation（支撑教学目标 1-1、1-2、1-3、2-1、2-2、2-3、2-6、3-1、3-2）

【1】知识点：

(1) Convergence of RVs.

(2) Limit theorems.

(3) Stochastic simulation.

(4) Simulation of RVs.

【2】学习目标：

了解：Convergence of RVs.

理解：Limit theorems; Stochastic simulation.

掌握：Simulation of RVs.

【3】重点内容：

(1) Simulation of RVs.

【4】难点内容：

(1) Convergence of RVs.

(2) Stochastic simulation.

【5】思政案例：

Work autonomously or in teams to demonstrate professional and responsible analysis of real-life problems that require application of mathematics and statistics.

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 4 章：Introduction to stochastic processes，Gaussian SPs，stationary SPs（支撑教学目标 1-2、1-3、2-1、2-2、2-4、2-5、2-6、3-2）

【1】知识点：

(1) General definitions.

(2) Gaussian processes.

(3) Stationary processes.

【2】学习目标：

理解：General definitions.

掌握：Gaussian processes; Stationary processes

【3】重点内容：

(1) Gaussian processes.

【4】难点内容：

(1) Gaussian processes.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 5 章：Markov processes，discrete-time Markov chains（支撑教学目标 1-2、1-3、2-1、2-2、2-4、2-5、2-6、3-2）

【1】知识点：

(1) Definition and general properties.

(2) Gaussian Markov processes.

(3) Chapman-Kolmogorov equations.

(4) Discrete-time homogenous Markov chains.

【2】学习目标：

理解：Definition and general properties.

掌握：Gaussian Markov processes; Chapman-Kolmogorov equations; Discrete-time homogenous Markov chains.

【3】重点内容：

(1) Gaussian Markov processes.

(2) Discrete-time homogenous Markov chains.

【4】难点内容：

(1) Gaussian Markov processes.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 6 章：Continuous-time Markov chains，compound Poisson processes（支撑教学目标 1-3、

2-1、2-2、2-4、2-5、2-6、3-2）

【1】知识点：

(1) Continuous-time homogenous Markov chains.

(2) Compound Poisson processes.

【2】学习目标：

掌握：Continuous-time homogenous Markov chains; Compound Poisson processes.

【3】重点内容：

(1) Continuous-time homogenous Markov chains.

(2) Compound Poisson processes.

【4】难点内容：

(1) Continuous-time homogenous Markov chains.

(2) Compound Poisson processes.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 7 章：ARMA processes（支撑教学目标 1-1、1-2、1-3、2-1、2-2、2-4、2-5、2-6、3-2）

【1】知识点：

(1) Definitions; Motivation.

(2) Filters.

(3) Calculus of shift operator.

(4) Stationarity.

(5) Causality and invertibility.

(6) Non-stationarity.

【2】学习目标：

了解：Definitions; Motivation.

理解：Filters; Causality and invertibility; Non-stationarity.

掌握：Calculus of shift operator; Stationarity.

【3】重点内容：

(1) Calculus of shift operator.

(2) Stationarity.

【4】难点内容：

(1) Calculus of shift operator.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

第 8 章：Elements of diffusion processes，stochastic integration，Ito formula（支撑教学目标 1-2、1-3、2-1、2-2、2-4、2-5、2-6、3-2）

【1】知识点：

(1) Definitions.

(2) Transition densities.

(3) Kolmogorov backward equation in Black-Scholes model.

(4) Stochastic integrals with respect to Brownian motion.

【2】学习目标：

理解：Definitions; Transition densities.

掌握：Kolmogorov backward equation in Black-Scholes model; Stochastic integrals with respect to Brownian motion.

【3】重点内容：

(1) Stochastic integrals with respect to Brownian motion.

【4】难点内容：

(1) Stochastic integrals with respect to Brownian motion.

【5】思政案例：

Use succinct and accurate presentation of reasoning and conclusions to communicate mathematical solutions, and their implications, to a variety of audiences, using a variety of approaches.

五、教学安排与学时分配

This course mainly focuses on classroom teaching, supplemented by discussion forms.

Classroom teaching revolves around the basic concepts, theories, and methods of this course.

The allocation of class hours is shown in Table 2.

表 2 学时分配表

讲 课 内 容		学时				
		讲课	实验	上机	设计	课外
第 1 章	Introduction to axiomatic approach, probability basics	6	0	0	0	0
第 2 章	Multivariate Gaussian random variables	8	0	0	0	0
第 3 章	Methods of stochastic simulation	6	0	0	0	0
第 4 章	Introduction to stochastic processes，Gaussian SPs，stationary SPs	8	0	0	0	0
第 5 章	Markov processes，discrete-time Markov chains	8	0	0	0	0
第 6 章	Continuous-time Markov chains，compound Poisson processes	8	0	0	0	0
第 7 章	ARMA processes	6	0	0	0	0
第 8 章	Elements of diffusion processes，stochastic integration，Ito formula	6	0	0	0	0
小计		56	0	0	0	0
总计	56					

六、教学方法

1、Teach basic principles, integrate theory with practice, emphasize the fundamental theory and application of stochastic processes, and cultivate students' innovative abilities.

2、Using a combination of multimedia courseware and traditional teaching methods to give the classroom vitality.

3、Combining theoretical teaching with discussion forms to stimulate students' learning enthusiasm, cultivate their self-learning ability, teamwork ability, and problem-solving ability.

七、成绩评定

1、This course is assessed based on the concept of full process monitoring, and the score evaluation method is a percentage system. The course assessment includes three parts, namely attendance, homework, and final exam. The specific requirements and scoring methods are as follows:

1、Attendance: Students are required to participate in all aspects of this course. Attendance score accounts for 20% of the total score. If more than one-third of the students are absent from class (including taking leave and skipping classes), their exam qualification for this course will be cancelled.

2、Homework: Class assignments require students to complete independently and submit within the specified time. The homework score accounts for 30% of the total score. Failure to submit assignments on time or plagiarism (similarity) in assignments will result in deduction of points or zero points based on the severity of the situation.

3、Final exam: The final exam accounts for 50% of the total score.

4、Students who fail their regular grades, including attendance and homework, will have their exam eligibility revoked.

八、评价及持续改进

1、Teaching syllabus

Assessment cycle: 4 years, revision cycle: 4 years.

Improvement measures: The course leader organizes all teachers in the course team to discuss and propose improvement suggestions, which are reviewed by the head of the teaching and research department and approved by the dean of the teaching department.

2、Performance evaluation and assessment

Assessment cycle: 1 academic year, evaluation basis: comprehensive analysis of students' final grades.

Improvement measures: Based on the distribution of students' final grades, adjust and optimize the content accordingly, and improve teaching methods.

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