Introduction of SEU International Summer School Program

2021 International Summer Courses on Mathematics and Statistics, Southeast University

This program will select appropriate problem models from the cutting-edge aspects of mathematics and statistics respectively, and introduce the latest research results in the related fields, in order to improve the understanding and utilization of knowledge for students. The emphasis of both theory and application is the highlight of this course. In addition, the reflection of the interdisciplinary cross-integration is also the main goal of this course. The program consists of three 24-period short online courses with 1 credit for each course.

2021 7 5 2021 8 1
July 5, 2021 August 1, 2021

1 Mini Course Selected Topics in Modern Mathematics

Hours/Credits: 24 hours/ 1 credit

Lecturer:
We will invite the teaching team from University of Luxembourg to teach this course, including:
Geometry Prof. Dr. Jean-Marc Schlenker;

Analysis Dr. Fei Pu;
Algebra Prof. Dr. Antonella Perucca (course 1) and Prof. Dr. Gabor Wiese (course 2);
Probability and Statistics Prof. Dr. Ivan Nourdin (course 1) and Prof. Dr. Mark Podolskij (course 2).

Jean-Marc Schlenker

Description

======== GEOMETRY ========

Teacher: Prof. Dr. Jean-Marc Schlenker

Title: The geometry of polyhedra in Euclidean space

Abstract: We intend to present some classical and more recent results on the geometry of convex polyhedra in Euclidean space, as well as some open problems of current interest. The course could fit over 2 sessions of 135mn. Assessment could be done through a few multiple-choice of numerical-answer questions in a moodle-type test.

======== ANALYSIS ========

Teacher: Dr. Fei Pu

Title: Basics of Fourier Analysis

Abstract: I am planning to follow Stein's book to present some basic materials on Fourier Analysis and the key words are: Fourier inversion, Plancherel identity, Poisson summation formula, Theta and zeta functions.

======== ALGEBRA ========

Teachers: Prof. Dr. Antonella Perucca (course 1) and Prof. Dr. Gabor Wiese (course 2)

Title: Finite fields: from the cyclicity of the unit group to Artin's conjecture on primitive roots, Gauss' quadratic reciprocity law, primality tests and the Langlands program

Abstract:
Part 1 -
We start by considering the unit group (Z/pZ)* of the integers modulo a prime number p, and then

investigate the multiplicative order and index of an element in this group. By varying the prime number,

for primitive roots. To understand the conjecture and its heuristics we introduce cyclotomic number fields and Kummer extensions. To conclude we present recent results on this topic obtained by mathematicians in Luxembourg.

Part 2 - A primality test, quadratic reciprocity, and more general reciprocity laws (G. Wiese)
From Part 1, we know that half of the elements in (Z/pZ)* are squares and half are non-squares. The famous quadratic reciprocity law conjectured by Euler and proved by Gauss relates this for two primes: say p_1,p_2 are two primes that are 1 mod 4; then p_1 is a square mod p_2 if and only if p_2 is a square mod p_1. This law can be proved using cyclotomic fields, introduced in Part 1. As a practical application of quadratic reciprocity, we introduce the Solovay-Strassen primality test for deciding if a given positive integer is a prime number or not.
In a final part, we give some hints on generalisations of quadratic reciprocity leading us (vaguely) to the Langlands program.

======== PROBABILITY AND STATISTICS ========

Tentative schedule

Day	Start time	End time	Teacher	Topic
July 5 (Monday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Jean-Marc Schlenker	Geometry
July 8 (Thursday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Jean-Marc Schlenker	Geometry
July 12 (Monday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Antonella Perucca	Algebra
July 15 (Thursday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Gabor Wiese	Algebra
July 19 (Monday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Dr Fei Pu	Analysis
July 22 (Thursday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Dr Fei Pu	Analysis
July 26 (Monday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Ivan Nourdin	Probability and Statistics
July 29 (Thursday)	8:45am (UL time) 2:45pm (SEU time)	11am (UL time) 5pm (SEU time)	Prof. Dr. Mark Podolskij	Probability and Statistics

2 Mini Course: Selected Topics in Frontier of Scientific Computation

2.1 Mini Course: Selected Topics in Frontier of Scientific Computation (Part I) Topic: Machine Learning and Design optimization under uncertainty

Hours/Credits: 12 hours/ 0.5 credit

Lecturer:
Matin Stynes

Beijing Computational Science Research Center
(m.stynes@csrc.ac.cn   http://www.csrc.ac.cn/en/people/faculty/151.html

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Description

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Prerequisites

Calculus, Linear Algebra, Differential Equations, Numerical Analysis. Students are strongly encouraged to use MATLAB for programming.

Textbooks

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Course objectives

After this course, students should be able to

Understand the background of the convection-diffusion problems

Understand the fundamental theory of the one-dimensional convection- diffusion problems

Master the finite difference method for the one-dimensional convection- diffusion problems and its convergence analysis

Class schedule

Hours 1-2	Introduction to the convection-diffusion problems by some motivating examples
Hours 3-4	
	Asymptotic analysis to the convection-diffusion problems,
Hours 7-8	A priori bounds on the solution and decompositions of the solution
Hours 9-10	Upwinding scheme for solving the convection-diffusion problems
Hours 11-12	Shishkin meshes, uniformly convergent schemes

Evaluation methods

Project.

2.2 Mini Course: Selected Topics in Frontier of Scientific Computation (Part II)

Topic: Introduction to Numerical Methods for Stochastic Differential Equations

Hours/Credits: 12 hours/ 0.5 credit

Lecturer:

Yanzhao Cao
Department of Mathematics & Statistics,
Auburn University

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Description

In this short course, I will introduce numerical methods for stochastic differential equations, which have been used widely used in biology, finance and engineering. Topics include Brownian motion and stochastic calculus in linear and nonlinear equations, analytic and numerical methods for SDEs, and parameter estimation for SDEs.

Prerequisites

Calculus, linear algebra, differential equations and probability. Students are strongly encouraged to use MATLAB for programming.

Textbooks

There will be no textbooks but lecture notes will be provided.

Course objectives

After this course, students should be able to

Learn the background and application to the mathematical models with random parameters or stochastic disturbance

Master basic algorithms for solving problems with stochastic disturbance or random parameters

Learn the algorithms to stochastic computation based on machine learning

Class schedule

Hours 1-2	Introduction to stochastic differential equations, including some motivating examples.
Hours 3-4	Random walk, Brownian motion and stochastic calculus, and stochastic differential equations
Hours 5-6	Strong solutions, Well-posedness, Solution techniques
Hours 7-8	Basic concepts of numerical methods for stochastic differential equations, simulation of white and color noises Numerical methods for linear equations: stability and convergence
Hours 9-10	Numerical methods for nonlinear equations. Stiffness and treatment
Hours 11-12	Parameter estimation or stochastic differential equations

Evaluation methods

Project.

3 Mini Course: Categorical Data Analysis

Hours/Credits: 24 hours/ 1 credit

Lecturer:

Prof. Weixin Yao
Department of Statistics, University of California, Riverside

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