科目ナンバリング	G-LAS12 80038 SE76						
授業科目名 <英訳>	Mathematics and Numerical Computing Mathematics and Numerical Computing			担当者所属 職名・氏名	工学研究科　教授　　外輪　健一郎		
群	大学院横断教育科目群	分野(分類)	統計・情報・データ科学系	使用言語	英語		
旧群		単位数	1.5単位	週コマ数	1コマ	授業形態	演習（対面授業科目）
開講年度・ 開講期	2026・後期	曜時限	木4	配当学年	大学院生	対象学生	理系向

（工学研究科の学生は，全学共通科目として履修登録できません。所属部局で履修登録してください。）

[授業の概要・目的]

This course aims to develop students' proficiency in numerical computation and scientific programming using Python, with a particular emphasis on eigenvalue problems and their computational methods. The course is structured in two progressive parts: the first focuses on building Python programming skills and essential mathematical tools (arithmetic operations, class design, polynomials, and orthogonal functions), while the second half concentrates on eigenvalue problems#8212their mathematical foundations, various computational algorithms, and practical applications. Through hands-on programming exercises and project work, students will gain deep understanding of eigenvalue computations and learn to apply these concepts to solve real-world problems in engineering and science.

[到達目標]

Upon completion of this course, students will be able to:

1. Develop practical Python programming skills for scientific computing through implementing numerical algorithms and designing custom mathematical classes (fractions, polynomials)

2. Develop a comprehensive understanding of eigenvalue problems#8212including their mathematical foundations, geometric interpretations, and fundamental role in scientific computation#8212and appreciate the deep connections between theory and applications

3. Implement and apply various eigenvalue computation methods to solve practical problems such as polynomial equation solving, data analysis, and dimensionality reduction (PCA)

[授業計画と内容]

(1) Introduction to Python - Python programming environment, basic syntax, variable types, control structures (loops, conditionals), and simple input/output

(2) Basic Arithmetics Using Python - Arithmetic operations, numerical precision, handling floating-point errors, and basic mathematical functions from NumPy

(3) Manipulating Fractions Using Python Class - Design and implementation of a custom Fraction class; operator overloading; practical applications in exact arithmetic

(4) Python Class for Handling Polynomials - Design and implementation of a Polynomial class; polynomial operations (addition, multiplication, evaluation); symbolic and numerical representations

(5) Orthogonal Functions - Introduction to orthogonal function systems; properties of orthogonal polynomials (e.g., Legendre, Chebyshev); applications in numerical analysis and approximation theory

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Mathematics and Numerical Computing(2)

(6) Introduction to Eigenvalue Problem - Fundamental concepts of eigenvalues and eigenvectors; characteristic polynomial; geometric and physical interpretations; relationship to linear transformations

(7) Estimation of Eigenvalues - Gershgorin's theorem, power iteration method, inverse power iteration method, and deflation method for computing individual eigenvalues

(8) QR Methods - QR decomposition and QR algorithm for simultaneous computation of all eigenvalues; convergence properties; practical implementation in Python

(9) Application of Eigenvalue to Solution of Higher Order Equations - Relationship between polynomial roots and matrix eigenvalues; companion matrix method; finding all solutions of polynomial equations using eigenvalue algorithms

(10) Application of Eigenvalue: Principal Component Analysis (PCA) - Theoretical foundations of PCA; dimensionality reduction; variance maximization; practical applications in data analysis, feature extraction, and image processing

(11) Final Presentation - Each student presents a computational project involving eigenvalue problems or their applications, demonstrating understanding of both theory and implementation

[履修要件]

特になし

[成績評価の方法・観点]

Attendance, assignment and presentation will count.

[教科書]

Detailed lecture notes and handouts will be provided for each session.

[参考書等]

（参考書）
授業中に紹介する

[授業外学修（予習・復習）等]

Assignments will be given as necessary.

[その他（オフィスアワー等）]

This course is offered every other year. Students are encouraged to start planning their final presentation topics by mid-semester.

[主要授業科目（学部・学科名）]