MATH 307 Applied Linear Algebra

Course Outline 2021S1

Linear systems of equations, orthogonality, least squares approximation, eigenvalue problems, matrix decompositions LU, QR and SVD, discrete Fourier transform. Applications: interpolation, finite difference method, data fitting, principal component analysis, Markov chains, PageRank, image deblurring, computed tomography, digital signal processing. Matrix computations with mathematical software Python, SciPy and Jupyter.

Learning Goals

- Summarize properties and constructions of matrix decompositions LU, QR and SVD
- Perform matrix computations using mathematical software Python, SciPy and Jupyter
- Compute solutions of large systems of linear equations using matrix decompositions
- Compute least squares approximations of large linear systems using matrix decompositions
- Compute eigenvalues of large matrices using iterative methods
- Analyze digital signals using the discrete Fourier transform
- Create and analyze mathematical models of real-world phenomenon

Instructor Information

Patrick Walls	Instructor	pwalls@math.ubc.ca
–	Teaching Assistant	–

Online Learning

All communications, course materials, lectures and assessments are deployed via canvas.ubc.ca. Please visit keeplearning.ubc.ca for resources to help you set up, learn effectively online, understand the technologies used at UBC and get support.

Online Lectures

Tuesday	Wednesday	Thursday
2–4pm	2–4pm	2–4pm

- **First lecture is Monday May 10 2-3pm**
- All lectures delivered on Canvas via Zoom
- All lectures to be recorded and posted on Canvas

Schedule

Lectures	Topics
9	**Linear systems of equations.** Gaussian elimination, elementary matrices, LU and Cholesky decompositions, vector and matrix norms, condition number. Applications: interpolation, finite difference method.
9	**Subspaces, orthogonality and least squares approximation.** Orthogonal subspaces, fundamental subspaces of a matrix, orthogonal projection, Gram-Schmidt orthogonalization, QR decomposition. Applications: fitting models to data.
10	**Eigenvalue problems.** Spectral theorem, power method, singular value decomposition, pseudoinverse, SVD expansion. Applications: Markov chains, PageRank, principal component analysis, image deblurring, computed tomography.
8	**Discrete Fourier transform.** Complex vector spaces, discrete Fourier transform, amplitude and phase, fast Fourier transform, convolution theorem. Applications: digital signal processing
36	

Assessments

Quizzes	$5 \times 10\%$ each $= 50\%$
Python Assignments	$4 \times 5\%$ each $= 20\%$
Final Exam	30%

- Weekly quizzes scheduled Monday 2-3pm (except Quiz 2 Tuesday May 25 2-3pm)
- Alternate quiz time to be announced (for students in different time zones)
- Python assignments do not require prior programming experience
- Final Exam delivered on Canvas during the exam period June 21–25

Textbooks and Resources

MATH 307 Course Notes	Mathematical Python
Linear Algebra with Applications	Syzygy
Scientific Computing	

Prerequisites

Linear Algebra	One of MATH 152, MATH 221, MATH 223
Multivariable Calculus	One of MATH 200, MATH 217, MATH 226, MATH 253, MATH 254

- See the UBC Course Schedule

Important Dates

Monday May 10	First day of class
Monday May 24	Victoria Day (no lecture or quiz)
Thursday June 17	Last day of class
June 21–25	Final exam period

- See the UBC Academic Calendar 2020/2021

Student Resources

Science Advising	Health and Wellbeing	Centre for Accessibility
Academic Concession	Academic Integrity	Counselling Services

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website.