MATH 307

Applied Linear Algebra   *Course Outline: Summer 2020*

Linear systems of equations, least squares approximation, singular value decomposition, the discrete Fourier transform and applications: interpolation, finite difference method, data fitting, network analysis, PageRank, computed tomography, image and 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

- Construct and analyze mathematical models of real-world phenomenon

Instructor Information

Patrick Walls	Instructor	pwalls@math.ubc.ca
Xiaowei Li	Teaching Assistant	xli@math.ubc.ca

Online Learning

All communications, course materials, lectures and assessments are deployed via canvas.ubc.ca. This is a new experience for most of us including your instructors. Please visit keeplearning.ubc.ca for resources to help you set up, learn effectively online, understand the technologies used at UBC, take care of yourself, answer questions, and get support in this new context.

Online Lectures

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

- **Lecture 1** is scheduled Monday May 11 2–3pm

- Monday 2–3pm time slot previously scheduled for lectures is now reserved for online quizzes

- All lectures delivered on Canvas via Collaborate Ultra

- All lectures to be recorded and available to view on Canvas after lecture is finished

Textbooks

Scientific Computing	Michael Heath
Linear Algebra with Applications	Keith Nicholson
Digital Signal Processing in Python	Allen Downey
Mathematical Python	Patrick Walls
A First Course in Numerical Methods	Uri Ascher and Chen Greif

Assessments

Quizzes	$5 \times 10\%$ each $= 50\%$
Python Assignments	$2 \times 10\%$ each $= 20\%$
Final Exam	30%

- Quizzes deployed on Canvas with True/False, multiple choice and long answer questions

- Quizzes made available at specific times (2–3pm PST Monday/Tuesday) with a time limit

- File uploads for long answer questions require students to either (i) write solutions on a tablet with a note taking app and upload files, or (ii) write solutions on paper, scan or take photos and upload image files

- Python assignments do not require prior programming experience

- Final Exam delivered on Canvas during the exam period June 22–26

Schedule

Lectures	Topics
10	**Linear systems of equations**: Gaussian elimination, elementary matrices, LU and Cholesky decompositions, errors and condition number, conjugate gradient method. Applications: interpolation, finite difference method.
7	**Least squares approximation**: orthogonal subspaces, normal equations, QR decomposition, Householder transformations, Gram-Schmidt orthogonalization. Applications: data fitting, computed tomography.
10	**Eigenvalue problems**: spectral theorem, singular value decomposition, power method, shift and invert technique. Applications: principal component analysis, image processing, network analysis, PageRank.
9	**Digital signal processing**: complex vector spaces, discrete cosine transform (DCT), discrete Fourier transform (DFT), fast Fourier transform (FFT), convolution theorem. Applications: image compression, image and signal processing.
36	

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 11	First day of class
Monday May 18	Victoria Day (no lecture or quiz)
Thursday June 18	Last day of class
June 22–26	Final exam period

- See the UBC Academic Calendar 2019/2020

Python and Jupyter

All UBC students have access to Python and Jupyter notebooks at ubc.syzygy.ca. See Mathematical Python for an introduction to mathematical computing with Python, SciPy and Jupyter notebooks.

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.