MAT 562 : Advanced Linear Algebra **Spring 2023**

Much of modern mathematics plays out against a backdrop of linear algebra:

- ☐ analysts study differential operators on vector spaces of functions
- ☐ geometers approximate small patches of curved spaces by flat vector spaces
- ☐ topologists use dimensions of vector spaces to count holes in surfaces
- ☐ applied mathematicians use linear approximation to find efficient solutions to many different kinds of complex problems.

Methods of linear algebra are also vitally important to users of mathematics: statisticians, physicists, chemists, engineers, computer scientists, biologists, data scientists, economists, and many others.

One reason why linear algebra is so broadly useful is that it blends the abstract with the concrete. First courses in linear algebra, like UMaine's MAT 262, tend to focus on the concrete aspect of computations with finite matrices. MAT 562, on the other hand, investigates the very flexible theoretical framework that allows those powerful computational methods to be brought to bear on problems in the diverse fields listed above. Students who successfully complete this course will be well-placed to engage with the linear-algebraic aspects of whatever specialty they pursue.

Content: The course begins by introducing the abstract notions of vector spaces and linear maps, in both finite and infinite dimensions. We then proceed to study dual spaces, quotient spaces, tensor products, chain complexes and homology, canonical forms of linear maps, inner-product spaces, and the spectral theorem.

Prerequisites: MAT 262 (linear algebra), MAT 425 (real analysis 1) and MAT 463 (abstract algebra 1). The most important prerequisites are a first course in linear algebra, and some experience with abstract mathematics and proofs.

Credits: 3

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