

**Math 411 – Linear Algebra (3 credits)**  
**University of Hawai‘i at Mānoa**  
**Fall 2016**

**Course catalog description:** Vector spaces over arbitrary fields, minimal polynomials, invariant subspaces, canonical forms of matrices; unitary and Hermitian matrices, quadratic forms.

**Prerequisites:** 307 or 311, and 321; or consent.

**Recommended textbooks:** B. Cooperstein, *Advanced Linear Algebra*, CBC Press  
S. Axler, *Linear Algebra Done Right*, Springer  
K. Hoffman and R. Kunze, *Linear Algebra*, Prentice Hall

**Suggested Schedule**

1. Vector spaces: axiomatic definition, basic constructions, bases and dimension. (2 weeks)
2. Linear transformations: kernel and range, isomorphism theorems, the matrix of a linear transformation. (2 weeks)
3. Theory of a single linear operator: minimal polynomials, invariant subspaces, canonical forms. (3 weeks)
4. Inner product spaces: Gram–Schmidt process, orthogonal complements, projections, dual spaces and transpose, normed spaces (if time allows). (3 weeks)
5. Linear operators on inner product spaces: spectral theorems, polar and singular value decompositions. (2 weeks)
6. Bilinear and quadratic forms (2 weeks)
7. Trace and determinants (if time allows)
8. Tensor products (if time allows)

**Student learning outcomes:** A successful student will:

- have an understanding of the major concepts of linear algebra,
- know the principal results and constructions in the theory,
- be able to compute examples,
- be able to apply techniques learned in 311 and 321 to write proofs beyond an introductory level.

**Program objectives:** Linear algebra is one of the basic and foundational topics in mathematics. It is applied in many areas of mathematics and in related fields. The material covered in 411 directly addresses the linear algebra component of our undergraduate degree at an advanced level. Students will develop their proof techniques and computational abilities. The algorithmic nature of many of the standard proofs addresses that program goal as well.