EE 635: Applied Linear Algebra

Syllabus

- **Systems of linear equations:** Matrix-vector representation, elementary row-operations, row-reduced echelon form, row-equivalence, the complete solution of a homogeneous system of linear equations.
- **Vector-spaces:** Fields, definition of a vector-space, examples, subspaces, sums and intersections of subspaces, span, linear independence, bases, dimension, basis extension, coordinates, calculations of bases concerning solutions of linear equations, quotienting.
- **Linear maps:** Definition, examples, null/kernel space, range/image space, matrix representations of linear maps, row-rank, column-rank, rank-nullity theorem, algebra of linear maps, linear functionals, the double dual.
- **Polynomials:** Rings, ideals, PIDs, prime factorization, quotient ring.
- **Eigenvalues and eigenvectors:** Eigenvalues, eigenvectors, polynomials of a linear map, annihilating polynomial, minimal polynomial, Cayley-Hamilton theorem, invariant subspaces, direct sum decomposition, cyclic subspaces, Jordan canonical form.
- **Inner product spaces:** Inner products, orthogonality, Gram-Schimdt orthogonalization, orthogonal complement, spectral theory of operators on an inner product space.
- **Applications:**
  - Graphs, KCL and KVL.
  - Signal deconvolution using a Wiener filter.
  - Solving linear ODEs, Malgrange's theorem.
  - The geometry of gradient descent.
  - Best approximation.
  - Multi-agent systems.
  - Compressed sensing.

Textbooks

- **K. Hoffman and R. Kunze**, *Linear Algebra*, Pearson, 2015.
- **S. Axler**, *Linear Algebra Done Right*, Springer, 2014.

Grading policy

- **Two quizzes:** 10% + 10%.
- **Midsem:** 20%.
- **Endsem:** 50%.
- **Assignments and class performance:** 10%.