Applications of topics in LA

When learning Linear Algebra the first time, it is often hard to imagine how some of the topics could ever be used in real life, or even in later chapters of Linear Algebra. The gray boxes in the book are devoted to applications, so look over each of those as you come to them. Chapters 2 and 3 have very few gray boxes, so you need some patience and faith then. Also, this page lists some major topics in Leon's book are how they are used later in the book or in non-math applications.

To keep it short, I've left out some common themes such as 'A is nonsingular' (used everywhere) and some ways of factoring a matrix (which can be used to improve some simple algorithms used in this course).

Chap	Topic	Application
1	G.Elim'n	Solving systems (Ch.1), which appear in most sciences Finding A^{-1} or $A^{-1}B$ (used often later!) Finding $N(A)$ (Ch.3)
	REF + RREF	Part of the G.Elim process Used in many proofs later (thm 2.2.2, 3.6.6, etc) finding the row/column/null space of A (Ch3.6)
	E's	understanding G.Elim factoring a nonsingular A (eg in Ch 2.2)
	A^T	converts rows to columns (See Ch3.5) can use it to reverse order (eg $(AB)^T = B^T A^T$) a major tool in Ch5 (to do geometry)
2	Det(A)	Testing if A is singular (Ch.2), can help find A^{-1} (2.3) = a ratio of areas (Multiv. Calc., the Jacobian matrix) Computing eigenvalues (Ch.6)
3	vector space subspaces	= 'the setting' for chapters 4-6, and much science includes nullspaces, column spaces, eigenspaces etc

	nullspace, $N(A)$	Computing eigenvectors (Ch.6) Finding $S^{\perp}$ (Ch.5.2) Finding Ker(L) (Ch4)
	linear indep.	understanding basis, dimension, rank related to singularity of A
	basis	used to define/understand a new vector space a major idea throughout Chs 4-6
4	$L : V \to W$	Physics (L could be a rotation, etc) Computer graphics Differential Equations (L could be the derivative, etc)
	Matrix Rep'n	to study L (ex: Ker$(L) = N(A)$ or to find e'vals of L) to understand similarity of matrices (Ch4.3)
	Similarity	Diagonalization (Ch.6)
5	Projections	Least Squares (approximations, Statistics, many sciences) Used in the Gram-S process (Ch.5.6) Fourier series, Spectral Decomposition (6.4 HW19)
	Inner Products	Provides geometry when $V \neq R^n$ (eg Ch 5.7)
	Gram-S method	Used to get a better (ONL) basis of S in many settings (eg Ch5.7, Ch6.4 Ex4, misc. physics). To get $A = QR$ (for least sq's (Ch5), or eigenvalues (7.6)
6	Eigenvalues	Diagonalization of A (6.3) Solving systems of DE's (6.2)
	Diagonaliz'n	To compute A^n (for a Markov process) or e^A (for DE's)
	A is Hermitian	Quantum physics, Pauli matrices Representation of self-adjoint operators