Abstract. Complex matrix similarity was set on a solid foundation in 1870 by C. Jordan. Among the many canonical forms in matrix analysis, Jordan’s is perhaps the best known and most widely used. Its utility is enhanced by its simplicity. Only one type of canonical block is involved, and all the blocks are determined by a single algorithm that relies on one family of invariants. Simple canonical forms are now known for complex matrix congruence and congruence, equivalence relations no less important than similarity. These new canonical forms involve three types of canonical blocks, which are determined by algorithms that rely on two families of invariants. Starting with a singular square matrix, a regularization algorithm identifies both (a) a family of invariants that determine the singular blocks, and (b) a nonsingular block (the regular part) whose equivalence class is uniquely determined. The invariants of the regular part, and their associated Canonical Form of its cosquare or cosquare. Perhaps the best-known canonical form under congruence is the inertia theorem often attributed to J.J. Sylvester: two Hermitian matrices of the same size are congruent if and only if they have (a) the same number of positive eigenvalues, and (b) the same number of negative eigenvalues. The theory of congruence that we discuss applies to any square complex matrix; it reduce to Sylvester’s Theorem if the matrix is Hermitian. The general theory of congruence also applies to any square complex matrix; for complex symmetric or skew-symmetric matrices, it reduces to the classical fact that their congruence class is determined by their rank. The talk will describe algorithms that determine simple canonical forms for complex matrix congruence and congruence. As time permits, applications of these canonical forms will be discussed, e.g., canonical pairs for a (Hermitian, Hermitian) pair and for a (symmetric, skew symmetric) pair; zero and the field of values; congruence of any matrix and its transpose; congruence class of a normal matrix; canonical forms under unitary congruence and congruence.