Summary Chart of Incompressible Flow Turbulence Models

Created by John M. Cimbala

- The order is from least complex to most complex.
- Consider incompressible flow without buoyancy, but the flow is three-dimensional.
- DNS is included for completeness, even though it is not a turbulence model.

Model Classification	Number of *additional* transport eqs.	Assumptions/Approximations/Models
Algebraic models (zero-equation models)	0	Mixing length
One-equation models	1	Boussinesq eddy viscosity model, $-\rho\overline{u_i u_j} \approx -\frac{2}{3}\rho K\delta_{ij} + 2\mu_e S_{ij}$
Two-equation models	2	
Algebraic Reynolds stress models (ASM)	2	Nonlinear extension of Boussinesq eddy viscosity model, $-\rho\overline{u_i u_j} \approx -\frac{2}{3}\rho K\delta_{ij} + 2\mu_e E_{ij}$ + additional higher-order terms
Reynolds stress models (RSM) & **Anisotropic Dissipation Rate models**	7	Solve for ensemble-averaged quantities only (no details about time-dependent turbulence quantities)
Detached Eddy Simulation (DES) & similar hybrid models (PANS)	additional equations in RANS regions only	Model all turbulent scales, but only in RANS regions
Large Eddy Simulation (LES)	0 (algebraic) or 1 (transport) for smallest scales only	"Exact" time-dependent solution of large scales; Model small-scale turbulence
Direct Numerical Simulation (DNS)	0	"Exact" - solve *all* scales of turbulence (small to large)