Formula 1

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Formula 2

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Formula 3

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Detailed Explanation

The flowchart begins with the fundamental conservation axioms: mass (continuity), momentum (Newton's second law applied to a fluid control volume), and energy (for compressible/thermal flows). Using Reynolds transport theorem and divergence theorem, these integral balances are converted into local partial differential equation (PDE) forms. The stress tensor is decomposed using Cauchy's postulate and constitutive assumptions (Newtonian fluid, linear stress–strain rate relation via viscosity), yielding the full vector Navier-Stokes equations. Subsequent branches apply domain-specific simplifications: incompressibility (?·v = 0) eliminates density variation; steady-state assumption removes time derivatives; negligible viscous terms recover the Euler equations; creeping flow (Re ? 1) drops inertial terms to obtain the Stokes equations; and irrotational, inviscid, steady assumptions lead to Bernoulli's equation along streamlines. Each simplification is annotated with its mathematical consequence, physical validity criteria (e.g., Reynolds, Mach, Froude numbers), and typical applicability domains—enabling practitioners to trace modeling fidelity versus computational cost trade-offs. The flowchart also highlights common pitfalls, such as misapplying Bernoulli across regions with vorticity or ignoring thermal coupling in high-speed compressible flows.

Key Components

#	Component
1	Conservation Law Foundations
2	Constitutive Relations (Newtonian Stress Tensor)
3	Dimensionless Number-Guided Simplification Logic

Applications

#	Application
1	Computational Fluid Dynamics (CFD) model selection
2	Undergraduate and graduate fluid mechanics curriculum design
3	Engineering design validation (e.g., aerodynamic vs. microfluidic regimes)

Related Concepts

#	Concept
1	Reynolds Transport Theorem
2	Cauchy Stress Tensor
3	Dimensionless Numbers (Re, Ma, Fr)

Tags

> fluid-dynamics, navier-stokes, flowchart, continuum-mechanics, engineering-education