Basic Definitions

1. Fluid: A liquid or a gas that flows/deforms continuously under the action of a shearing/tangential stress, no matter how small that shear stress may be.
2. Shearing stress: The stress component that is tangential to the sides of a fluid element acting to deform the element; $\tau = F / A$.
3. Velocity gradient: Rate at which velocity changes in a given spatial direction. In fluids, velocity gradients are a measure of the local rates of strain/deformation of fluid elements.
4. Newton's law of viscosity: It states that the shearing stress and the rate of deformation are directly proportional through a constant of proportionality called viscosity; $\tau = \mu \,\mathrm{d}u / \mathrm{d}y$.
5. Newtonian fluid: A fluid that obeys Newton's law of viscosity, and which is characterized by the presence of shear stresses that vary linearly with velocity gradients indicative of local rates of strain/deformation.
6. Viscosity: Also called "dynamic viscosity," or "first coefficient of viscosity," is the constant of proportionality in Newton's law of viscosity that relates shearing stresses to fluid motions. Viscosity is a measure of the fluid resistance to deformation. It is equal to the applied tangential stress needed to produce a unit of deformation rate; $\mu = \dfrac{\tau}{\mathrm{d}u / \mathrm{d}y}$. The higher the viscosity, the higher will be the stress needed to produce a given rate of deformation.
7. Apparent viscosity: Is the slope of the shearing stress versus rate of strain which varies with the rate of strain for non-Newtonian fluids. For Newtonian fluids, the apparent viscosity is the same as the dynamic viscosity; $\eta = \dfrac{\tau}{\mathrm{d}u / \mathrm{d}y} = k(\mathrm{d}u / \mathrm{d}y)^{n-1}$.
8. Kinematic viscosity: Is the viscosity per unit density; $\nu = \mu / \rho$.
9. Non-Newtonian fluid: A fluid that does not obey Newton's law of viscosity. In non-Newtonian fluids, shearing stresses and rates of strain/deformation are not linearly related.
10. Dilatant fluid: Also called "shear-thickenning," this is a non-Newtonian fluid with an apparent viscosity that increases with increasing deformation rate.
11. Pseudoplastic fluid: Also called "shear-thinning," this is a non-Newtonian fluid with an apparent viscosity that decreases with increasing deformation rate. Most non-Newtonian fluids fall under this category.
12. Steady flowfield: Flowfield where velocity does not vary with time at any spatial location. In a time-independent field, the velocity may only vary from one spatial location to another.
13. Unsteady flowfield: Flowfield in which velocity components can vary with time.
14. Uniform velocity: Constant velocity at a given station or spatial location.
15. Uniform flowfield: Flowfield where velocity is everywhere the same.
16. One-dimensional flowfield: Flowfield where velocity can be fully determined by specifying one independent spatial coordinate.
17. Two-dimensional flowfield: Flowfield where velocity can be fully determined by specifying two independent spatial coordinates.
18. Streamlines: Instantaneous lines that are everywhere tangent to the velocity vector.
19. Streaklines: Lines joining particles that have, at some instant, passed through the same point in space.
20. Pathline: A path/trajectory traced out by a single particle in the flow.
21. Timeline: A line of adjacent fluid particles identified at a given instant of time.
22. Inviscid flow: A shearless/frictionless flow in which viscosity is ignored (sometime called "ideal"). Such flows may be used to approximate the behavior of fluids in regions that are removed from solid boundaries.
23. No-slip condition: An extraordinarily important boundary condition that is often employed to solve fluid problems. It states that fluid particles in direct contact with solid boundaries will adhere/stick to the boundaries because of viscosity. As a result, the velocity of fluid layers that are in contact with solid surfaces will be the same as the velocity of contact surfaces.
24. Viscous flow: A "real" flow where viscosity plays an important role, such as in the vicinity of solid boundaries where the velocity-adherence (no-slip) condition must be satisfied.

25. Reynolds number: Is the product of the density, average velocity, characteristic length, and the reciprocal of the viscosity; $\mathrm{Re} = \dfrac{\rho V L}{\mu}$.
26. Laminar flow: A well-structured flow characterized by smooth and organized motion of fluid particles in laminae or well-defined layers, usually occurring at relatively small Re.
27. Turbulent flow: An unstable/agitated flow characterized by unorganized motion of fluid particles in random directions, usually occurrig at higher Re. In turbulent flows, Newton's shear-strain rate relationship holds no more.
28. Critical Reynolds number: An average value of Re above which the flow is expected to become turbulent.
29. Boundary layer region: A region that is established near solid boundaries that is characterized by the presence of viscous forces, rotationality (vorticity), and nonzero velocity gradients.
30. Boundary layer thickness: A measure of the distance from the solid boundary to the point where the presence of the boundary is no longer significant, and where, typically, the velocity would have reached 99% of its final value.
31. Absolute pressure: The actual thermodynamic, or static pressure, a compressive local stress caused by the level of packing of fluid molecules, generating pressure forces that are normal to the contact surfaces.
32. Gage pressure: The amount by which pressure exceeds the local atmospheric pressure.
33. Vacuum pressure: The amount by which pressure falls short of the local atmospheric pressure.
34. Favorable pressure gradient: It occurs when the pressure decreases in the flow direction; $\mathrm{d}p/\mathrm{d}x < 0$.
35. Adverse or unfavorable pressure gradient: It occurs when the pressure increases in the flow direction; $\mathrm{d}p/\mathrm{d}x > 0$. This can induce flow separation or detachment from the solid boundaries.
36. Attached flow: Flow in which the boundary layer is attached to the surface.
37. Separated flow: Flow in which the boundary layer becomes unattached from the surface causing a separated region to form. The flow separates at the point where the velocity gradient normal to the wall vanishes (velocity does not increase above the wall; $\mathrm{d}u/\mathrm{d}y = 0$). This often occurs as a result of fluid particles losing their momentum in presence of an adverse pressure gradient, when not possessing enough energy to overcome the higher pressure ahead.
38. Incompressible flow: Flow in which density variations are negligible; $\nabla \cdot \vec{V} = \dfrac{1}{\forall}\dfrac{\mathrm{d}\forall}{\mathrm{d}t} = -\dfrac{1}{\rho}\dfrac{\mathrm{d}\rho}{\mathrm{d}t} = 0$.
39. Compressible flow: Flow in which density variations are not negligible, such as in high speed gas motions.
40. Vorticity: It is twice the average angular velocity vector of fluid particles that is a measure of the intensity of local angular rotation. Rapid velocity changes lead to large relative motions between fluid layers and therefore to large angular speeds of spinning particles. Large vorticity implies large velocity gradients (i.e., rapid changes in speed) and large viscous stresses; $\vec{\zeta} \equiv 2\vec{\omega} = \nabla \times \vec{V}$.
41. Rotational flow: Flow in which vorticity is present; $\nabla \times \vec{V} \neq 0$.
42. Irrotational flow: Flow in which vorticity is not present; $\nabla \times \vec{V} = 0$.
43. Body force: A force that is distributed over the entire body/volume of the fluid and acting from a distance. Gravitational, buoyancy, electromagnetic, coriolis, centrifugal, and inertial forces are examples of body forces.
44. Surface force: A force that is developed through direct physical contact with the boundaries of a medium. Viscous, friction, pressure, drag, and lift forces are examples of surface forces.
45. Volumetric flow rate: Volume of fluid crossing a given cross-sectional area in space per unit time; $Q = \int_A \vec{V} \cdot d\vec{A}$.
46. Mass flow rate: Mass of fluid crossing a given cross-sectional area in space per unit time; $\dot{m} = \int_A \rho \vec{V} \cdot d\vec{A}$.
47. Basic laws and constitutive equations: Conservation of mass, momentum (Newton's second law), and energy (first law of thermodynamics) equations. Ideal gas equation and the Newton's law of viscosity. Vorticity transport equation (curl of the momentum), second law of thermodynamics, and angular momentum equations.