(3%) 1. Streamlines are lines which are tangent to the velocity vector at any of their points. Yes or no?

(3%) 2. Pathlines are lines which are tangent to the velocity vector at any of their points. Yes or no? Why?

(5%) 3. In fluid flow, conservation of volume is equivalent to conservation of mass. Yes or no? Why?

(5%) 4. "$\frac{P}{\rho} + \frac{V^2}{2g} + gz = \text{constant}$" is called the Bernoulli equation, and is universally available in the flow field. Yes or no? Why?

(5%) 5. The dimensional formula for pressure is $ML^{-2}T^{-2}$ Yes or no? Why?

(5%) 6. In a fluid flow, the direction of the acceleration vector coincides always with that of the pressure gradient. Yes or no? Why?

(5%) 7. In steady fluid flow, the net momentum flux equals the sum of the forces on the control volume considered. Yes or no? Why?

(5%) 8. The assumption of incompressibility is acceptable in Fluid Mechanics only for liquids, not for gases. Yes or no. Why?

(5%) 9. A fluid with variable density cannot be incompressible. Yes or no? Why?

(5%) 10. $\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \vec{V}) = 0$ is valid for both laminar flow and turbulent flow. Yes or no? why?

(5%) 11. Conservation of volume is a consequence of conservation of mass. Yes or no? why?

(5%) 12. When the velocity of a flow is given by $\vec{V} = \nabla \phi$, the flow is irrotational, i.e. $\nabla \times \vec{V} = 0$. Yes or no? Why?

(5%) 13. If a fluid flow can be expressed in terms of a stream function, so that $V_x = \frac{\partial \Psi}{\partial y}$, $V_y = -\frac{\partial \Psi}{\partial x}$, the fluid must behave as incompressible. Yes or no? Why?

14. A two-dimensional flow is given by a velocity potential $\phi = (\sin xy)(\cos kt)$, where x and y denote the Cartesian coordinates, t the time, k a constant.

(3%) ① Conservation of volume cannot be checked for this flow because we do not know if the density is constant. Yes or no? Why?

(3%) ② This flow has constant vorticity. Yes or no? Why?

(3%) ③ This flow has local acceleration different from zero but the convective acceleration is zero everywhere. Yes or no? Why?

(4%) ④ There are infinite points in this flow with zero velocity. Yes or no? Why?

(5%) 15. The Navier-Stokes equations for the flow of a Newtonian, incompressible fluid with constant viscosity μ is given in vector form by

$$\rho\frac{\partial\vec{V}}{\partial t}+\rho(\vec{V}\cdot\nabla)\vec{V}=-\nabla P+\mu\nabla^2\vec{V}+\rho\vec{f}$$

Explain in words what each term of the equation represents.

(5%) 16. The circulation in irrotational flows is always zero. Yes or no? Why?

17. Explain the physical meaning of

(3%) (a) Reynolds number,

(3%) (b) Froude number

(10%) 18. Draw the Moody's diagram and explain it briefly.