MOMENTUM TRANSFER

1. What is the meaning of no slip boundary condition? What happens if system works in slip boundary condition?
   Ans: when velocity of adjacent layer of fluid is equal to velocity of solid surface, there is no slip boundary condition. In slip boundary condition, effect of solid boundary on fluid flow will not be considered.

2. Write the assumption for solving problem of air flow in pipe at moderate velocities?
   Ans: Newtonian fluid, constant viscosity, steady state and isothermal condition.

3. Write the condition when viscosity of fluid is not constant for Newtonian fluids?
   Ans: Viscosity is function of temperature for Newtonian fluid. For non-isothermal condition viscosity will not be constant.

4. Write comparison between Newton's law of viscosity and Hooke's law of elasticity?
   Ans: Newton's law of viscous deformation deals with deformation of fluids which is subjected to a load. As load is removed, the fluid does not recover its original shape. It is time dependent deformation. Newton' law state that shears stress is proportional to shear strain. Hooke's law of elasticity deals with deformation in solids which are subjected to a load. As load is removed, the solid recovers its original shape instantaneously. It is not time dependent deformation. Hooke's law states that stress is proportional to strain.

5. What is the physical significance of Reynolds's number?
   Ans: It is ratio of inertial force to viscous force. Reynolds's number is used to characterize different flow regimes. Turbulent flow occurs at high Reynolds number and laminar flow at low Reynolds number. Viscous force is dominant in laminar flow while inertial force in turbulent flow.

6. What are the reasons of turbulent flow?
   Ans: Turbulent flow causes due to disturbances and noise present in environment.

7. If fluid is flowing in between two parallel plates due to motion of lower plate. How many boundary layers are formed?
   Ans: Two boundary layers are formed. At upper surface, velocity of fluid will be zero while it is equal to the velocity of solid boundary at lower surface.

8. Is a boundary layer formed if fluid is fully slip on solid surface?
   Ans: No. For slip boundary condition, velocity of fluid is not equal to velocity of solid surface.

9. What is the meaning of fully developed and developing flow region?

Ans: If boundary layer region keep growing along the direction of flow, it is called developing flow region. Velocity is function of radial and axial direction in developing flow region while it is only function of radial direction in fully developed flow.

10. When we can take assumption of neglecting developing flow region?
Ans: If length of pipe or tube is very large compared to width or diameter of pipe, effect of developing flow region can be neiglected.

11. How can we define momentum flux and how it is different to shear stress?
Ans: Momentum flux is defined as transport of momentum of fluid per unit surface area per unit time. It is same as shear stress but only at opposite direction. Shear stress is defined as the force acting by solid boundary on fluid per unit surface area. But momentum flux of fluid act the force on solid boundary.

12. Write the boundary conditions at air-water interface in a channel which is filled by half of water and half of air. Water is flowing due to very high air velocity which produces drag on water?
Ans: Shear stresses are equal at air-water interface.

13. In wire coating problem if wire is rotating with angular velocity Ω and moving axially with velocity v_z. Write the non-zero velocity component and direction where these velocities are changing?
Ans: Non-zero velocities are v_z and v_θ. v_z and v_θ are function of r direction only.

14. How can we incorporate developing flow region in Hagan –Poiseuille equation If we use a capillary flow meter with small length?
Ans: Basically Hagan-Poiseuille equation is used for fully developed region. We can incorporate developing flow region in Hagan-Poiseuille equation by using effective length L_{eff}.

15. A Newtonian fluid is flowing in a rectangular channel. Write the non-zero velocity components and where these velocities are changing?
Ans: v_z and v_x are the non zero velocities and they depend on z and x directions.

16. A Newtonian fluid is flowing through a narrow slit. Find relation between friction factor and Reynolds's number for laminar flow?
Ans.

Friction Factor $= f = \dfrac{\tau_w}{\dfrac{1}{2}\rho v_{avg}^2}$

For Narrow Slit

$$\tau_{xz} = -\frac{(p_L - p_o)}{L} x$$

$$\tau_w = -\frac{(p_L - p_o)}{L} B$$

$$v_{avg} = -\frac{1}{3} \frac{(p_L - p_o)}{\mu L} B^2$$

Substituting in friction factor equation

$$f = \frac{6}{\dfrac{B\rho v_{avg}}{\mu}}$$

$$f = \frac{12}{N_{Re}}$$