K.L.E Society's
S. Nijalingappa College
II BLOCK RAJAJINAGAR, BENGALURU -10

PG Department of Mathematics
QUESTION BANK

Fluid Mechanics:

1. State and prove Kelvin's minimum energy theorem.
2. State and prove Blasius theorem
3. Find the image doublet of strength 'μ' whose axis makes an angle 'α' with the positive direction of x-axis and passes through $z = a$.
4. Derive Helmholtz vorticity equation in its usual form and hence deduce that $\frac{\vec{\omega}}{\rho}$ is constant, for a two dimensional flow.
5. Write a short note on
   (i) Dimensional analysis (ii) Dimensional homogeneity
   (iii) Reynolds number (iv) Froude number

   Find the image doublet of strength 'μ' whose axis makes an angle 'α' with the positive direction of x-axis and passes through $z = a$.
   State and prove Blasius theorem.

5. Show that in a two dimensional flow having a complex potential $w = \frac{ik}{2\pi}\log z$, the circulation around any closed curve on $x -$ axis is constant.

   Derive the stress-strain rate relation for a linear isotropic compressible viscous fluid in its usual form.
6. Obtain the velocity distribution, maximum velocity, average velocity and mass flow rate for Hagen-Poiseuille flow.
7. Derive the complex potential for a point source flow. Plot the stream lines and potential lines
8. State and prove Milne-Thomson circle theorem.
9. Obtain the complex potential for a flow whose uniform velocity vector is inclined at

10. an angle $'\alpha'$ to the horizontal x-axis.

11. Define complex potential and discuss the flow whose complex potential is given by $w = \frac{2f}{z}$, where f is a constant

12. Establish permanence of irrotational motion for an inviscid flow.

b) Write a short note on
   (i) Dimensional analysis
   (ii) Dimensional homogeneity
   (iii) Froude number
   (iv) Euler number.

13. Obtain the velocity distribution for Stokes's second problem.

14. Derive the Prandtl boundary layer equations for an incompressible viscous fluid flow over a flat plate in their usual form.

15. Derive the equation of state connecting pressure, density and temperature.

16. Derive the equation of impulsive motion and deduce that the impulsive pressure satisfies the Laplace equation in the absence of body force.

17. Obtain the equation for speed of sound in a gas. Show that the irrotational motion of a fluid occupying a simple connected region has less kinetic energy than any other motion consistent with the same normal velocity on the boundary.

18. For a flow due to a uniform stream U along the negative x-axis, a source m_1 at the origin and another source m_2 at $z = z_0$, show that the complex potential of this combination is the sum of the complex potential of individual flows.

19. Find the image system of a flow whose complex potential is given by $w = \frac{ik}{2\pi} \ln(z - a)$, where k is a constant.

20. Obtain the velocity distribution for a plane-Poiseuille flow

21. Obtain the equation for speed of sound in a gas.

22. Using a similarity transformation on Prandtl boundary layer equations, obtain non-linear Blasius equation $\frac{d^3 f}{d\eta^3} + f \frac{d^2 f}{d\eta^2} = 0.$.

23. Obtain the velocity distribution for Stokes's first problem in the form $u = U\,[1 - \text{erf}(\eta)]$, where the quantities have their usual meaning.

24. Stating the assumptions made, derive the vorticity transport equation in the form

$\frac{D\vec{w}}{Dt} = \nu \nabla^2 \vec{w}$, where the quantities have their usual meaning and show that $\vec{w}$ decays rapidly with time.

25. Derive the equation of motion for a steady compressible isentropic flow in the form $PV^{\gamma} =$ constant, where the quantities have their usual meaning.