**STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086**
**(For candidates admitted during the academic year 2004 – 05 & thereafter)**

**SUBJECT CODE : MT/PC/FD34**

**M. Sc. DEGREE EXAMINATION, NOVEMBER 2007**
**BRANCH I - MATHEMATICS**
**THIRD SEMESTER**

**COURSE : MAJOR – CORE**
**PAPER : FLUID DYNAMICS**
**TIME : 3 HOURS** **MAX. MARKS : 100**

**SECTION – A** **( 5 X 8 = 40 )**

**ANSWER ANY FIVE QUESTIONS**

1. Define Local and Particle rates of change and find the relation between them.
2. Derive the equation of continuity for a fluid moving in a fine tube of variable section $A$ in the form $A\frac{\partial \rho}{\partial t}+\frac{\partial}{\partial s}(A\rho v)=0$
3. Define pressure at a point in a moving fluid and prove that the pressure p at any point p of a moving inviscid fluid is the same in all directions.
4. Define Stoke's stream function and prove that it is constant along stream lines.
5. Find the equations of stream lines due to uniform line sources of strength "m" through the points A(-c,0), B(c,0) and a uniform line sink of strength "2m" through the origin.
6. Discuss the flow due to a uniform line doublet at O of strength $\mu$ per unit length, its axis being along $\overline{OX}$.
7. Derive an expression for energy dissipation due to viscosity in the form $W=\mu\int_V \zeta^2 \, dv$

**SECTION – B** **( 3 X 20 = 60 )**

**ANSWER ANY THREE QUESTIONS**

8. a) Derive the equation of continuity in the form $\frac{\partial \rho}{\partial t}+\nabla.(\rho\vec{q})=0$. Prove that for a homogeneous, irrotational incompressible fluid, the velocity potential $\phi$ satisfies Laplace's equation.

   b) Show that a fluid of constant density can have a velocity $\overline{q}$ given by

$$\overline{q}=\left[\frac{-2xyz}{\left(x^2+y^2\right)^2},\frac{\left(x^2-y^2\right)z}{\left(x^2+y^2\right)^2},\frac{y}{x^2+y^2}\right].$$

9. a) Derive Euler's equation of motion in the form $\frac{d\bar{q}}{dt} = \bar{F} - \frac{1}{\rho}\nabla p$. Deduce Bernoulli's equation from it.
   b) State and prove Kelvin's theorem on circulation.

10. a) State and prove Milne-Thomson circle theorem.
    b) Discuss the flow through a tube having uniform elliptic cross-section and prove that the total volume discharged per unit time is $Q = \frac{\pi P a^3 b^3}{4\mu(a^2 + b^2)}$

11. a) State and prove Blasius theorem.
    b) Prove that an infinite circular cylinder in uniform stream, with circulation experiences an uplifting force.

12. a) Derive Navier-Stoke's equation of motion of a viscous fluid.
    b) Discuss the problem of steady motion between parallel planes and prove that the velocity profile between the plates is $v(z) = \left(\frac{V}{h} + \frac{Ph}{2\mu}\right)z - \frac{P}{2\mu}z^2$. Find the total flow per unit breadth.

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