STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2009-10 & thereafter)

SUBJECT CODE : MT/PE/FD43

M. Sc. DEGREE EXAMINATION, APRIL 2012
BRANCH I – MATHEMATICS
FOURTH SEMESTER

COURSE : ELECTIVE
PAPER : FLUID DYNAMICS
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

ANSWER ANY FIVE QUESTIONS : **(5 X 8 = 40)**

1. Define vorticity vector. Prove that vortex lines and tubes cannot originate or terminate at internal points in fluid.

2. For a fluid moving in a fine tube of variable section A, prove from first principles that the equation of continuity is $A\ \frac{\partial \rho}{\partial t} + \frac{\partial}{\partial \Delta}\ (A\rho v) = 0$ where v is the speed at a point P and $'s'$ is the length of tube upto P. What does this become for steady incompressible flow?

3. Discuss the case of steady motion under conservative body forces.

4. State and prove Kelvin's theorem on circulation.

5. Discuss the uniform flow past a fixed infinite circular cylinder.

6. Find the equation of the streamlines due to uniform line source of strength m through the points $A(-c, 0), B(c, 0)$ and a uniform line sink of strength $2m$ through the origin.

7. Discuss steady flow through tube of uniform circular cross section.

SECTION – B

ANSWER ANY THREE QUESTIONS : **(3 X20 = 60)**

8. a) Derive the equation of continuity for a homogeneous incompressible fluid.
   b) Prove the acceleration of a fluid in the form
   $$\bar{f} = \frac{\partial \bar{q}}{\partial t} + \nabla\left(\frac{1}{2}q^2\right) - \bar{q} \wedge (\nabla \wedge \bar{q})$$

9. a) Show that at any point P of a moving inviscid fluid the pressure p is the same in all directions.
   b) Derive Euler's equation of motion and deduce Bernoulli's equation from it.

..2

10. a) Discuss three dimensional flow due to a doublet present in a uniform stream.
    b) Obtain the complex velocity potential for line doublets in two dimensional flow.

11. a) State and prove Blasiu's theorem.
    b) Show that if an infinite circular cylinder with circulation is placed in the flow of an uniform stream then the cylinder will experience an uplifting force.

12. a) Derive the Navier – Stoke's equation of motion of a viscous fluid.
    b) Discuss the steady motion between parallel planes.