STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted from the academic year 2011-12)

SUBJECT CODE : 11MT/PE/FD44

M. Sc. DEGREE EXAMINATION, APRIL 2013
BRANCH I – MATHEMATICS
FOURTH SEMESTER

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

SECTION – A

ANSWER ALL QUESTIONS : **(5 X 2 = 10)**

1. Verify the flow with $\vec{q} = [-\omega y, \omega x, 0]$ $\omega = const.$ is of potential kind?
2. Write down the Euler's equation of motion.
3. Define simple source and simple sink.
4. State Milne-Thomson circle theorem.
5. What do mean by laminar flow?

SECTION – B

ANSWER ANY FIVE QUESTIONS : **(5 X 6 = 30)**

6. Define vorticity vector, prove that the vortex tube and vortex lines cannot originate or terminate at internal points of fluid flow.
7. Derive the acceleration of a fluid in the form $\vec{f} = \frac{\partial \vec{q}}{\partial t} + \nabla\left(\frac{1}{2}q^2\right) - \vec{q} \wedge (\nabla \wedge \vec{q})$.
8. Derive the Bernoulli's equation for homogeneous incompressible fluid under the assumptions that the body forces are conservative.
9. State and prove the Kelvin's theorem.
10. Describe in detail the doublet in uniform stream.
11. Find the equations of the streamlines due to uniform line sources of strength m through the points $A(c, 0), B(c, 0)$ and a uniform line strength $2m$ through the origin.
12. Discuss the steady motion between parallel planes.

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SECTION – C

ANSWER ANY THREE QUESTIONS : (3 X 20 = 60)

13. a) Derive the equation of continuity for the homogeneous incompressible fluid. (12)

    b) At the point in an incompressible fluid having spherical polar coordinates (r, θ, ψ), the velocity components are $[2Mr^{-3}\cos\theta\,, Mr^{-3}\sin\theta\,, 0]$ where M is a constant. Show that the velocity is of potential kind. Find the velocity potential and the equations of stream lines. (8)

14. a) Explain how Pitot tubes are used to measure the fluid velocities. (8)

    b) Discuss the case of steady motion under conservative body forces. (12)

15. a) Prove that for irrotational incompressible two dimensional flow the equipotential and streamlines intersect orthogonally. (10)

    b) Discuss the flow for which $w = z^2$. (10)

16. a) State and prove Blasius theorem. (12)

    b) Prove that an infinite circular cylinder in uniform stream with circulation experiences an uplifting force. (8)

17. a) Derive the Navier-Stoke's equation of motion of viscous fluid. (10)

    b) Obtain the rate of discharge of viscous fluid flowing steadily through a tube having uniform elliptic cross-sections. (10)