STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI 600 086
(For candidates admitted during the academic year 2015 – 16 and thereafter)

SUBJECT CODE : 15MT/PC/FD34

M. Sc. DEGREE EXAMINATION, NOVEMBER 2019
BRANCH I - MATHEMATICS
THIRD SEMESTER

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

SECTION – A

ANSWER ALL THE QUESTIONS: **(5 × 2 = 10)**

1. When is a flow said to be steady?
2. What is Beltrami vector?
3. Give an example for an axi-symmetric flow.
4. Define complex velocity potential.
5. Define Laminar flow.

SECTION – B

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

6. 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 the potential kind. Find the velocity potential and the equations of the streamlines.
7. Obtain the acceleration of a fluid.
8. Derive Bernoulli's equation of motion.
9. Discuss the flow described by $w = z^2$.
10. Show how the circle theorem applied to determine modified flows when a long circular cylinder is introduced into a given 2 dimensional flow.
11. Discuss the case of steady motion under conservative body forces.
12. Derive Navier-Stokes equation of motion.

SECTION – C

ANSWER ANY THREE QUESTIONS: **(3 × 20 = 60)**

13. a) Show that at all points of the field of flow the equipotentials are cut orthogonally by the streamlines.
    b) State and prove the Equation of Continuity.

…2

14. a) Derive Euler's equation of motion.

b) *AB* is a tube of small uniform bore forming a quadrantal arc of a circle of radius *a* and centre *O*, *OA* being horizontal and *OB* vertical with *B* below *O*. The tube is full of liquid of density ρ, the end *B* being closed. If *B* is suddenly opened, show that initially $u/dt = 2g/\pi$, where $u = u(t)$ is the velocity, and that the pressure at a pont whose angular distance from *A* is θ immediately drops to $\rho g a\ (\sin\theta - \frac{2\theta}{\pi})$

15. a) Derive the stream function for i) a uniform flow of magnitude *U*; ii) a uniform line source of strength *m*.

b) Find the velocity potential due to the doublet at O. (12+8)

16. a) 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 sink of strength $2m$ through the origin.

b) State and prove Blasius theorem. (8+12)

17. a) State and prove Uniqueness theorem.

b) Obtain the total volume of fluid discharged per unit time in a tube having uniform elliptic cross-section. (12+8)