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 2017
BRANCH I - MATHEMATICS
THIRD SEMESTER

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

SECTION – A

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

1. Define lamellar vector.
2. State any one important result in hydrostatics.
3. Give an example of an axi-symmetric flow.
4. Show that in a 2-dimensional flow the vorticity vector is perpendicular to the plane of flow.
5. Write down the tensor form of equation of motion.

SECTION – B

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

6. Show that at all points of the field of flow the equipotentials are cut orthogonally by the stream lines.
7. Explain how to measure the fluid velocities using Pitot tube.
8. Show that the stream lines lie in planes passing through the axis of the doublet.
9. Doublets of strengths $\mu 1, \mu 2,$ are situated at points A_1, A_2 whose Cartesian coordinates are $(0, 0, c_1)$, $(0, 0, c_2)$, their axes being directed towards and away from the origin respectively. Find the condition that there is no transport of fluid over the surface of the sphere $x^2 + y^2 + z^2 = c_1 c_2$.
10. Discuss the flow for which $w = z^2$.
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 sink of strength $2m$ through the origin.
12. Discuss the steady viscous flow in tubes of uniform cross-section.

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SECTION – C

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

13. (a) Prove that the vortex lines and tubes cannot originate or terminate at internal points in a fluid.

    (b) With the usual notation prove that $f = \frac{\partial \vec{q}}{\partial t} + \nabla\left(\frac{1}{2}\vec{q}^2\right) - \vec{q}\Lambda(\nabla\Lambda\vec{q})$.

(10+ 10)

14. (a) Derive Bernoulli's equation of motion.

(b) Discuss the steady motion of a fluid and the conservative body forces considering the different cases that arise.

(10 + 10)

15. Prove that the velocity potential at a point P due to a uniform finite line source AB of strength m per unit length is of the form $\psi = m\, log\, f$, where

$$f = \frac{r_2+x_2}{r_1+x_1} = \frac{r_1-x_1}{r_2-x_2} = \frac{a+l}{a-l}$$

in which $AB = 2l$, $PA = r_1$, $PB = r_2$, $NA = x_1$, $NB = x_2$, N being the foot of the perpendicular from P on the line AB, and $2a$ the length of the major axis of the spheroid through P having A, B as foci.

16. State and prove the theorem of Blasius and use it to prove that an infinite circular cylinder in a uniform stream with circulation experiences an uplifting force.

17. (a) Derive the Navier stokes equation of motion of a viscous fluid.

    (b) Discuss the steady flow between concentric rotating cylinder. (10 + 10)