C 80710 (Pages : 3) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, MARCH 2020

(CUCSS)

Mathematics

MT 4E 09—FLUID DYNAMICS

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *the questions.*

Each question carries weightage 1.

1. What is the transport theorem ?
2. Show that a vortex filament cannot terminate at a point within the fluid.
3. Obtain the pressure equation for irrotational motion.
4. Define reducible circuit in a region and give an example of it.
5. Show that the stream function is constant along a streamline.
6. Obtain the equation satisfied by the velocity potential.
7. State Blasius's theorem.
8. What is Cavitation ?
9. Write a note on Aerofoil.
10. Determine the stagnation points if $w = 2z + 3iz^2$.
11. Let there be a source of strength m at $z = f$, where f is real, outside the cylinder of radius a whose centre is at the origin. Determine the complex potential.
12. What is axisymmetrical motion ?
13. Apply Rankine's method to drawing the streamlines for the flow due to two equal sources.
14. How are air ship forms formed ?

(14 × 1 = 14 weightage)

Turn over

Part B

Answer any **seven** *questions.*
Each question carries weightage 2.

15. Consider the fluid body which at time t occupies the interior of a closed surface S. Determine the rate of change of momentum within S as S moves about with the fluid.

16. Derive the velocity from the stream function.

17. Derive Bernoulli's equation.

18. Show that the velocity potential $\phi = \frac{1}{2}\log\frac{(x+a)^2+y^2}{(x-a)^2+y^2}$ gives a possible motion, and determine the form of the streamlines.

19. State and prove Circle theorem.

20. Prove that the velocity potential $\phi = U\left(r+\frac{a^2}{r}\right)\cos\theta$ represents a streaming motion past a fixed circular cylinder.

21. State and prove the theorem of Kutta and Joukowski.

22. Show that if we map the z-plane on the ξ-plane by a conformal transformation $\xi = f(z)$, then a source in the z-plane will transform into a source at the corresponding point of the ξ-plane.

23. OX, OY are fixed rigid boundaries and there is a source at (a, b). Find the form of the streamlines and show that the dividing line is $xy\left(x^2-y^2-a^2+b^2\right)=0$.

24. Verify that $\psi = \left(\frac{A}{r^2}\cos\theta + Br^2\right)\sin^2\theta$ is a possible form of Stoke's stream function, and find the corresponding velocity potential.

(7 × 2 = 14 weightage)

Part C

Answer any **two** *questions.*
Each question carries weightage 4.

25. Establish the equation of continuity for an incompressible fluid in the form $\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$.

Show that $u=\frac{-2xyz}{\left(x^2+y^2\right)^2}$, $v=\frac{\left(x^2-y^2\right)z}{\left(x^2+y^2\right)^2}$, $w=\frac{y}{\left(x^2+y^2\right)^2}$ are the velocity components of a possible fluid motion. Is this motion irrotational ?

26. Show that the Joukowski transformation maps the concentric circles with centre at the origin in the Z-plane into confocal ellipses in the z-plane.

27. Discuss the streaming and circulation for a circular cylinder.

28. Determine the effect on a wall of a source parallel to the wall.

(2 × 4 = 8 weightage)