Program : M.A./M.Sc. (Mathematics)

M.A./M.Sc. (Final)

Paper Code:MT-07

Viscous Fluid Dynamics

Section – C

(Long Answers Questions)

1. Write five physical properties that a fluid passes discuss any two.

A MT-07, Pg. No. 2

2. Prove that general motion of a fluid particle consists of three parts a translation, a rotation and a deformation.

A MT-07, Pg. No. 3

3. Discuss both strain and stress analysis.

A MT-07, Pg. No. 5

4. Show that stress tensor is symmetric.

A MT-07, Pg. No. 7

5. Define stress and stress vector and also write component of stress vector.

A MT-07, Pg. No. 5,6

6. What is state of stress a point in the fluid. Prove that state of stress at a point is completely known if the nine components of stress tensor at that point are known.

A MT-07, Pg. No. 8

7. Discuss plane stress, Principal stresses and Principal directions.

A MT-07, Pg. No. 10

8. Discuss stress when.
   (a) Fluid is at rest
   (b) Fluid is in motion

A MT-07, Pg. No. 11,12

9. Describe relationship between stress and rate of strain components.

A MT-07, Pg. No. 12

10. State Generalized law of heat conduction and specific heat.

A MT-07, Pg. No. 14

11. Write about :
    (a) Stoke's law of friction

    (b) Thermal conductivity

A MT-07, Pg. No. 13,14

12. What type of motion do the following velocity components constitute?
    $\mu = a + by - cz$
    $v = d - bx + ez$
    and $w = f + cx - ey$
    Where a, b, c, d, e, f are arbitrary constants.

A MT-07, Pg. No. 16

13. Velocity field at the point is given by $1 + 2y - 3z, 4 - 2x + 6z, 6 + 3x - 5y$ Show that it represents a rigid body motion.

A MT-07, Pg. No. 17

14. Write down fundamental equations of flow of viscous compressible fluids. Write notes on each of the equations.

A MT-07, Pg. No. 19, 20, 22, 23

15. Obtain equation of continuity in Cartesian coordinate system.

A MT-07, Pg. No. 20

16. Derive equation of continuity in vector form.

A MT-07, Pg. No. 21

17. Obtain Navier-stokes equation of motion in Cartesian coordinates for two dimensional incompressible viscous flow.

A MT-07, Pg. No. 22

18. Derive energy equation in terms of internal energy and fluid temperature.

A MT-07, Pg. No. 23

19. State & prove Kelvin's circulation theorem.

A MT-07, Pg. No. 27

20. Prove that the varticity $\overline{\pi}$ satisfies the differential equation.

    $D\overline{\pi} = (\overline{\pi}\,\nabla)\overline{q} + v\,\nabla^2(\overline{\pi})$ Dt

A MT-07, Pg. No. 26

21. Define circulation show that the time rate of change of circulation in a cloud circuit. Drawn in a viscous incompressible fluid under the action of conservative forces. Moving with fluid depends only on the kinematic

viscosity and on the space rated of change of the vorticity components at the contour.

A MT-07, Pg. No. 27

22. Write fundamental equation of a viscous incompressible fluid motion with constant fluid properties in cartsian coordinates (x, y, z)

A MT-07, Pg. No. 29

23. Deduce fundamental equations of a viscous incompressible fluid with constant fluid properties in cylindrical polar coordinates (r, q, z)

A MT-07, Pg. No. 30

24. Write down the fundamental equations of a viscous incompressible fluid with constant fluid properties in spherical polar coordinates (r, q, d)

A MT-07, Pg. No. 31

25. Explain the principal of dynamic similarity.

A MT-07, Pg. No. 34

26. State and prove Buckingham π-theorem.

A MT-07, Pg. No. 35

27. Find out the complete set of π-products when the physical quantities involved in a phenomenon are L.U, P, μ, g, p, C_p and T symbols have their usual meaning.

A MT-07, Pg. No. 36

28. Explain the physical significance of the Reynlod number, mach number, Prandtl number and Froude number.

A MT-07, Pg. No. 37,38

29. Define following non-dimensional coefficients.
    (a) Lift and drag coefficient.
    (b) Skin friction coefficient.
    (c) Nusselt number
    (d) Recovery factor

A MT-07, Pg. No. 40

30. Define any four from the following :
    (a) Eckert Number
    (b) Grashoff number
    (c) Pe'clet number
    (d) Brinkman nmber
    (e) Euler number

A MT-07, Pg. No. 39

31. Discuss the flow of an incompressible viscous fluid between two parallel plates taking the fluid properties to be constant when one of the plate is given a constant velocity in its own place.

A MT-07, Pg. No. 45

32. Discuss the plane poiseuille flow between two parallel plates.

A MT-07, Pg. No. 46

33. Discuss the generaliged plane coquette flow. Derive the results for various characteristic for plane coquette flow taking that as a particular case.

A MT-07, Pg. No. 48

34. A viscous incompressible fluid moves in a steady flow under constant pressure gradient P parallel to axis in the annular space between two co-axial cylinders of radii a and b (b > a). Show that the volume rate of flow is given by:

$$Q = \frac{\pi P a^4}{8\mu}\left[(n^4 - 1) - \frac{(n^2-1)^2}{\log n}\right]$$

Where n = a/b

A MT-07, Pg. No. 54

35. Show that the volume rate of flow is given by $Q = \frac{27Pa^4}{20\sqrt{3}\mu}$ in the steady flow of a viscous incompressible fluid through a tube with uniform equilateral triangular cross section.

A MT-07, Pg. No. 57

36. Find the velocity distribution for the steady flow of a viscous incompressible fluid in the annular region between two concentric cylinders.

A MT-07, Pg. No. 53,54

37. Obtain the viscous stress in the flow between two concentric rotating cylinder when the inner cylinder being at rest also find the torque.

A MT-07, Pg. No. 60

38. What is Hager-poiseville flow find velocity distribution in a non-dimensional form.

A MT-07, Pg. No. 50

39. Find the volume rate of flow of a viscous incompressible fluid through a tube of circular cross section.

A MT-07, Pg. No. 53,54

40. What do you mean steady motion, obtain velocity distribution for the flow between two parallel plates which are kept at a finite distance a part.

A MT-07, Pg. No. 43,44

41. Discuss stagnation point flow of a incompressible viscous fluid (Hiemang flow).

A MT-07, Pg. No. 64

42. A viscous incompressible fluid is bounded on one side (z > 0) by a circular disc of infinite radius and lying at z = 0 and rotating about its axis r = 0 verify that the steady flow if given by:

$v_r = wrF(\eta)\ \ v_0 = wr\, G(\eta)\ \ v_z = (vw)^{1/2}\, H(\eta)\ and\ p = pvwP(\eta)$

Where w is the angular velocity of the plate and η= $\left(\frac{w}{v}\right)^{1/2} z$ with other symbols have their usual meanings.

A MT-07, Pg. No. 67

43. Discuss the flow due to a plane wall suddenly set in motion in its own plane in an infinite mass of viscous incompressible fluid, which is otherwise at rest.

A MT-07, Pg. No. 72

44. Viscous incompressible fluid occupies the region y > 0 on one side of an infinite plate y = 0. The plane oscillates with a velocity $\cup_0 \cos nt$

In the x-direction show that the velocity distribution of fluid motion is given by $u = \cup_0\ e^{-n \cos(nt-\eta)}$

η = $\left(\frac{n}{2v}\right)^{1/2} y$

A MT-07, Pg. No. 74

45. Discuss the starting flow in plane –couette motion.

A MT-07, Pg. No. 76

46. Obtain an expression for the flow between two parallel porous plates.

A MT-07, Pg. No. 78

47. Discuss the temperature distribution in plane coquette flow.

A MT-07, Pg. No. 81

48. Discuss the temperature distribution in plane Posieville flow.

A MT-07, Pg. No. 85

49. Discuss the temperature distribution in Generalized Couette flow.

A MT-07, Pg. No. 86

50. Discuss the temperature distribution in pipe when the wall of the pipe is kept at a constant temperature.

A MT-07, Pg. No. 87

51. Discuss the temperature distribution in pipe when the wall of the pipe is kept at a uniform temperature gradient.

A MT-07, Pg. No. 87,89

52. Discuss the temperature distribution between two concentric rotating cylinders.

A MT-07, Pg. No. 91

53. Discuss the temperature distribution of plane coquette flow with transpiration cooling.

A MT-07, Pg. No. 92

54. Discuss the plane couette flow when both plates are kept at the same constant temperature.

A MT-07, Pg. No. 83

55. Explain stokes flow past a sphere.

A MT-07, Pg. No. 96

56. Explain Oseen's flow past a sphere.

A MT-07, Pg. No. 102

57. Write stoke's equation for slow motion. Discuss stresses on the surface of the sphere in stoke's flow past a sphere.

A MT-07, Pg. No. 96,98

58. What are Oseen's equation? Compare OSeen's equation from stoke's equation.

A MT-07, Pg. No. 101

59. Discuss stoke's stream function and oseen's stream function.

A MT-07, Pg. No. 100, 104

60. Write a note on boundary layer theory.

A MT-07, Pg. No. 106

61. Write a note on characteristic parameters of boundary layer theory.

A MT-07, Pg. No. 108

62. Discuss former and later situations to Prandtl's work. State Prandtl's boundary layer theory.

A MT-07, Pg. No. 106, 108

63. Derive two dimensional boundary layer equation for the viscous incompressible fluid flow past a thin plate.

A MT-07, Pg. No. 110

64. Derive boundary layer equations by asymptotic approach.

A MT-07, Pg. No. 112

65. Derive boundary layer equation by magnitude approach.

A MT-07, Pg. No. 111

66. Derive two dimensional thermal boundary layer equation for the viscous incompressible fluid past a thin plate.

A MT-07, Pg. No. 114

67. Discuss the boundary layer flow over a flat plate.

A MT-07, Pg. No. 116

68. Obtain Crocco's first integral for $P_r = 1$

A MT-07, Pg. No. 119

69. Obtain Blasius series solution for large η

A MT-07, Pg. No. 118

70. Discuss the flow of a viscous incompressible fluid through a tube of Rectangular cross-section.

A MT-07, Pg. No. 58

71. Distinguish between coefficient of skin friction of generalized plane coquette flow and Hagen-poiseville flow.

A MT-07, Pg. No. 50, 52

72. Find volume rate of flow Q of tube of elliptic cross section.

A MT-07, Pg. No. 56