$$\mu = bx\frac{\partial \phi}{\partial n}, v = \sqrt{bv}\phi(n), n = y\sqrt{bv},$$

Where $d^3\phi/dn^3 + d^2\phi/dn^2 - (d\phi/dn)^2 + 1 = 0$ with bounding conditions.

Whee n = 0, $\phi = 0$ and $n = \omega$, $d\phi/dn = 1$

M.Sc. Final Examination, June 2015

MATHEMATICS

Paper: MSCMT-07

(Viscous Fluid Dynamics)

Time Allowed: 3 Hours
Maximum Marks: 80

Note:- The Question paper is divided into three sections A, B, and C. Use of calculator is allowed in this paper.

Section- A

Section 'A' contain 08 Very Short Answer Type Questions. Examinees have to attempt all questions. Each question is of 02 marks and maximum word limit is thirty words.

1. (i). Give the equation of continuity in vector form.
   (ii). Define Himenz Flow.
   (iii). State the Reynold's law.
   (iv). What do you mean by 'Suction'?
   (v). Write the Stoke's equation for slow motion.
   (vi). What do you mean by adiabatic exponent of gases?
   (vii). State Kelvin's circulation theorem.
   (viii). What do you mean by dynamical similarity?

Section- B

Section 'B' contain 08 Short Answer Type Questions. Examinees will have to answer any four (04) questions. Each question is of 08 marks. Examinees have to delimit each answer in maximum 200 words.

2. The stress tensor at a point P is:

$$\sigma ij = \begin{vmatrix} 7 & 0 & -2 \\ 0 & 5 & 0 \\ 2 & 0 & 4 \end{vmatrix}$$

Determine the stress vector on the plane at P whose unit normal is

$$\hat{n} = \frac{2\hat{\imath}}{3} - \frac{2}{3}\hat{\jmath} + \frac{1\hat{k}}{3}$$

3. Define Nusselt number and Newton's cooling law.
4. Oil is filled between 2 concentric rotating cylinders with radii 5 in and $5\frac{1}{2}$ inches. Assuming μ = 0.005 lbf – sec/ft^3 · The inner cylinder rotates at a speed of 5 rpm, while the outer cylinder is at rest. Calculate the stress at the wall of the inner cylinder.
5. Explain – (i) Mach number, (ii) Brinkman Number
6. Write about steady laminar flow of viscous incompressible fluid between two infinite stationary parallel plates.
7. Show that penetration depth is proportional to the *i* square root of the product of viscosity & time .
8. What do you mean by porous boundaries? Distinguish between two flow problems:

   (a) Flow between two parallel porous plates.
   (b) Plane coquette flow with porous walls.
9. Define stoke's stream function and also write the stream function of the superimposed flow.

Section- C

Section 'C' contain 04 Long Answer Type Questions. Examinees will have to answer any two (02) questions. Each question is of 16 marks. Examinees have to delimit each answer in maximum 500 words.

10. Obtain Navier-stokes equation of motion in Cartesian coordinates for two dimensional incompressible viscous flow.
11. 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

12. 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.
13. Two-dimensional potential flow of an inviscid and incompressible fluid near the stagnation point at the origin at a fixed point taken as y=0 is given by $u - bx$. Show that the corresponding problem for a viscous liquid has a solution.