5144

M. Sc. (Final) Examination, 2016

MATHEMATICS

Paper–IV

(Viscous Fluid Dynamics)

Time : Three Hours

Maximum Marks : 100

PART - A (खण्ड-अ) [Marks : 20

Answer all questions (50 words each).

All questions carry equal marks.

सभी प्रश्न अनिवार्य हैं। प्रत्येक प्रश्न का उत्तर पचास शब्दों से अधिक न हो।

सभी प्रश्नों के अंक समान हैं।

PART - B (खण्ड-ब) [Marks : 50

Answer *five* questions (250 words each).

Selecting *one* from each unit. All questions carry equal marks.

प्रत्येक इकाई से **एक-एक** प्रश्न चुनते हुए, कुल **पाँच** प्रश्न कीजिए।

प्रत्येक प्रश्न का उत्तर 250 शब्दों से अधिक न हो।

सभी प्रश्नों के अंक समान हैं।

PART - C (खण्ड-स) [Marks : 30

Answer any *two* questions (300 words each).

All questions carry equal marks.

कोई **दो** प्रश्न कीजिए। प्रत्येक प्रश्न का उत्तर 300 शब्दों से अधिक न हो।

सभी प्रश्नों के अंक समान हैं।

PART - A

UNIT - I

1. (i) Define normal stress and shear stress.

(ii) Define mach number.

UNIT - II

(iii) WRite equations of motion in case of plane couette flow.

(iv) Define volume rate of flow.

UNIT - III

(v) Write N.S. equation in case of slow motion of a sphere.

(vi) What is Prandtl hypothesis for fluids with very small viscosity ?

UNIT - IV

(vii) What do you mean by similarity variable ?

(viii) In boundary layer separation, what will happen if pressure gradient is hero ?

UNIT - V

(ix) Derfine thermal boundary layer.

(x) Write importance of Eckert number in thermal boundary layer.

PART - B

UNIT - I

2. Define stress at a point and show that it is a tensor of order two.

3. Explain physical importance of Reynolds number and Froude number.

UNIT - II

4. Establish the formula $\left(\frac{1}{8}\right)\left(\frac{\pi a^4}{\mu L}\right)(p_1 - p_2)$ for the rate of steady flow of an incompressible fluid through a uniform circular pipe of radius a, p_1 and p_2 being the pressures at the two sections of the pipe distant L apart.

5. Discuss the flow of a viscous incompressible fluid in the neighbourhood of a stagnation point.

UNIT - III

6. Explain Osceen's improvement of Stoke's theory.

7. Derive the Prandtl boundary layer equations for two dimensional flow of a slightly viscous incompressible fluid moving along a plane wall.

UNIT - IV

8. Give a short account of Gortler new series method.

9. Discuss Walz-Thwaites method based on energy integral equations.

UNIT - V

10. Find out the simple integrals of the thermal boundary layer equations for the flow of an incompressible fluid past a flat plate kept at a constant temperature when the prandtl number of the fluid is unity.

11. Obtain the exact solution of the problem of the plate thermometer and show that for very large prandtl numbers the recovery factor is given by

$$r = 1.92\, P_r^{1/3}$$

PART - C

UNIT - I

12. Derive Navier-Stokes equations concerning the motion of a viscous fluid.

UNIT - II

13. Discuss the unsteady flow of a viscous incompressible fluid over an oscillating plate.

UNIT - III

14. Discuss and obtain characteristic boundary layer parameters for Blasius-Topfer solution.

UNIT - IV

15. Show that the velocity distribution in the boundary layer flow along the wall of a convergent channel is given by

$$\frac{\mu}{U} = 3\tanh^2\left(\eta/\sqrt{2} + 1.146\right) - 2$$

where $\eta = \frac{y}{x}\sqrt{\frac{\mu_1}{\nu}}$ and $U(x) = -\mu_1/x$ is

the potential flow velocity. Also calculate the characteristic boundary layer parameters.

UNIT - V

16. Investivate the solution of thermal energy integral equation for the cooling problem of Pohlhausen's by taking a fourth degree temperature profile analogous to the velocity profile. Obtain the locul Nusselt number for various ranges of the Prandtl number.