KBA-1659

M. A. / M. Sc. (Final) Examination-2025

MATHEMATICS

Paper - II

(Optional)

Fluid Dynamics

(Only for Due/Ex Students)

Time Allowed : **Three Hours**

Maximum Marks : **100**

This question paper contains **three** sections as under :

Section-A खण्ड–अ ***Max. Marks-10***

This section contains one compulsory question with 10 parts, having 2 parts from each unit, short answer in 20 words for each part. All questions carry equal marks.

इस खण्ड में एक अनिवार्य प्रश्न है जिसमें प्रत्येक इकाई से 02 लघु प्रश्न लेते हुये कुल 10 लघु प्रश्न होंगे। प्रत्येक लघु प्रश्न का उत्तर 20 शब्दों से अधिक में न हो। सभी प्रश्नों के अंक समान हैं।

Section-B खण्ड–ब ***Max. Marks-50***

This section contains 10 questions having 2 questions from each unit. Answer 5 questions (250 words each) selecting one question from each unit. All questions carry equal marks.

इस खण्ड में प्रत्येक इकाई से 02 प्रश्न लेते हुये कुल 10 प्रश्न हैं। प्रत्येक इकाई से एक प्रश्न का चयन करते हुये कुल 05 प्रश्नों के उत्तर देने हैं। प्रत्येक प्रश्न का उत्तर 250 शब्दों से अधिक में न हो। सभी प्रश्नों के अंक समान हैं।

Section-C खण्ड–स ***Max. Marks-40***

This section contains 04 descriptive type questions (questions may have sub-division) covering all units but not more than one question from each unit. Answer any two questions (500 words each). All questions carry equal marks.

इस खण्ड में 04 वर्णनात्मक प्रश्न होंगे (प्रश्न में भाग भी हो सकते हैं) जो सभी इकाईयों में से दिये जायेगें, किन्तु एक इकाई से एक से अधिक प्रश्न नहीं होगा। कोई दो प्रश्नों के उत्तर दिये जाने हैं। प्रत्येक प्रश्न का उत्तर 500 शब्दों से अधिक न हो। सभी प्रश्नों के अंक समान हैं।

SECTION - A

1 (i) Define Streak lines.

(ii) Write Lagrange's hydro-dynamical equations of motion.

(iii) Define conformal mapping.

(iv) Briefly explain impulsive motion of a fluid.

(v) What is vortex motion.

(vi) State Blasius Theorem.

(vii) Define plastic fluids.

(viii) Write Navier-Stoke equation of motion in cylindrical coordinates in r-direction only.

(ix) State Buckingham's π-theorem.

(x) Define Drag and Lift.

SECTION - B

UNIT - I

2 Show that $\frac{x^2}{a^2}\tan^2 t+\frac{y^2}{b^2}\cot^2 t=1$ is a possible form for the boundary surface of a liquid, and find an expression for the normal velocity.

3 Derive Euler's equations of motion.

UNIT - II

4 Derive complex potential due to a doublet.

5 Obtain general equations of motion for impulsive motion.

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UNIT - III

6 Determine the stream function and velocity potential when an elliptic cylinder moves in an infinite liquid with velocity U parallel to major axis of the cross section.

7 Show that the product of the cross section and vorticity at any point on a vortex filament is constant along the filament.

UNIT - IV

8 The stress tensor at a point P is given by

$$T_{ij} = \begin{bmatrix} 7 & -5 & 0 \\ -5 & 3 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

Determine the stress vector on the plane passing through the point P and having for its equation.

$$\frac{x}{4} + \frac{y}{2} + \frac{z}{6} = 1$$

9 Derive Navier-Stoke equations of motion for Cartesian coordinates.

UNIT - V

10 Discuss the plane Poiseville flow and obtain drag at lower plate.

11 Write importance of Prandtl's boundary layer theory in fluid dynamics.

SECTION - C

12 State and prove Milne circle theorem.

13 The liquid is contained in the intervening space between two spheres of radii a and b ($a < b$). The impulsive forces are so applied that the inner sphere starts moving with velocity U and the outer with velocity V in the same direction. determine the velocity potential of the initial motion.

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14. Derive relation between stresses and rate of strain for compressible Newtonian viscous fluid.

15. Discuss steady laminar flow through a tube of uniform circular cross section.

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