

University dept. of mathematics

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M.Sc: 4<sup>th</sup> semester

Paper code: ECMATH 403 A

Paper : Boundary Layer theory  
(B.L.T)

SET: C

Answer form all the section as directed.  
Q.No. 1 is compulsory.

The figures in the right-hand margin  
indicate marks.

Candidate are required to give their  
answers in their own words as far  
as practicable.

SECTION-I  
(compulsory)

1. choose the correct option of the following  
: 1x10

<a> "No-slip" condition is present in

<i> Real fluid

<ii> Perfect fluid

<iii> Ideal fluid

<iv> None.

<b> If the Reynolds number is  
more than  $5 \times 10^5$ , the boundary

Layer is called \_\_\_\_\_

- i) laminar boundary layer
- ii) turbulent boundary layer
- iii) either of the above.
- iv) none of these.

<c> If  $\nu$ ,  $\mu$  and  $\rho$  denotes respectively be the kinematic viscosity, viscosity and density of a viscous fluid, then which of the following is true?

- i)  $\nu = \frac{\mu}{\rho}$
- ii)  $\nu = \frac{\rho}{\mu}$
- iii)  $\nu = \mu\rho$
- iv) none of these.

<d> In a plane-couette flow, the velocity distribution is \_\_\_\_\_

- i) Quadratic
- ii) constant
- iii) linear
- iv) cubic.

<e> Vorticity transport equation is

- i)  $\frac{D\vec{\omega}}{Dt} = (\vec{\omega} \cdot \nabla) \vec{q} + \nu \nabla^2 \vec{\omega}$
- ii)  $\frac{D\vec{\omega}}{Dt} = (\vec{\omega} \times \nabla) \vec{q} + \nu \nabla^2 \vec{q}$
- iii)  $\frac{D\vec{\omega}}{Dt} = (\nabla \times \vec{\omega}) \vec{q} + \nu \nabla^2 \vec{q}$
- iv) None.

<f> Due to which of the following boundary layer exists?

- <i> Viscosity of fluid
- ii> Surface tension
- iii> Gravitational effect
- iv> none of these.

<g> The energy thickness ( $\delta_e$ ) is given by

<i>  $\int_0^{\delta} \frac{u}{U^2} \left( 1 - \frac{u^2}{U^2} \right) dy$  .

ii>  $\int_0^{\delta} \frac{u}{U} \left( 1 - \frac{u^2}{U^2} \right) dy$

iii>  $\int_0^{\delta} u \left( 1 - \frac{u^2}{U^2} \right) dy$

iv> None .

<h> The theory of laminar boundary layer was given by

<i> L. Rayleigh

ii> M. Couette

iii> Ludwig Prandtl.

iv> None.

<i> The type of flow in which the fluid characteristic like velocity, pressure, density, etc; at a point do not change with time is called —

<i> Unsteady flow      ii> steady flow

iii> Uniform flow      iv> Laminar flow.

Q9) Displacement thickness ( $\delta_1$ ) can be defined as

i)  $\int_0^{\delta} u \left(1 - \frac{u}{U}\right) dy$

ii)  $\int_0^{\infty} \left(1 - \frac{u}{U}\right) dy$

iii)  $\int_0^{\delta} \frac{u}{U} \left(1 - \frac{u}{U}\right) dy$

iv) None.

### SECTION - II (15X4)

Answer any four questions (15X4)

Q2) Derive Navier-Stokes equation of motion for a viscous flow.

Q3) Discuss the flow between two concentric rotating cylinders.

Q4) Derive the momentum equation for the boundary layer.

Q5) Discuss Prandtl's Boundary Layer Theory.

Q6) Prove that the energy thickness

$$\delta_3 = \int_0^{\delta} \frac{u}{U} \left(1 - \frac{u^2}{U^2}\right) dy$$

and  $\delta_3 = \int_0^{\infty} \frac{u}{U} \left(1 - \frac{u^2}{U^2}\right) dy$

- 7> Discuss unsteady flow of viscous incompressible fluid over a suddenly accelerated flat plate and obtain shear stress at the plate
- 8> Discuss the plane Poiseuille's flow bet<sup>n</sup> two parallel walls and introduce theory of lubrication.

## Answer Key

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## Answer Key

SET: C

Q. No.

corresponding ans.

1. Q1 \_\_\_\_\_ I
- Q2 \_\_\_\_\_ II
- Q3 \_\_\_\_\_ I
- Q4 \_\_\_\_\_ III
- Q5 \_\_\_\_\_ I
- Q6 \_\_\_\_\_ I
- Q7 \_\_\_\_\_ II
- Q8 \_\_\_\_\_ III
- Q9 \_\_\_\_\_ II
- Q10 \_\_\_\_\_ II