University Deptt. of Mathematics
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M.Sc : 4^{th} semester
paper code : ECMATH403A
paper : Boundary Layer theory (B.L.T)

SET : A

Answer form all the section as directed.
Q.No. 1 is compulsory.
The figures in the right-hand margin indicate marks.
Candidates 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 : 1×10

<a> On account of which of the following boundary layer exists ?

<i> surface tension
<ii> viscosity of fluid
<iii> Gravitational effect.
<iv> None.

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

<i> Ideal fluid
<ii> Perfect fluid

iii> Real fluid

iv> None.

<c> Reynolds number (Re) = ____________

<i> $\frac{\text{Viscous force}}{\text{Inertia force}}$

<ii> $\frac{\text{Inertia force}}{\text{Viscous force}}$

<iii> $\frac{\text{Viscous force}}{\text{Shear force}}$

<iv> $\frac{\text{Inertia force}}{\text{Shear force}}$

<d> Vorticity transport equation is

<i> $\frac{D\vec{\Omega}}{Dt} = (\vec{\Omega} \cdot \nabla)\vec{q} + \nu \nabla^2 \vec{\Omega}$

ii> $\frac{D\vec{\Omega}}{Dt} = (\vec{\Omega} \times \nabla)\vec{q} + \nu \nabla^2 \vec{\Omega}$

iii> $\frac{D\vec{\Omega}}{Dt} = (\vec{\nabla} \times \Omega)\vec{q} + \nu \nabla^2 \vec{\Omega}$

<iv> None

<e> The displacement thickness δ^* is given by

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

<ii> $\int_\delta^\infty \left(1 - \frac{u}{U}\right) dy$

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

iv> None

<f> The boundary layer exists in which of the following ?

<i> Flow of real fluids

<ii> Flow of ideal fluids

iii> Flow over flat surfaces only

iv> Pipe - flow only

<g> The displacement thickness is the

<i> layer in which the loss of energy is minimum

<ii> layer which represents reduction in momentum caused by the boundary layer

iii> thickness upto which the velocity approaches 99% of the free-stream velocity

iv> distance measured ⊥r to the boundary by which the free-stream is displaced on account of formation of boundary layer.

<h> Von Karman momentum Integral eqn $\left(\frac{\tau_0}{\rho U^2} = \frac{\partial \theta}{\partial x}\right)$ is applicable to

<i> laminar boundary layer flow only

ii> turbulent boundary layer flow only

iii> transition boundary layer flow only.

iv> Laminar, transition and turbulent boundary layer flows.

i> The concept of boundary layer theory was first introduced by

<i> M. Couette
ii> L. Prandtl
iii> G. G. Stokes
iv> J. L. M. Poiseuille.

<j> The skin friction τ_{yx} (shearing stress at the plate) in plane couette flow is given by

<i> $\frac{\mu U}{h}$ <ii> $\frac{1}{2} \cdot \frac{\mu U}{h}$ <iii> $\frac{2\mu U}{h}$

iv> $\frac{\mu}{U h^2}$

SECTION – II

Answer any four questions (15×4)

<2> Derive Navier-Stokes equations of motion of viscous fluid

<3> <a> Write short notes on any two of the following

<i> Boundary layer thickness (δ)
ii> Displacement thickness (δ_1)
iii> Reynold's number (Re)

<3> For the velocity distribution in the boundary layer is given by

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2,$$

δ being boundary layer thickness, calculate the following:

<i> Displacement thickness (δ_1)

ii> Momentum thickness (θ)

iii> Energy thickness (δ_e)

<4> Derive the equation of boundary layer flow in a convergent channel.

<5> Derive similar solution of the boundary layer equations.

<6> Discuss Prandtl's boundary layer theory.

<7> Derive the momentum Integral eqn for the two dimensional boundary layer.

<8> Derive couette flow equations betn two parallel walls and introduce theory of lubrication,

Answer Key

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Answer key

SET : A

Q. No.	Corresponding ans.
1. <a>	<ii>
<b>	<iii>
<c>	(ii)
<d>	(i)
<e>	<i>
<f>	<i>
<g>	<iv>
<h>	<iv>
<i>	<ii>
<j>	<i>