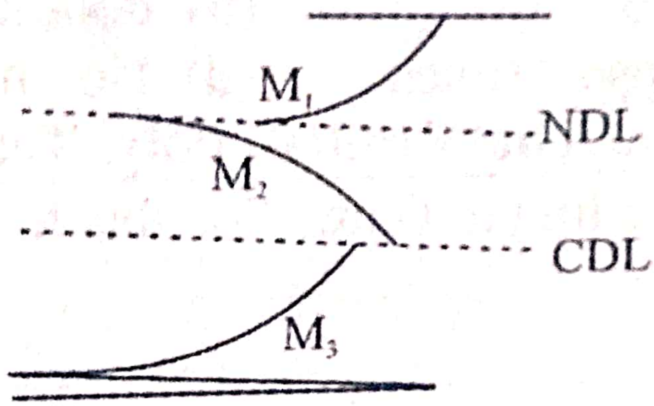
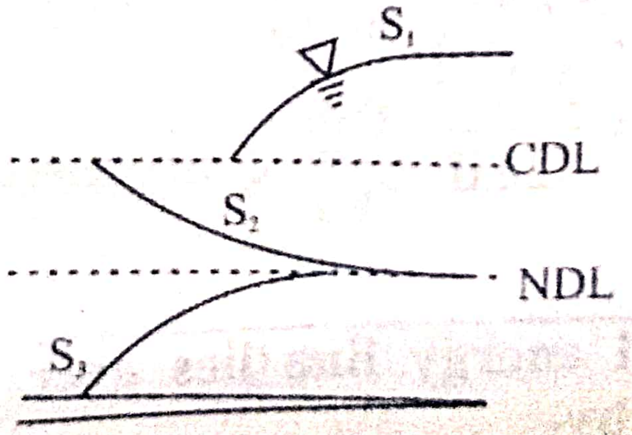
1080. Which of the following surface profiles represents the supercritical state of flow?
(a) M_3, H_2 and M_1 (b) M_2, S_1 and M_3
(c) S_1, S_2 and S_3 (d) S_2, S_3 and C_3

(JPSC Combined AE Paper VI 2013)

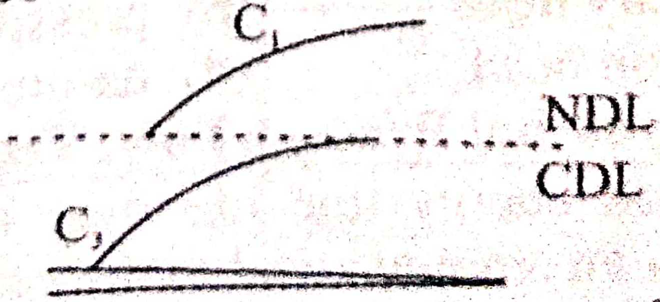
Ans : (d) In super critical state of flow, the depth of flow is below the critical depth line.
flow profile for various sections–
(a) Mild slope



(b) steep slope



(c) critical slope



Therefore M_3, S_2, S_3, C_3 are flow profiles for super

1081. **Match List-I with List-II and select the correct answer using the Code given below the Lists :**

List-I Flow regimes for Gradually varied flow	**List-II** type of gradually varied flow profile
(a) $y_c > y_0 > y$	1. C_1
(b) $y > y_0 > y_c$	2. M_1
(c) $y_0 > y > y_c$	3. S_3
(d) $y > y_c > y_0$	4. M_2
	5. S_1

Where

y_0 = normal depth

y_c = critical depth

y = depth of gradually varied flow

(a) a-1, b-2, c-3, d-4 (b) a-3, b-4, c-5, d-2

(c) a-3, b-2, c-4, d-5 (d) a-5, b-4, c-3, d-1

(JPSC Combined AE Paper VI 2013)

Ans : (c)

$S_3 - y_c > y_0 > y$

$M_1 - y > y_0 > y_c$

$M_2 - y_0 > y > y_c$

$S_1 - y > y_c > y_0$

... less than the critical

1084. For laminar flow in pipes the momentum correction factor is

(a) less than 1 (b) 1.03

(c) 1.33 (d) 2.0

[UPPSC State Eng. A.E. 2011 Ist Paper]

Ans : (c) Momentum correction factor (β)

(i) Laminar flow (β) = 1.33

(ii) Turbulent flow (β) = 1.2

1085. Where the flow in an open channel is gradually varied, the flow is said to be?

(a) Steady uniformed flow

(b) Steady non–uniform flow

(c) Unsteady uniform flow

(d) Unsteady non–uniform flow

UKPSC AE (Paper–I) 2007)

Ans : (b) When the flow is changing slowly, it is known as gradually varying flow. In an open channel with gradually varying flow, the velocity, discharge and slope of channel varies with distance along channel but are constant for a position with respect to time.

1086. Laminar flow of a real fluid is given by which of the following equations?

(a) Hagen–Poiseulle (b) Bernoulli

(c) Euler (d) Navier–Stokes

(UP RVNL AE 2016)

[UPPSC Civil Eng. A.E. 2013(I)]

Ans.: (d) Laminar flow is a flow in which the fluid particles move along well defined paths or stream line and all the stream lines are straight and parallel. It is represented by Navier-Stokes equation for a real fluid.

1090. Specific energy of a flowing fluid per unit weight is equal to

(a) $\frac{P}{W}+\frac{V^2}{2g}$

(b) $\frac{P}{W}+h$

(c) $h+\frac{V^2}{2g}$

(d) $\frac{P}{W}+\frac{V^2}{2g}+h$

TRB Poly. Tech. Lect. 2012

1089. **At a sluice gate across a rectangular channel, the upstream flow conditions are: depth of 2.0 m; velocity of flow of 1.25 m/sec. The flow conditions at the vena contracta just downstream of the gate can be taken as: depth of 0.44 m; velocity of flow of 5.68 m/sec. What is the total thrust on the gate on its upstream face (to the nearest 10 units)?**

(a) 770 kgf (b) 800 kgf

(c) 825 kgf (d) 870 kgf

ESE 2017

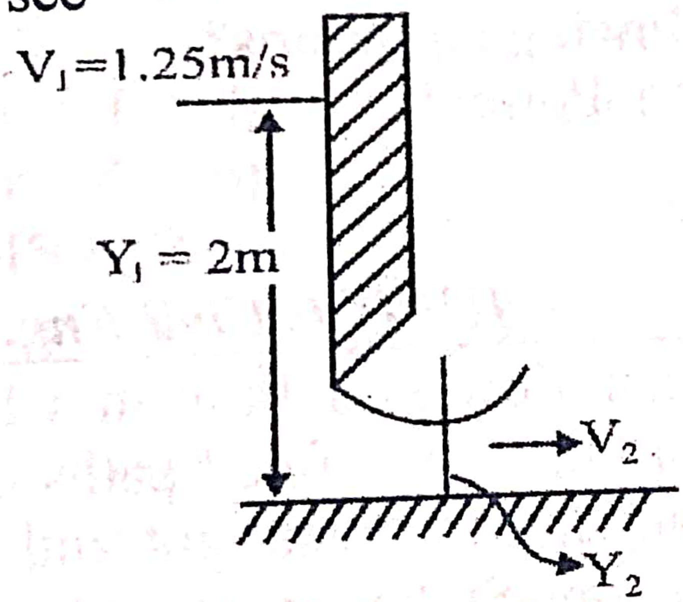
Ans. (a)

Depth 'Y_1' = 2m

Velocity of flow V_1 = 1.25m/sec.

$Y_2 = 0.44$m

$V_2 = 5.68$m/sec



The total thrust 'F' = $\frac{\rho_w}{2}\left[\frac{(y_1 - y_2)^3}{y_1 + y_2}\right]$

$$F = 1000 \times \frac{1}{2}\left[\frac{(2-0.44)^3}{2+0.44}\right] \Rightarrow F = 777.954 \approx 770 \text{ kgF}$$

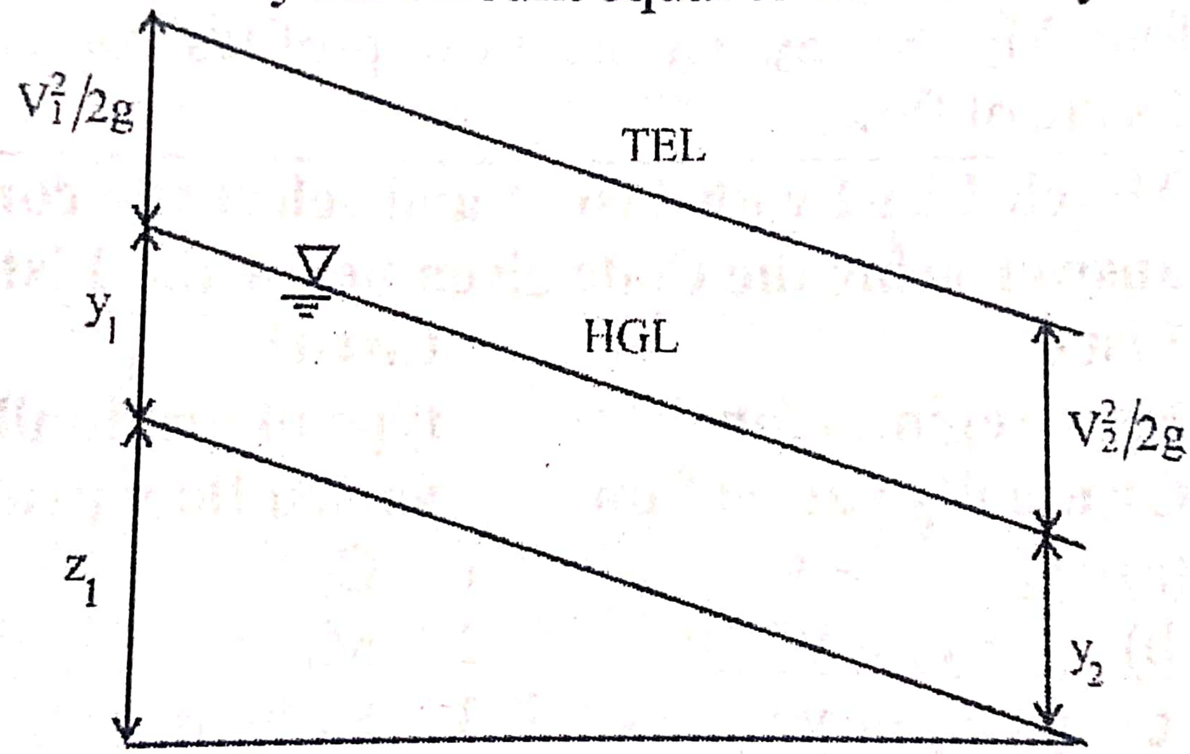
flowing fluid per unit

1092. The total energy line lies over the hydraulic gradient by-

(a) velocity head
(b) pressure head
(c) friction head
(d) datum head

Arunachal Pradesh Poly. Tech. Lect. 2019

Ans. (a) : Total energy line lies over the hydraulic gradient line by an amount equal to the velocity head.



$$\frac{V^2}{2g} = \text{velocity head}$$

1096. Flow measurement with prandtl-pitot tube showed that tip reading varies only across the flow while the side opening varied only along the flow. The type of flow is

(a) Uniform Irrotational
(b) Uniform rotational
(c) Non Uniform Irrotational
(d) Non Uniform rotational

Vizag steel MT 2017

Ans. (d) : For flow measurement with prandtl-pitot tube showed that tip reading varies only across the flow while the side opening varied only along the flow. The type of flow is Non Uniform rotational flow.

1097. In a venturimeter the flow takes place at:

(a) gauge pressure (b) absolute pressure
(c) atmospheric pressure (d) none of the above

(UKPSC AE (Paper–I) 2007)

1100. Tranquil flow must always occur

(a) above normal depth
(b) below normal depth
(c) above critical depth
(d) below critical depth

[UPPSC State Eng. A.E. 2011 Ist Paper]
WBPSC AE 2014

Ans : (c) In tranquil flows, the velocity will be less than the critical velocity (V_c) and this is some time termed as sub-critical flows.
(i) $V < V_3$
(ii) $Y < Y_0$
(iii) Froude Number (F_r) < 1

1101. Match the following lists:

List–I	List–II
A. Strong hydraulic jump	1. $F_r < 1.70$
B. Weak hydraulic jump	2. $4.5 < F_r < 9.0$
C. Undular hydraulic jump	3. $F_r > 9.0$
D. Steady hydraulic jump	4. $1.7 < F_r < 2.5$

where F_r is initial Froude Number. Select the correct answer using the codes given below.

Codes

	A	B	C	D
(a)	3	4	1	2
(b)	4	3	2	1
(c)	4	3	1	2
(d)	3	4	2	1

[UPPSC State Eng. A.E. 2011 Ist Paper]

1104. For laminar flow in circular pipe, the Darcy-Weisbach friction factor (f) is equal to

(a) $\frac{64}{R_e}$ (b) $\frac{16}{R_e}$

(c) $\frac{32}{R_e}$ (d) $\frac{80}{R_e}$

Where R_e = Reynolds number

[UPPSC State Eng. A.E. 2011 Ist Paper]

[UPPSC State Eng. A.E. 2007(II)]

Ans : (a) Darcy - Weisbach Friction factor

(i) Laminar flow

$$F = \frac{64}{R_e} \quad \text{when } R_e < 2000$$

(ii) for turbulent flows

$$F = \frac{0.316}{(R_e)^{1/4}} \quad \text{when } R_e > 4000$$

1121. The discharge through a channel of rectangular section will be maximum if :

(a) Its depth is twice the breadth
(b) Its breadth is twice the depth
(c) Its depth is thrice the breadth
(d) Its breadth is thrice the depth

TNPSC AE 2015

Ans. (b) : For the maximum discharge through a rectangular channel width should be two times of depth

$$\boxed{b = 2h}$$

For most economical rectangular section hydraulic mean depth should be $\left(m = \frac{h}{2}\right)$

1122. Select the true statement.

i. Hydraulic jump occurs when a supercritical stream meets a subcritical stream of sufficient depth.

ii. Hydraulic jump occurs when a supercritical stream meets a critical stream of sufficient depth.

(a) Both the statements (i) and (ii) are true
(b) Statement (ii) alone is true
(c) Statement (i) alone is true
(d) Both the statements (i) and (ii) is false
(e) Information insufficient

CGPSC AE 2017

Ans. (c) When the fl-

1124. The hydraulic jump occurs when there is a break in grade from a:

(a) mild slop to steep slope

(b) steep slop to mild slope

(c) steep slope to steeper slope

(d) mild slope to milder slope

[UPPSC State Eng. A.E. 2004(I), 2008]

Ans : (b) The phenomena of hydraulic jump occurs when the gradient shifts from high gradient to low gradient or the high velocity stream meets the low velocity stream.

1127. If relationship between discharge and head for a measuring equipment is given by $Q = kH^{7/2}$, and error in the head measurement is 2.5%; then the error in discharge measurement would be

(a) 9.25%
(b) 7.50%
(c) 4.75%
(d) 8.75%

GPSC AE June 2019

Ans. (d) : Given equation $Q = kH^{7/2}$,

$$\frac{\Delta Q}{Q} = \frac{7}{2}\frac{\Delta H}{H}$$

$$\frac{\Delta Q}{Q} \times 100 = \frac{7}{2} \times \frac{\Delta H}{H} \times 100$$

$\because$ error in head measurement = 2.5

$$\left(\frac{\Delta H}{H} \times 100 = 2.5\right)$$

$$= \frac{7}{2} \times 2.5$$

$$\frac{\Delta Q}{Q} \times 100 = 8.75$$

error in discharge = 8.75%

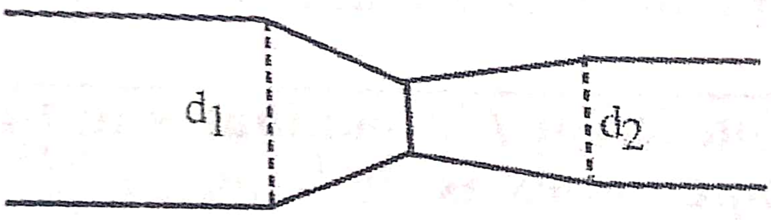
1138. Flow through a venturi flume is maximum when the depth at the throat is

(a) One-fourth (b) One-third

(c) Two-third (d) Half

Haryana PSC AE 2010

Ans. (b) : Flow through a venturi flume is maximum when the depth at the throat is one-third.



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1142. The top width and depth of flow in a rectangular channel were measured as 4m and 1m respectively. The measured velocities on the center line at the water surface, 0.2m and 0.8m below the surface are 0.7m/s, 0.8m/s, 0.6m/s respectively. Using two point method of velocity measurement, the discharge (in m^3/s) in a channel is

(a) 1.4 (b) 1.2
(c) 1.0 (d) 0.8

ISRO Scientist/Engineer 2014

Ans : (a) As per two point method of velocity measurement –

$$V_{mean} = \frac{V_{0.2} + V_{0.8}}{2} = \frac{0.8 + 0.6}{2} = 0.7\,m/s$$

$$\text{So, } Q = V \times A = 0.7\left(\frac{1}{2} \times 4 \times 1\right) = 1.4\ m^3/sec$$

1143. A rectangular open channel of width 5m is carrying a discharge of 100 m^3/s. Froude number of flow is 0.8. The depth of flow in the channel is –

(a) 4m (b) 5m
(c) 6m (d) 20m

ISRO Scientist/Engineer 2014

8. Flow Measurement
(Statics, Kinematic & Dynamics Flow)

1177. Match List-I (Devices) with List-II (Uses) and select the correct answer using codes the given lists :

List-I (Devices)	List-II (Uses)
A. Pitot tube	1. Measuring pressure in a pipe
B. Manometer	2. Measuring velocity of flow in a pipe
C. Venturimeter	3. Measuring air and gas velocity
D. Anemometer	4. Measuring discharge in a pipe

	A	B	C	D
(a)	1	2	4	3
(b)	2	1	3	4
(c)	2	1	4	3
(d)	4	1	3	2

RPSC POLY. TECH. LECT. 2014

Ans : (c)

Instrument	Uses
Venturimeter	Discharge
Rota meter	Discharge
Orifice meter	Discharge
Pitot tube	Velocity
Anemometer	Velocity of gas and air
Hydrometer	Specific gravity
Manometer	Pressure

1189. _______________ is an imaginary line drawn through a flowing fluid in such a way that the tangent to it at any point gives the direction of the velocity of flow at that point–

(a) Vortex line (b) Stream line
(c) Streak line (d) Path line

Gujarat PSC AE (N.W.R.) 2020

Ans. (b) Stream line is an imaginary line drawn through a flowing fluid in such a way that the tangent to it at any point gives the direction of the velocity of flow at that point.

1190. A fluid field is given by, $U = xy\hat{I} + 3yz\hat{j} - (2yz + z^2)\hat{k} + 3t$. The acceleration in z direction at point (1, 2, 4) would be–

(a) 184 unit (b) 192 unit
(c) 204 unit (d) zero

Gujarat PSC AE (N.W.R.) 2020

Ans. (b) : $U = xy\hat{I} + 3yz\hat{j} - (2yz + z^2)\hat{k} + 3t$

$u = xy$, $v = 3yz$, $w = -2yz - z^2$

a_z = acceleration in z- direction.

$$a_z = \frac{u\partial w}{\partial x} + \frac{v\partial w}{\partial y} + \frac{w\partial w}{\partial z} + \frac{\partial w}{\partial t}$$

$(a_z) = 0 + 3yz(-2z) + (-2yz - z^2)(-2y - 2z)$

$(a_z)_{1,2,4} = 3 \times 2 \times 4(-2\times4)\ (-2\times2\times4 - 4^2)(-2\times2 - 2\times4)$

$= -24 \times 8 + (-16-16)(-4-8)$

$= -192 + 384 = 192$ unit.

1192. Flow rate of liquid is measured by the method __________.

(a) Coriolis method
(b) Thermal mass flow measurement
(c) Conveyor-based methods
(d) Bourdon tube

DMRC AM 2017

Ans. (a) : Flow rate of liquid is measured by the method Coriolis method.
Bourdon tube is used to measure local atmospheric pressure.

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1194. The stream function of a doublet with horizontal axis and of strength μ is

(a) $\frac{\mu}{2\pi} r$ (b) $\frac{\mu}{2\pi r}\cos\theta$

(c) $\frac{\mu}{2\pi} r\sin\theta$ (d) $\frac{\mu}{2\pi}\frac{\sin\theta}{r}$

ESE 2018

Ans. (d)

- The stream function of doublet is –

$$\left[\Psi = \frac{K}{\pi}\frac{\sin\theta}{r}\right] \quad \text{where} \left[K = \frac{\mu}{2}\right]$$

- The velocity potential function of doublet is–

$$\left[\phi = \frac{K}{\pi}\frac{\cos\theta}{r}\right] \quad \text{where} \left[K = \frac{\mu}{2}\right]$$

1195. Consider the following statements regarding flow net:

1. It helps determine the quantity of seepage.
2. It helps determine the upward lift below a hydraulic structure.
3. It is applicable to rotational flow only.

Which of the above statements are *correct?*

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

ESE 2017

Ans. (a) : Flow net is a graphical representation of flow of water through a soil mass. It is a curvilinear net formed by the combination of flow lines and equipotential lines.

- Estimation of seepage losses from reservoirs. It is possible to use the flow net in the transformed space to calculate the flow underneath the dam.

1203. Streamlines and Equipotential lines are lines that

(a) Can be drawn graphically for viscous flow around any boundary
(b) Form meshes of perfect squares
(c) Are orthogonal wherever they meet
(d) Can be determined mathematically for all boundary conditions

GPSC AE March 2018
JPSC AE 2009

Ans. (c) : Equation of equipotential line

$$\frac{dy}{dx} = \frac{-u}{v} = m_1$$

Equation of streamline

$$\frac{dy}{dx} = \frac{v}{u} = m_2$$

$$m_1 m_2 = \frac{-u}{v} \times \frac{v}{u}$$

$$\boxed{m_1 m_2 = -1}$$

Equipotential lines and stream lines are orthogonal to each other.

1204. There can be no flow across the

(a) Streak line
(b) Stream line
(c) Path line
(d) Time line

Vizag steel MT 2017

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1237. **The velocity distribution for a two dimensional flow is given by u = ax and v = ay. determine the equation of the streamline passing through the points (3, 1).**

(a) $3x + y = 0$ (b) $x - y = 3$
(c) $x - y = 1$ (d) $x + 3y = 0$

BHEL ET 2019

Ans. (b) : $u = ax, \quad v = ay$

$$\frac{dx}{u} = \frac{dy}{v}$$

$$\Rightarrow \quad \frac{dx}{ax} = \frac{dy}{ay}$$

$$\ln x = \ln y + \ln c$$

$$\ln c = \ln \frac{3}{1} \qquad \Rightarrow c = 3$$

equation of stream line $x - y = 3$

1239. Momentum equation is completely independent of

(a) compressibility effects

(b) frictional effects

(c) viscous effects

(d) momentum flux

APPSC AEE (Civil/Mechanical) 2012

Ans. (c) Momentum equation is completely dependent of

(i) Compressibility effects

(ii) Frictional effects

(iii) Momentum flux

Von Karman momentum equation for boundary layer flow–

$$\frac{\tau_0}{\rho U^2} = \frac{d\theta}{dx}$$

1248. **What will be the stream function of flow of an incompressible fluid is defined by u=2, v=8x.**

(a) $\psi = 2x^2 + 2xy + c$ (b) $\psi = 2x + 8y^2 + c$

(c) $\psi = 2y + 8x + c$ (d) $\psi = -4x^2 + 2y + c$

UPPCL AE 2014

Ans. (d) : Equation of stream function, $\frac{dx}{u} = \frac{dy}{v}$

$$\frac{dx}{2} = \frac{dy}{8x} \Rightarrow 4x^2 = 2y + c$$

$$\psi = -4x^2 + 2y + c$$

1249. **Shear strain rate is given by**

(a) $\frac{1}{2}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right)$ (b) $\frac{1}{2}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)$

(c) $\frac{1}{2}\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$ (d) $\frac{1}{2}\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$

APPSC (PHE) AE Paper-2 2012

Ans. (b) : Shear strain rate $= \frac{1}{2}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)$

1266. An inert tracer is injected continuously from a point in an unsteady flow field. The locus of locations of all the tracer particles at an instance of time represents :

(a) Streamline (b) Pathline

(c) Steamtube (d) Streakline

HPPSC Poly. Lect. 2016

Ans : (d) An inert tracer is injected continuously from a point in an unsteady flow field. The locus of location of all the tracer particles at an instance of time represent streakline.

1280. **If the flow field is steady, the fluid particle will undergo only a**

(a) Convective acceleration
(b) Local acceleration
(c) Total acceleration
(d) All of the above

APPSC AEE (CIVIL/MECHANICAL) 2019

Ans. (a) : Total acceleration is sum of local and convective acceleration. If flow is steady then local acceleration is zero. Hence only convective acceleration can be present.

1281. **Pascal's Law states that............., pressure at a point is equal in all directions.**

(a) in a turbulent flow (b) in a laminar flow
(c) in a static fluid (d) in a liquid at rest

SJVNL ET 2019

Ans. (c) : Pascal's Law states that in a stability fluid pressure at a point is equal in all directions.

1282. **The type of flow in which the velocity at any given time does NOT change with respect to space is known as :**

(a) Steady Flow (b) Compressible Flow
(c) Uniform Flow (d) Laminar Flow

SJVNL ET 2019

Ans. (c) : In case of uniform flow

$$\frac{dv}{dx} = \text{constant}$$

1286. What will be the value of convective acceleration and local acceleration for a flow water in uniform straight pipe of constant diameter with unsteady flow condition?

(a) Convective acceleration = 0,
Local acceleration = 0

(b) Convective acceleration = 0,
Local acceleration $\neq 0$

(c) Convective acceleration $\neq 0$,
Local acceleration $\neq 0$

(d) Convective acceleration $\neq 0$,
Local acceleration = 0

APPSC Poly. Tech. Lect. 2020

Ans. (b) : Convective acceleration = 0,
Local acceleration $\neq 0$

$$a_x = \frac{\partial u}{\partial t} + u.\frac{\partial u}{\partial x} + v.\frac{\partial u}{\partial y} + w.\frac{\partial u}{\partial z}$$

similarly

$$a_y = \frac{\partial v}{\partial t} + u.\frac{\partial v}{\partial x} + v.\frac{\partial v}{\partial y} + w.\frac{\partial v}{\partial z}$$

$$a_z = \frac{\partial w}{\partial t} + u.\frac{\partial v}{\partial x} + v.\frac{\partial w}{\partial y} + w.\frac{\partial w}{\partial z}$$

Local or temporal

convective or advective acceleration

1291. **The velocity components in x and y directions in terms of velocity potential, ϕ are**

(a) $u = -\frac{\partial \phi}{\partial x}; v = \frac{\partial \phi}{\partial y}$ (b) $u = \frac{\partial \phi}{\partial y}; v = \frac{\partial \phi}{\partial x}$

(c) $u = \frac{\partial \phi}{\partial x}; v = \frac{\partial \phi}{\partial y}$ (d) $u = -\frac{\partial \phi}{\partial x}; v = \frac{\partial \phi}{\partial y}$

AP (VSS-1) PART - A 2017

Ans : (d) :

velocity potential in x direction $u = \frac{-\partial \phi}{\partial x}$

velocity potential in y direction $v = \frac{\partial \phi}{\partial y}$

velocity potential in z direction $w = \frac{-\partial \phi}{\partial y}$

1292. **The flow of a liquid at constant rate in a uniformly tapering pipe is :**

(a) Steady, uniform flow
(b) Unsteady, uniform flow
(c) Steady, non-uniform flow
(d) Unsteady, non-uniform flow

KPSC AE 2020

Ans. (c) : The flow of a liquid at constant rate in a uniformly tapering pipe is steady, non uniform flow.

	Type of flow	Example
(i)	Steady and uniform	flow through a long pipe of constant diameter at constant rate
(ii)	Steady and non-uniform flow	flow through a tampering pipe at a constant rate
(iii)	Unsteady and uniform flow	constant diameter at either increasing or decreasing rate
(iv)	Unsteady and non-	flow through a

1304. In a steady radial flow into an intake, the velocity is found to vary as $(1/r^2)$, where r is the radial distance. The acceleration of the flow is proportional to

(a) $\frac{1}{r^5}$ (b) $\frac{1}{r^3}$

(c) $\frac{1}{r^4}$ (d) $\frac{1}{r}$

(BPSC AE Paper VI 2006)

1318. **A point in a compressible flow, where the velocity of fluid is zero, is called :**

(a) critical point (b) vena contracta

(c) stagnation point (d) none of the above

(UKPSC AE (Paper–I) 2007)

Ans : (c) A point in compressible flow, where the velocity of fluid is zero, is called stagnation point.

1319. **A flow in which each liquid particle has a definite path and paths of individual particles do not cross each other, is called a :**

(a) steady flow (b) uniform flow

(c) stream line flow (d) non–uniform flow

(UKPSC AE (Paper–I) 2007/

Ans : (c) A flow in which liquid particle has a definite path and paths of individual particles to not cross each other, is called a stream line flow.

stream line flow

1337. Path-lines refer to the motion of identified fluid particles of elements and therefore constitute feature of the-

(a) Lagrangian Approach

(b) Rayleigh's Approach

(c) Eulerian Approach

(d) None of the above

[MPSC 2015 Paper-II Mains]

Ans. (a) : Lagarangian method - In this method any fluid particle is selected and observation is made about the behavior of this particle during its course of motion through space (control mass approach).

Eulerian method–In this method, the observer concentrates on a point in the fluid system. Velocity, acceleration and other characteristics of the fluid at that particular point are studied.

1338. The path traced by a single particle of smoke issuing from a license stick is a

(a) stream line (b) flow line

(c) path line (d) streak line

TNPSC AE 2018

1350. **A steady-non-uniform flow is through**

(a) a tapering pipe at a constant rate

(b) a tapering pipe at either increasing or decreasing rate

(c) a long pipe at increasing rate

(d) a long pipe at decreasing rate

TNPSC AE 2019

Ans. (a) • **Steady and uniform flow**– Flow through a long pipe of constant diameter at constant rate.

• **Steady and non-uniform flow** – Flow through a tapering pipe at constant rate.

1364. A velocity potential exists

(a) Whenever the real fluid flow exists
(b) When the flow is real and rotational
(c) When the flow satisfies the conditions of irrotational motion
(d) When the flow satisfies the equation of continuity

GPSC AE Dec 2018

Ans. (c) : A velocity potential exists only for irrotational fluid flow.

1365. The assumption not made in the derivation of Bernoulli's equation is

(a) inviscid flow
(b) steady flow
(c) two-dimensional flow
(d) uniform flow

APPSC (PHE) AE Paper-2 2012

Ans. (d) : The assumption not made in the derivation of Bernoulli's equation is uniform flow.

1386. **Rotating fluid in washing machine is example of**

(a) Free vortex
(b) Forced vortex
(c) Irrotational flow
(d) Uniform flow

Vizag steel MT 2017

Ans. (b) : In this condition force is applied so, it is a forced vertex.

1387. **If Velocity potential satisfies Laplace equation the flow will be**

(a) Irrotational flow
(b) Free vortex flow
(c) Continuous flow
(d) Forced vortex flow

APPSC AEE 2016

Ans. (a) : If velocity potential satisfies Laplace equation it represents possible steady incompressible, irrotational flow.

388. **The flow of water through the hole in the bottom of a wash basin is an example of**

(a) Free vortex
(b) Forced vortex
(c) Steady flow
(d) Unsteady flow

[UPPSC State Eng. A.E. 2008, 2004(I)]

(UKPSC AE (Paper–I) 2007)

Ans : (a) Free vortex flow : When no external torque s required to rotate the fluid mass, that type of flow is called free vortex flow, thus, the liquid in case of free vortex is rotating due to the rotation which is imported o the fluid previously.

Force vortex flow : It is defined as that type of vortex low, in which some external torque is required to otate the fluid mass. The fluid mass in this type of flow otates at constant angular velocity.

Steady and unsteady : If all the flow parameters such as depth of flow, velocity and discharge are constant with respect to time at a particular section then flow is steady otherwise unsteady.

389. **The flow of water in the wash hand basin when**

zero no drag force is produced.

1391. For a fluid flow over a flat pipe with zero pressure gradient, the boundary layer thickness $\left(\frac{\delta}{x}\right)$ is proportional to

(a) $\sqrt{Re_x}$ (b) $\frac{1}{\sqrt{Re_x}}$

(c) Re_x (d) $\frac{1}{Re_x}$

APPSC AEE (CIVIL/MECHANICAL) 2019

Ans. (b) : The boundary layer would develop on either side, giving rise to boundary shear stresses. The magnitude of these stresses depends on R_{ex} and the boundary layer thickness δ.

$$\frac{\delta}{x} = \frac{5}{\sqrt{Re_x}} \text{ for laminar boundary layer}$$

i.e. $$\frac{\delta}{x} \propto \frac{1}{\sqrt{Re_x}}$$

1392. Which object generates less drag when subjected to a flow field?

(a) Cylinder (b) Sphere

(c) Aerofoil (d) Square

APPSC AEE (CIVIL/MECHANICAL) 2019

Ans. (c) : Aerofoil does not have pressure drag as flow doesn't separate on aerofoil.

Pressure drag is the dominant drag at moderate Reynolds number. Hence, aerofoil has least drag as compared to other blunt objects.

1400. Separation of boundary layer occurs when-

(a) $\left(\frac{dp}{dx}\right) < 0$ (b) $\left(\frac{dp}{dx}\right) = 0$

(c) $\left(\frac{dp}{dx}\right) > 0$ (d) $\left(\frac{dp}{dx}\right) > 0$ and the velocity

JPSC AE 2009

Ans. (a) : Separation of boundary layer occurs when it has travelled for enough in an adverse pressure gradient.

$$\left(\frac{dp}{dx}\right) < 0$$

1401. Relative thickness (δ/x) of turbulent boundary layer on flat plate-

(a) decreases with distance x
(b) increases with distance x
(c) remains constant
(d) depends on relative roughness

JPSC AE 2009
ESE 1996

Ans. (a) $\frac{\delta}{x} \propto \frac{1}{(R_{ex})^{1/5}}$

As 'x' increase, Reynolds's number increases. As Reynolds's number increases, relative thickness $\left(\frac{\delta}{x}\right)$ of boundary layer decreases.

1421. When compared to a streamlined body, a bluff body will have–

(a) More pressure drag and more friction drag
(b) More pressure drag and less friction drag
(c) Less pressure drag and more friction drag
(d) Less pressure drag and less friction drag

Gujarat PSC AE (N.W.R.) 2020
GPSC AE Dec 2018

Ans. (b) : When compared to a streamlined body, a bluff body will have More pressure drag and less friction drag.

1422. Change in boundary layer from laminar to turbulent is directly affected by-

(a) Roughness of plate
(b) Pressure gradient
(c) Intensity of turbulence
(d) Velocity of flow

Gujarat PSC AE (N.W.R.) 2020

Ans. (d) : Change in boundary layer from laminar to turbulent is directly affected by :

- Roughness of plate.
- Pressure gradient.
- Intensity of turbulence.

1423. The thickness of boundary layer at the leading (entrance) edge will be :

(a) Maximum
(b) Minimum
(c) Zero
(d) Average

Nagaland PSC CTSE 2017 Paper–II

Ans. (c) : Boundary Layer is a region in the immediate velocity of the Boundary surface in which the velocity

1427. Which factor does not affect the drag force acting on a body?

(a) Density of the fluid

(b) Velocity of the body

(c) Projected area of the body

(d) Density of the body

DMRC AM 2017

Ans. (d) : Drag fore is given as-

$$F_D = \frac{1}{2} C_D A.\rho U^2$$

Here-

C_D = coefficient of Drag.

A = Projected area of body

ρ = Fluid density

U = Uniform velocity or stream velocity.

* Drag force does not depend on density of body.

...lined body as shown in th

1430. If δ_1 and δ_2 are the laminar boundary layer thickness at a point M distant x from the leading edge when the Reynolds number of the flow are 100 and 484, respectively, then the ratio $\frac{\delta_1}{\delta_2}$ will be

(a) 2.2
(b) 4.84
(c) 23.43
(d) 45.45

ESE 2018

Ans. (a) For laminar Boundary Layer–

$$\delta = \frac{5.48x}{\sqrt{Re_x}}$$

$$\left[\delta \propto \frac{1}{\sqrt{Re_x}}\right]$$

So, $$\frac{\delta_1}{\delta_2} = \frac{\sqrt{Re_2}}{\sqrt{Re_1}}$$

$$\Rightarrow \frac{\delta_1}{\delta_2} = \frac{\sqrt{484}}{\sqrt{100}}$$

$$\Rightarrow \frac{\delta_1}{\delta_2} = \frac{22}{10}$$

$$\Rightarrow \left[\frac{\delta_1}{\delta_2} = 2.2\right]$$

1442. **If $\frac{dp}{dx}$ is the pressure gradient and $\frac{dv}{dx}$ the velocity gradient in a fluid flow, then the separation of boundary layer occurs the conditions are :**

(a) $\frac{dp}{dx} < 0; \frac{dv}{dx} > 0$

(b) $\frac{dp}{dx} < 0; \frac{dv}{dx} < 0$

(c) $\frac{dp}{dx} > 0; \frac{dv}{dx} > 0$

(d) $\frac{dp}{dx} > 0; \frac{dv}{dx} < 0$

BHEL ET 2019

TSPSC Deputy Engineer 2015

Ans. (d) : The boundary layer separation occurs when

$$\frac{dp}{dx} > 0; \frac{dv}{dx} < 0$$

1444. **Separation of fluid flow is caused by**

(a) Reduction of pressure in the direction of flow
(b) Presence of adverse pressure gradient
(c) Presence of favorable pressure gradient.
(d) Reduction of the boundary layer thickness

UPPCL AE 2014

Ans. (b) : Separation of fluid flow is caused by presence of adverse pressure gradient (i.e. $\frac{dp}{dx} > 0$)

1445. **The thickness of laminar boundary layer at a distance x from the leading edge over a flat plates varies as**

(a) $x^{4/5}$
(b) $x^{1/2}$
(c) $x^{1/5}$
(d) $x^{3/5}$

APPSC (PHE) AE Paper-2 2012

Ans. (b) : Let,
δ = thickness of laminar boundary layer at a distance x from loading edge.
Blassius equation

4.91x

1461. For hydrodynamically rough boundary with usual notation:

(a) $\frac{K}{\delta'} > 6.0$ (b) $\frac{K}{\delta'} = 6.0$

(c) $\frac{K}{\delta'} < 0.25$ (d) $0.25 < \frac{K}{\delta'} < 6.0$

[UPPSC State Eng. A.E. 2011 Ist Paper]

Ans : (a) Hydrodynamic rough boundary :

$\frac{K}{\delta'} > 6.0$

Hydrodynamic smooth boundary

$\frac{K}{\delta'} < 0.25$

Where, K = surface roughness

δ' = thickness of laminar sub layer.

1467. Drag force is a function of :

(1) projected area of the body
(2) mass density of the fluid
(3) velocity of the body

The correct answer is :

(a) 1 and 2
(b) 2 and 3
(c) 1 and 3
(d) all of the above

PSPCL AE 2012

Ans. (d) : We know drag force (F_D)

$$F_D = \frac{C_d}{2} \times \rho A V^2$$

F_D is function projected Area (a), ρ(density) & velocity of body.