"Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

B.Sc. Part-I SEM I ~~Internal Examination~~ (2024-25)
Paper- Properties of matter
Topic-Fluid dynamics
Open book test

Day: -Tuesday
Date: - 11/03/2025

Time: - 11.00 pm- 12.00 pm

Sr. No	Name of the students	Roll no.	sign
1.	Shrushti. S. Chougule	7324	S.S.C
2.	Anuja. M. Matwadkar	7329	~~Anuja.~~
3.	Samruddhi. S. Dixit	7230	SDixit
4.	Grishma. S. Tripankar	7227	gsm
5.	Anushka J. Patil	7245	APatil
6.	Samruddhi K. Pabbir	7241	Pawar.
7.	Shreya. P. Powar	7225	Pawar
8.	Pratiksha-R. Mohite	7251	~~Rmohite.~~
9.	Diksha. V. sutar	7258	~~Diksha~~
10.	Nandini A. Chorage	7303	AChorage
11.	Amruta Vikrant Malavade	7220	~~M~~Malavade.
12.	Priti ketan Maruda	7221	Rmaruda
13	Arpita Bhikaji Patil	7330	A.B.patil
14	Samarth Balasaheb Koli	7236	S.B.kole
15	Harshovardhan Babaso chavan	7322	hebchan
16	Nikhil K Methe	7238	NKmethe

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1]	Nikhil Sunil Salokhe	7209 ~~BSC FY~~	~~NS~~
2]	Aditya Anandrao Dalavi	7325	Dalavi.
3]	Parth Prakash Gavali.	7202	P.P.G
4]	Suyash Dasharath Ghugare	7327	~~Ghugare~~
5]	Abhay Nivas Patil	7531	~~APatil~~
6)	~~Sahil S.~~		
7]	Adarsh Rakesh Jha	7214	Ajha...
8)	Sahil S. Pachkatte	7222	~~Sahil~~
9]	Sahil S. kumbhar	7207	~~Sahil~~
10]	Pranav. D. Patil	7331	Patil
11]	Shivtej. V. Patil	7339	S.Patil.
12]	Athary. M. Salokhe	7208	~~Amsalv~~
13)	Saranj. S. Zapate.	7228	~~S Zapate.~~
14)	Shivam P. Bodake	7321	~~S~~
15)	Atharva R. Patil	7246	~~ARPatil~~
16)	Shreyash S. Singate	7335	~~sssingate~~
17)	Sajid. F. Mulla.	7231	Mulla
18)	Abhishek. S. Parale	7231	~~AS~~
19)	Ayan. S. Shaikh	7226	A.S.S
20)	Yash. L. Dhotre	7326	Dhotre
21)	~~Samarth B. koli~~	~~7236~~	~~S.B.koli~~
22)	~~Harshavardhan Baboso Chavan~~	~~7322~~	~~hbchavan~~
23	Purva. D. Chougale	7257	Pvc
	Parth. V. Patil	7224	~~PV.Pati~~
	Rushi. V. Pawar	7333	Rushi

Name:- Matwadkar Anuja Mahadev.

BSC (I)

13492

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

Signature of Jr. Super.

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

परीक्षेच्या _____ या विषयाच्या प्रयोग परीक्षा

Practical Examination in, _____

at the _____ Examination

उमेदवराचा आसन क्रमांक 7329. विभाग
(Candidate's Seat No.) (Section)

उमेदवारांना सूचना

Good.

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोटकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे क्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there by anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you.
3. Before doing any electrical experiment, it is absolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form. It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible.
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

प्र. क्र.
Q. No.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

1] General characteristic of fluid flow

→ i) Fluid flow is steady i.e. its velocity at each poi in space is constant with time. The fluid flow co be non-steady in which the velocities vary from po to point as well as from time to time.

ii) Fluid flow can be rotational or irrotational depe upon whether there is an angular momentum of th fluid about any point. Irrotational flow is rath simple. Rotational flow includes vortex motion, su as whirlpools or eddies.

iii) Fluid flow can be compressible or incompressible. Liquids can usually be considered as flowing incomp ssibly. But even a highly compressible gas may som- es undergo unimportant changes in density Its flo is then practically incompressible

iv) The fluid flow can be viscous or non-viscous. visco in fluids is an analog of friction in solids. viscodt introduces tangential forces between layers of fluid in relative motion & results in dissipation of mecha cal energy

2] Write a note on streamline flow & Turbulant flow.

In a streamline flow, each particle of the fluid travels along the same path as the particles & hence the velocity at each point of the fluid remains constant. The actual path taken by a particle of the moving fluid is called a streamline. streamline flow is

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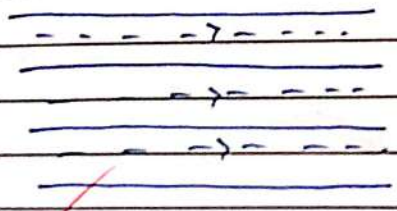
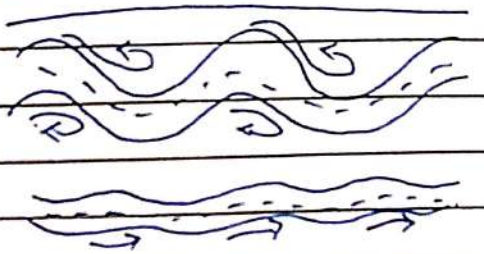
is characterized by a smooth and continuous flow of fluid. There is no turbulance or mixing between layers. streamline flow typically occurs at low velocities.



streamline flow

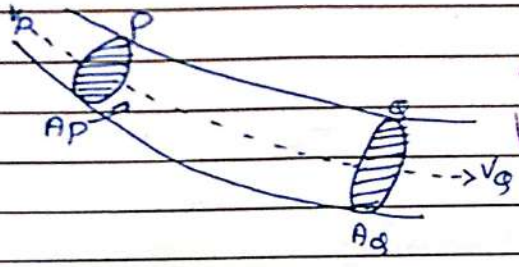


Turbulant flow.

When the velocity changes from particle to particle & hence the individual particles do not move in any particular direction or stream-line. The fluid particles intermingle from one tube to another & the path taken by the particles is zig-zag. The zig-zag motion results in the formation of eddy currents & consequently much energy is dissipated.

3] Derive an equation of continuity

→ consider a streamline flow of an incompressible fluid & tube of this flow of varying cross-section. Let AP & AQ be the area of cross-section of the tube and VP & VQ be the ~~area of cross-section of th~~ the velocities of the flow at two points P & Q.



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If ρ is the density of the incompressible fluid, the mass of the fluid entering the cross-section A_P one second is,

$$m_P = A_P \cdot V_P \cdot \rho \quad \text{—— (1)}$$

similarly,

$$m_Q = A_Q \cdot V_Q \rho \quad \text{—— (2)}$$

$$\therefore m_P = m_Q$$

$$\therefore A_P \cdot V_P \cdot \rho = A_Q V_Q \cdot \rho$$

$$\therefore A_P \cdot V_P = A_Q \cdot V_Q \quad \text{—— (3)}$$

cross-section x velocity of fluid is volume of the fluid flowing through the cross-section area per second. Hence eqn (3) becomes.

$$\frac{V_P}{V_Q} = \frac{A_Q}{A_P} \quad \text{or} \quad V \propto \frac{1}{A}$$

i.e. velocity of the flow varies inversely as the area of cross-section of the tube of the flow. Therefore at a narrowed portion of a tube, the velocity of flow increases

Q.4] Define critical velocity & Reynold's number.

→

Critical velocity :-

The maximum velocity at which a fluid flow remains streamline is known as the critical velocity (v_c).

or.

The minimum velocity above which the flow becomes turbulent is known as the critical velocity (v_c)

Name :- Matavadkar Anuja Mahadev.

॥ ज्ञान, विज्ञान आणि सुंसस्कार यासाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

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Students Sign. :	Anuja
Seat No. :	7329.
Seat No. in words :	
Suppliment No. :	
	47116
Centre	

प्र. क्र. Q. No.

Reynold's number -

If the velocity exceeds the critical velocity, the fluid flow becomes turbulent.

The critical velocity (v_c) is given by,

$$v_c = \frac{kn}{\rho r}$$

where, 'k' is Reynold's number

Q.5) Derive an expression for Bernoulli's Theorem

→ It states that the total mechanical energy of an incompressible, non-viscous fluid in streamline flow remains constant throughout the flow.

The theorem is mathematically expressed as;

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}.$$

Consider an incompressible fluid flowing through a pipe with varying cross-sections and height. According to Bernoulli's theorem, the sum of pressure energy, kinetic energy & potential energy per unit volume remains constant as the fluid flows.

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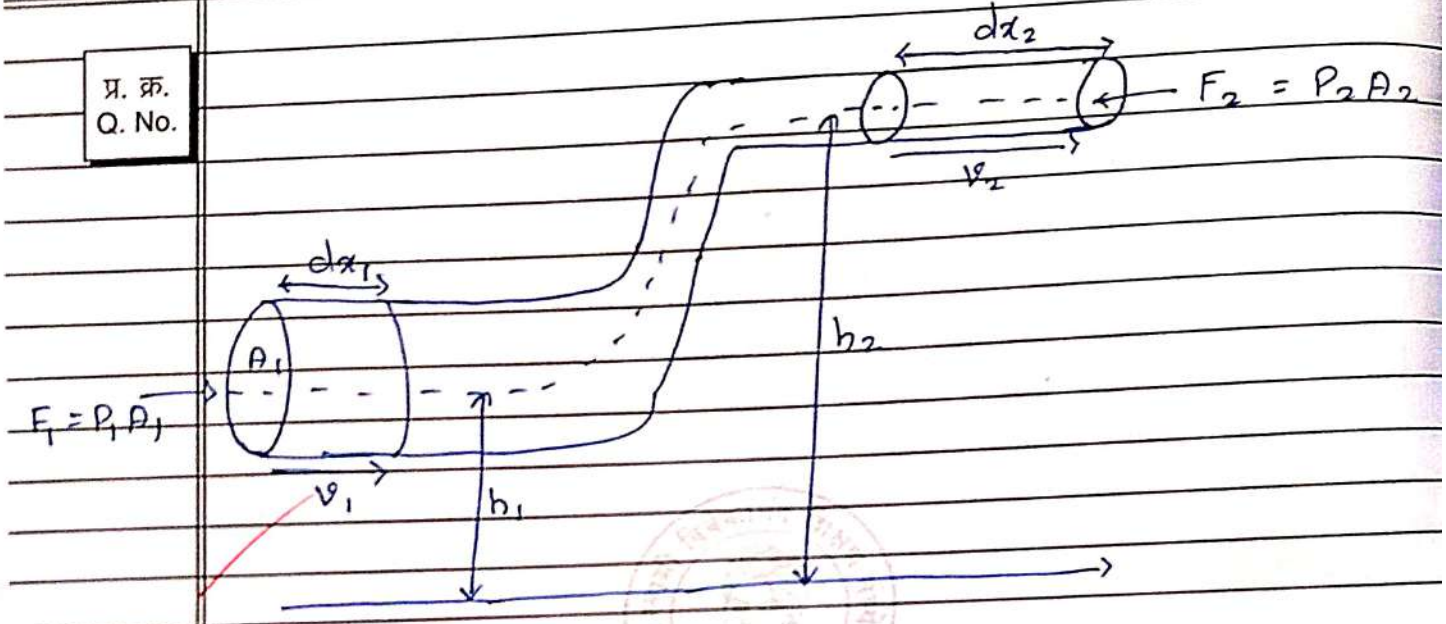
Q. No.



The work done on the fluid at the entrance & exit of the pipe is;

$$dW = F_1 dx_1 - F_1 dx_2$$

Let A_1 & A_2 are the cross-sectional areas.

$$dW = P_1 A_1 dx_1 - P_2 A_2 dx_2$$

It can be expressed as

$$dW = (P_1 - P_2)\, dv \quad \text{— (1)}$$

where, $dv = A_1 dx_1 = A_2 dx_2$ = volume of fluid flowing.

change in kinetic energy $= dk = \frac{1}{2} \rho (v_2^2 - v_1^2)$ — (2)

change in potential energy $= dv = \rho g (h_2 - h_1)$ — (3)

The total work done is,

$$dw = dk + dv \quad \text{— (4)}$$

substituting (1), (2), (3) in eqn (4) we get,

$$(P_1 - P_2) = \frac{1}{2}\rho(v_2^2 - v_1^2) + \rho g(h_2 - h_1)$$

$$\therefore P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

This shows that the sum of pressure energy, kinetic energy & potential energy per unit volume remains constant along the flow.

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(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

Signature of Jr. Super.

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Practical Examination in, Physics Open Book Test.

at the ——— Examination

उमेदवाराचा आसन क्रमांक 7230 विभाग BSc – I

(Candidate's Seat No.) (Section) Very good.

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
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INSTRUCTIONS TO CANDIDATES

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(येथून लेखनास सुरवात करा.) (Begin writing here.)

प्र. क्र.
Q. No.

Q1) Give the general ~~chacat~~ characteristics of fluid flow.

⇒ Some general characteristics of fluid flow are as follows

1) Fluid flow is steady i.e its velocity at each point in space is constant with time. The fluid flow can also be non-steady in which the velocities vary from point to point as well as from time to time.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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प्र. क्र.
Q. No.

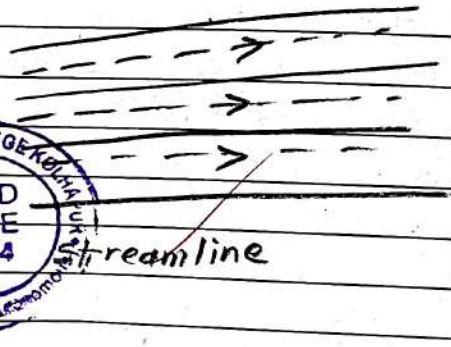
2) Fluid flow can be rotational or irrotational depend upon whether there is an angular momentum of th about any point. Irrotational flow is rather simple Rotational flow includes vortex motion.

3) Fluid flow can be compressible or incompressible. Li can usually be considered as flowing incompressibl But even a highly compressible gas may sometimes go unimportant changes in density.

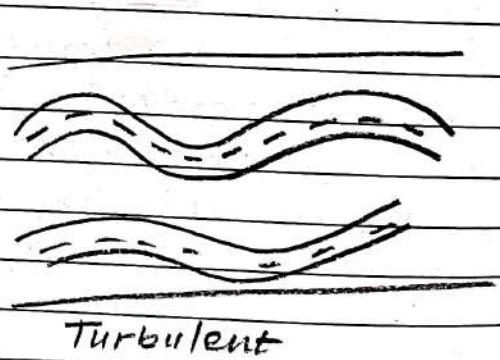
4) The fluid flow can be viscous or non-viscous. Visc in fluids is an analog of friction in solids. Visco introduces tangential force between layers of flu and results in dissipation of mechanical energy.

Q2) Write a note on – Streamline & Turbulent Flow

In a streamline flow each particle of the flu travels along the same path as the preceding par and hence the velocity at each point of the ~~field~~ fluid remains constant. The actual path taken by a particle of the moving fluid is called streamline ~~A st~~



Streamline



Turbulent

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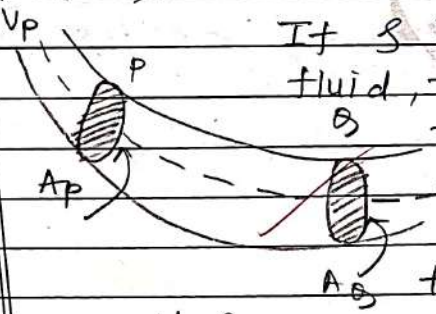
When the velocity changes from the particles and hence the individual particles do not move in any particular direction. The fluid particles intermingle from one tube to another and the path taken by the particles is zig-zag. The zig-zag motion results in the formation of eddy current. This flow is turbulent.

3) Derive Equation of Continuity.

Consider a streamline flow of an incompressible fluid and tube of this flow of varying cross-section. Let A_P and A_Q be the area of cross-section of the tube and V_P & V_Q be the velocities of the flow at points P & Q.



If ρ is the density of the incompressible fluid, then the mass of the fluid entering the cross-section A_P in 1 second is,

$$m_P = A_P \cdot V_P \cdot \rho \quad \text{——— (1)}$$

Similarly, the mass of fluid passing through the cross-section A_Q in one second is,

$$m_Q = A_Q \cdot V_Q \cdot \rho \quad \text{——— (2)}$$

In steady region, $m_P = m_Q$

$$\therefore A_P V_P \cdot \rho = A_Q \cdot V_Q \cdot \rho.$$

$$A_P V_P = A_Q V_Q \quad \text{——— (3)}$$

Cross-section × velocity of fluid is the volume of the flowing through the area per second.

$$\therefore \frac{V_P}{V_Q} = \frac{A_Q}{A_P} \quad \text{or} \quad V \propto \frac{1}{A}.$$

प्र. क्र. Q. No.

i.e. the velocity varies inversely as the area of cross-section of the tube of the flow.
∴ At a narrowed end of tube, velocity increas

Q4) Define critical Velocity & Reynold's Number

⇒ Critical Velocity — The maximum velocity at which the flow ~~increas~~ remains streamline is known as critical velocity OR The minimum velocity above which the flow becomes turbulent is known as critical velocity (V_c)

$$V_c = \frac{K\eta}{\rho r}$$

where K = Reynold's Number
Reynold's Number is a dimensionless, unitless quantity with its value around 2000.

Name – Samruddhi S. Dixit

॥ ज्ञान, विज्ञान आणि सुंसस्कार यासाठी शिक्षण प्रसार ॥
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
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SUPPLIMENT

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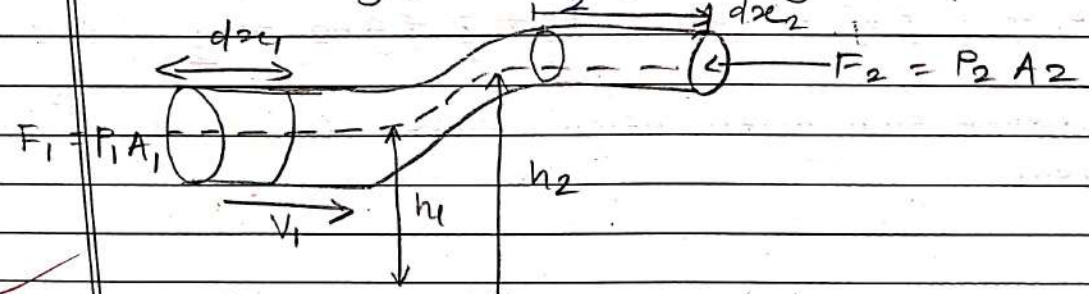
Students Sign. :	S.Dixit
Seat No. :	7230
Seat No. in words :	
Suppliment No. :	1.
	47122
Centre	

क्र. No.

Q5) Derive an expression for Bernoulli's Theorem –

⇒ Bernoulli's Theorem is a statement of law of conservation of energy for fluids. It states that the total mechanical energy of an incompressible non-viscous fluid in streamline flow is constant throughout the flow.

Mathematically, $P + \frac{1}{2}\rho V^2 + \rho g h = \text{constant}$.



Consider an incompressible, non-viscous fluid in the set-up in the figure above.

∴ The work done on the fluid at entrance P exist of the pipe.

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प्र. क्र. Q. No.

$$dW = F_1\,dx_1 - F_2\,dx_2$$

where $F_1 = P_1 A_1$ & $F_2 = P_2 A_2$

let A_1 & A_2 be the cross-sectional area at the respective point

$$dW = P_1 A_1\,dx_1 - P_2 A_2\,dx_2$$

$$\therefore \quad dW = (P_1 - P_2)\,dV \quad \text{——— (1)}$$

where $dV = A_1\,dx_1 = A_2\,dx_2$ = volume of fluid

Two energy changes are

$$\therefore \quad dK = \frac{1}{2}\rho\,(V_2^2 - V_1^2) \quad \text{——— (2)}$$

$$dU = \rho g (h_2 - h_1) \quad \text{——— (3)}$$

Thus the total work done

$$dW = dK + dU \quad \text{——— (4)}$$

Substituting (1) & (2) & (3) in (4)

$$(P_1 - P_2) = \frac{1}{2}\rho\,(V_2^2 - V_1^2) + \rho g (h_2 - h_1) \Rightarrow \text{for unit volume}$$

$$\therefore \quad P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho g h_2 + \frac{1}{2}\rho g h_2$$

The expression given below proves the Bernoulli's Theorem.

Name:- Grishma Sachin Tripankar.

13493

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

Signature of Jr. Super.

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

परीक्षेच्या _____ या विषयाच्या प्रयोग परीक्षा

Practical Examination in, _____

at the _____ Examination

उमेदवाराचा आसन क्रमांक 7227 विभाग _____
(Candidate's Seat No.) (Section)

उमेदवारांना सूचना

Excellent

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोटकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे क्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there by anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you.
3. Before doing any electrical experiment, it is absolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form. It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible.
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

प्र. क्र.
Q. No.

Q1.

1. General characteristics for fluid flow.

⇒ i) Fluid flow is steady i.e its velocity at each point in space is constant with time. The fluid flow can also be non-steady in which velocities vary from point to the point as well as from time to time

ii) Fluid flow can be rotational or irrotational depending upon whether there is an angular momentum of the fluid about any point. Irrotional flow is rather simple. Rotational

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flow include vertex motion such as whirlpool or eddies
iii) fluid flow can be compessible or incompressible
can usually be considered as flowing incompressible
But even a highly compressible gas may sometimes
undergo unimportant changes in density. Its flow is
then practically incompressible.
v) The fluid flow can be viscous or non viscous. Viscosity
in fluids is an analog of friction in solids viscosity
in fluids introduces tangential forces between layers
of fluid in relative motion & results in dissipation
mechanical energy.

Q2. Write note on streamline flow & turbulent flow.

Streamline flow:-

Streamline flow is a type of fluid flow where the fluid
moves in smooth, continuous paths.
streamline flow is also known as laminar flow.
streamline flow occures at low velocities
There is less formation of eddies in streamline flow

streamline flow

Turbulent flow

Turbulent flow is a type of fluid flow where the
fluid moves in chaotic, random paths
Turbulent flow occures at high velocities

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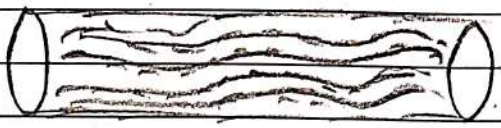
क्र. No.

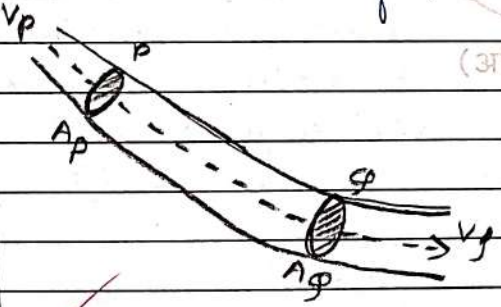
There is significant formation of eddies in turbulent flow.
Turbulent flow promotes mixing and diffusion of fluids. and the path is zigzag.



Turbulent flow

Q3. Derive the Equation of continuity.

⇒ Consider a streamline flow of an incompressible fluid & tube of this flow or varying cross section. let Ap & Aq be the area of cross section of the tube an Vp & Vq be the velocities of the flow at two points P & Q.



If ρ is the density of the incompressible fluid, then the mass of the fluid entering the cross section Ap in one second is

$$m_p = A_p \cdot V_p \cdot \rho \quad \text{— (1)}$$

Similarly, the mass of the fluid passing through the cross section Aq in one second is

$$m_q = A_q \cdot V_q \cdot \rho \quad \text{— (2)}$$

In the steady state, there can be no accumulation of fluid in any region of the tube & hence $m_p = m_q$

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Q. No.

$\therefore$ eqn ① = eqn ②

$A_p \cdot V_p \rho = A_g \cdot V_g \cdot \rho$

$\therefore A_p V_p = A_g \cdot V_g$ ——— [3]

Cross section × velocity of ~~the~~ fluid is the volm of the fluid flowing through the cross section area per second.

from eq³ ③ also we can write

$$\frac{V_p}{V_g} = \frac{A_g}{A_p} \quad \text{or} \quad V \propto \frac{1}{A}$$

i.e velocity of the flow varies inversly as the ar of cross section of the tube of the flow. Therefore at a narrowed portion of a tube, the velocity of flow increases.

Qu. Define critical velocity & Reynold's Number.

⇒ Critical velocity - The maximum velocity at which the flow remains streamline is known as critical velocity OR the minimum velocity above which the flow becomes turbulent is known as critical velocity (V_c)

$$V_c = \frac{K\eta}{\rho r}$$

where K = Reynold's Number.

Reynold's Number is a dimensionless, unitless quantity with its value around 2000.

॥ ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ॥

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Yes.
Seat No. :	7227
Seat No. in words :	
Suppliment No. :	2.
	47134
Centre	

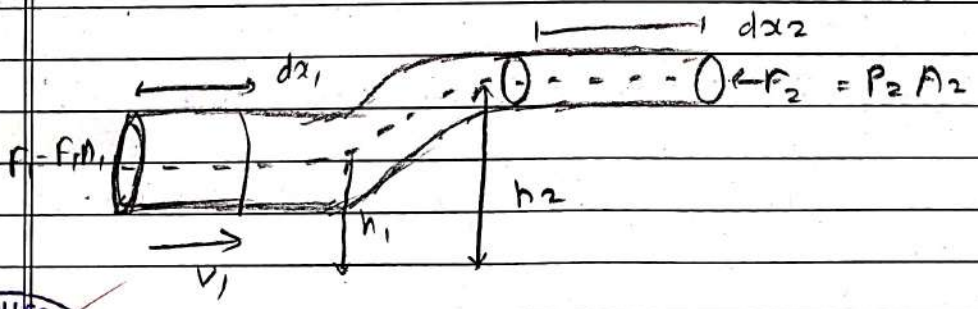
Yeishma Sachin Tripankar.

प्र. क्र.
Q. No.

Q5. Derive an expression for Bernoulli's theorem.

⇒ Bernoulli's theorem :- is a statement of law of conservation of energy for fluids. It state that the total mechanical energy of incompressible non-viscous fluid in streamline flow is constant throughout the flow.

Mathamatically $P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$.



Consider, an incompressible, non-viscous fluid in the set-up in the figure above
the work done on the fluid at entrance & exist of the pipe

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		Marks												

प्र. क्र.
Q. No.

$dw = f_1 dx_1 - f_2 dx_2$

Using this, where, $f_1 = P_1A_1$ & $F_2 = P_2A_2$ are the force section 1 & 2 respectively

Let A_1 & A_2 are the cross sectional areas at the respective points then

$dw = P_1A_1\, dx_1 - P_2A_2\, dx_2$

Using this, the work done on the fluid can be expressed

$$dw = (P_1 - P_2)\, dv \quad \text{—— ①}$$

where, $dv = A_1 dx_1 = A_2 dx_2$ = Volume of fluid

Two energy changes are.

$$\therefore dK = \frac{1}{2} \rho (V_2^2 - V_1^2) \quad \text{—— ②}$$

$$dv = \rho g (h_2 - h_1) \quad \text{—— ③}$$

Thus, the total work done

$$dw = dK + dU \quad \text{—— ④}$$

Substituting eqn ① & ② & ③ & ④

we get,

$(P_1 - P_2) = \frac{1}{2} \rho (V_2^2 - V_1^2) + \rho g (h_2 - h_1)$ ⇒ for unit volume

$$\therefore P_1 + \frac{1}{2} \rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho g h_2 + \frac{1}{2} \rho g h_2$$

The expression given below proves the Bernoulli's Theorem.

Name: shrushti satish chougule
R.N = 7324
class = BSC-fy

13491

Signature of Jr. Super.

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

परीक्षेच्या _____ या विषयाच्या प्रयोग परीक्षा

Practical Examination in, _____

at the _____ Examination

उमेदवराचा आसन क्रमांक _____ विभाग _____
(Candidate's Seat No.) (Section)

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोटकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे क्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

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(येथून लेखनास सुरवात करा.) (Begin writing here.)

प्र. क्र.
Q. No.

Q.1] General characteristics of fluid flow

→ i) fluid flow is steady i.e its velocity at each ~~at~~ points in space is constant with time. the fluid flow can also be non-steady in which the velocities vary ~~from~~ from point to point as well as from time to time.

ii) fluid flow can be rotational or irrotational depending upon whether there is an angular momentum of the fluid about any point. Irrational flow is rather simple. rotational flow includes

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Q. No.

Vortex motion, such as whirlpools or eddies

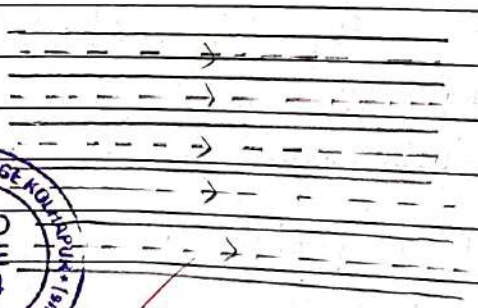
iii) Fluid flow can be compressible or incompressible. liquid can usually be considered as flowing incompressibly. But a highly compressible gas may sometimes undergo unimpeded change in density. its flow is then practically incompressible

iv) The fluid flow can be viscous or nonviscous. Viscosity in fluids is an analog of friction in solids. viscosity introduces tangential force both layer of fluid in rotational motion and results in dissipation of mechanical energy

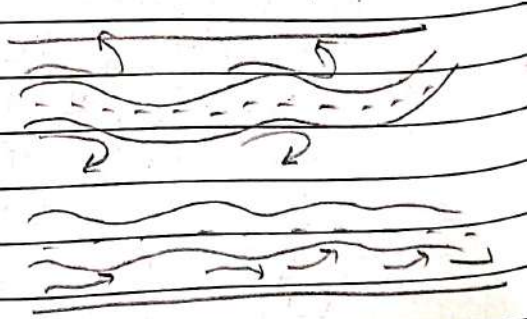
Q.2] write note on streamline flow and ~~Turbulent~~ Turbulent flow

In a streamline flow, each particle of the fluid travels along the same path as the preceding particles and hence the velocity at each points of the fluid remain constants, both in magnitude and direction. The actual path taken by a ~~fluid~~ particle of moving fluid is called streamline.

Characteristics ~~of~~ ~~the~~ smooth and continuous streamline flow is characterized by a smooth and continuous flow of fluid. there is no turbulence or mixing between layers. The fluid flows in parallel layer or streams. Streamlines flow typically occurs at low velocities.



Streamline flow



Turbulent Flow

Section	Q. No.													03
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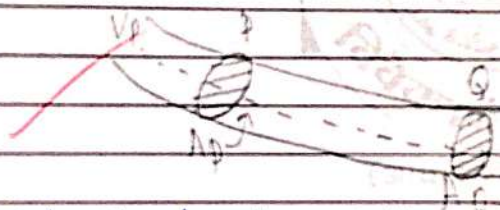
प्र. क्र.
Q. No.

when the velocity changes from particle to particle and hence the individual particles do not move in any particular direction or stream-line. the fluid particles intermingle from one tube to another and the path taken by the particles is zig-zag. the zig-zag motion results in the formation of eddy current. and consequently much energy is dissipated.

Q.3] Derive an equation of continuity

consider a streamline flow of in incompressible fluid and tube of this flow of varying cross-section. let Ap and AQ be the area of cross-section of the tube and Vp and VQ be the velocities of the flow at two points P and Q.



If ρ is the density of the incompressible fluid, then the mass of fluid entering the cross-section Ap in one second is,

$$m_p = A_p . V_p . \rho \quad \text{——} (1)$$

similarly,

$$m_Q = A_Q . V_Q . \rho \quad \text{——} (2)$$

$m_p = m_Q$

eqn (1) = eqn (2)

$A_p . V_p . \rho = A_Q . V_Q . \rho$

$A_p . V_p = A_Q . V_Q \quad \text{——} (3)$

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		Marks												

प्र. क्र.
Q. No.

cross-section x velocity of fluid is the volume of the fluid flowing through the cross-section area per second.

From eqn (3), also we can write,

$$\frac{V_p}{V_q} = \frac{A_q}{A_p} \quad \text{or} \quad V \propto \frac{1}{A}$$

i.e velocity of the flow varies inversely as the area of cross-section of the tube of the flow. therefore at a narrow portion of a tube, the velocity of flow increase.

Q.4 Define critical velocity and Reynold's Number

The maximum velocity at which a fluid flow ~~becomes turbulent~~ remains streamline is known as the critical velocity (V_c)

OR

The minimum velocity above which the flow becomes turbulent is known as the critical velocity (V_c)

Reynold's Number:

if the velocity exceeds the critical velocity the fluid flow becomes turbulent.

The critical velocity (V_c) is given by,

$$V_c = \frac{k\eta}{\rho d \gamma}$$

where, k - Reynolds number

॥ ज्ञान, विज्ञान आणि सुंसस्कार यासाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	
Seat No. :	
Seat No. in words :	
Suppliment No. :	
	47115
Centre	

प्र. क्र. Q. No.

Q.5] Derive an expression for Bernoulli's Theorem.

it states that the total mechanical energy of an incompressible non-viscous fluid in streamline flow remains constant throughout the flow

The theorem is mathematically expressed as;

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Consider an incompressible fluid flowing through a pipe with varying cross-sections and heights. according to Bernoulli's theorem, the sum of pressure energy, kinetic energy and potential energy per unit volume remains constant as the fluid flows

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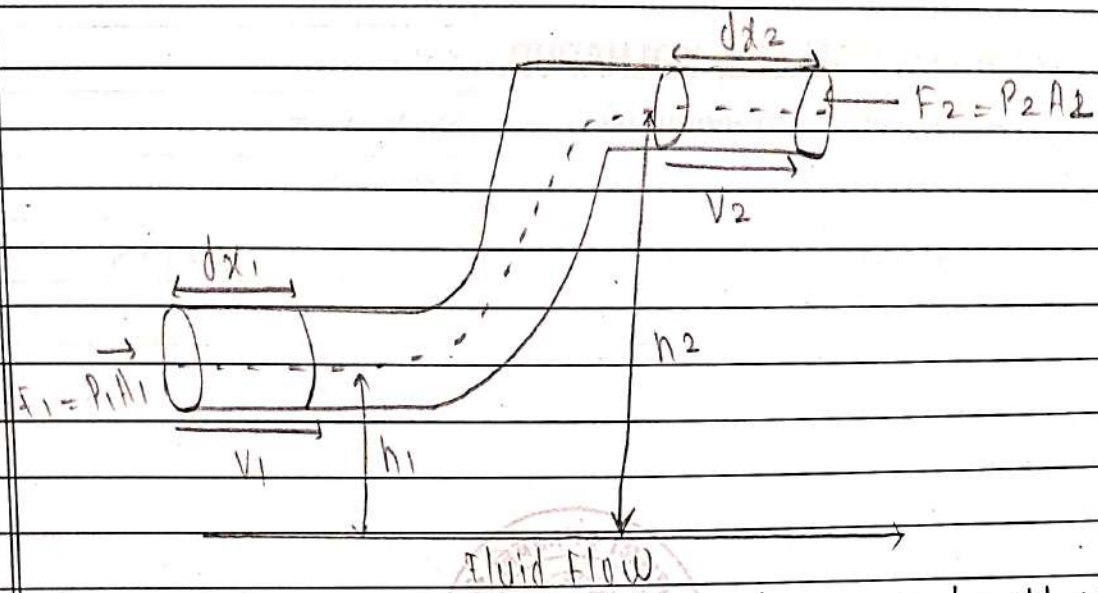
प्र. क्र.
Q. No.



The work done on the fluid at the entrance and exit of the pipe is

$$dW = F_1 dx_1 - F_2 dx_2$$

Where, $F_1 = P_1 A_1$ and $F_2 = P_2 A_2$

Let A_1 and A_2 are the cross-sectional area ~~at~~ at the respec point, then

$$dW = P_1 A_1 dx_1 - P_2 A_2 dx_2$$

using this, the work done on the fluid can be expressed as,

$$dW = (P_1 - P_2)\, dv \quad \text{——} (1)$$

where, $dv = A_1 dx_1 = A_2 dx_2$ = volume of the fluid flowing.

This work done is the result of 2 energy changes;

- change in kinetic energy = $dK = \frac{1}{2} \rho (v_2^2 - v_1^2)$ —— (2)
- change in potential energy = ~~dU~~

$$= dU = \rho g (h_2 - h_1) \quad \text{——} (3)$$

$$dW = dK + dU \quad \text{——} (4)$$

प्र. क्र.
Q. No.

Now by substituting eqn ①, ②, ⑤ in eqn ④

$$(P_1 - P_2) = \frac{1}{2}\rho(V_2^2 - V_1^2) + \rho g(h_2 - h_1) \quad \text{---(6)}$$

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

This shows that the sum of pressure energy, kinetic energy and potential energy per unit volume remains constant along the flow.

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Roll No: 7209. BSc.FY

13499

Signature of Jr. Super.

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Practical Examination in, _____

at the Vivekanand college, Kolhapur Examination

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) 7209 विभाग (Section) _____

उमेदवारांना सूचना

Good.

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोटकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे क्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there by anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you.
3. Before doing any electrical experiment, it is absolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form. It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible.
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

Q.1 write a Note on:

प्र. क्र. Q. No.

[i] General characteristics of fluid flow.

→ [i] fluid flow is steady i.e. its velocity at each point in space is constant with time. the fluid flow can also be non-steady in which the velocities vary from point to point as well as from time to time

[ii] Fluid flow can be rotational or irrotational depending upon whether there is an angular momentum of the fluid about any point. Irrotational flow is rather simple. Rotational flow includes vortex motion.

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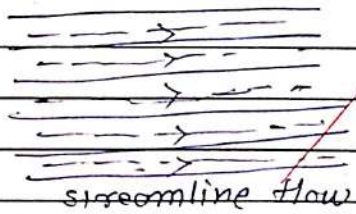
[iii] fluid flow can be compressible or incompressible. Liq
can usually be considered as flowing incompressibly. But ev
a highly compressible gas may sometimes undergo insignifi
nt changes in density

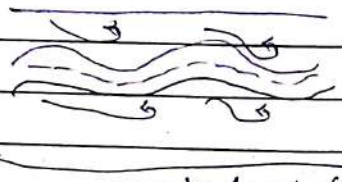
iv] The fluid flow can be viscous or non viscous. Viscosity
fluids is an along at friction in solids. viscosity introduc
tangential forces between layers of fluid in relative mot
& results in dissipation of mechanical energy.

2] write a note on streamline flow & turbulent flow.

In a streamline flow, each particle of the fluid travels a
the same path as the preceding particles & hence the velocity
at each point of the fluid remains constant, both in magnit
de & direction the actual path taken by a particle of the
moving fluid is called a streamline. A streamline is a curv
the tangent to which at any point gives the direction of flow
of the fluid at that point.



streamline flow



Turbulent flow

When the velocity changes from particle to particle and hence
the individual particles do not move in any particular direc
tion or streamline The fluid particles inter mingle from one
tube to another & the path taken by the particles is zig-zag
zig-zag motion results in the formation of eddy curren

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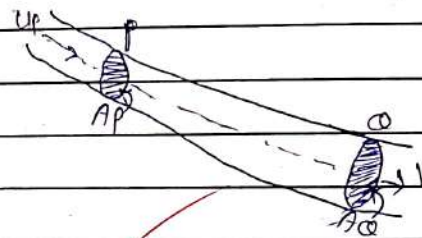
3] Derive an expression for equation of continuity.

Consider a streamline flow of an incompressible fluid & tube of this flow of varying cross-section. Let Ap & Aq be the area of cross-section of the tube and Vp & Vq be the velocities of the flow at two points P & Q.



If ρ is the density of the incompressible fluid, then the mass of the fluid entering the cross-section Ap in one second is.

$$m_p = A_p \cdot V_p \cdot \rho \quad \text{——— (1)}$$

The mass of fluid passing through the cross-section Aq in one second is,

$$m_q = A_q \cdot V_q \cdot \rho \quad \text{——— (2)}$$

In the steady state, there can be no accumulation of fluid in any region of the tube & hence $m_p = m_q$

$$\therefore \text{equ}^n (1) = \text{equ}^n (2)$$

$$A_p \cdot V_p \cdot \rho = A_q \cdot V_q \cdot \rho$$

$$\therefore A_p \cdot V_p = A_q \cdot V_q \quad \text{— (3)}$$

cross-section × velocity of fluid is the volume of the fluid flowing through the cross-section area per second. Hence equ (3) shows that the volume of the fluid entering the cross-section at P per second is equal to the volume of the fluid leaving the cross-section at Q per second.

From equ (3)

$$\frac{V_p}{V_q} = \frac{A_q}{A_p} \quad \text{or} \quad V \propto \frac{1}{A}$$

Velocity of the flow varies inversely as the area of cross section of the tube of the flow. At a narrowed portion of a tube the velocity of flow increases.

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Q. No.

4] Define critical velocity & Reynold's number.

→ osborne Reynold's was the first to experimentally determine the critical velocity of a liquid flowing through a tube. the critical velocity of a fluid gives transition between Streamline & turbulent flow.

"The maximum velocity at which a fluid flow remains streamline is known as the critical velocity"

or

If the velocity exceeds the critical velocity, the fluid flow becomes turbulent.

The critical velocity (V_c)

$$V_c = \frac{K\eta}{\rho r}$$

K - Reynold's number (a dimensionless constant, typically around 2000 for most fluids)

η = dynamic viscosity of the fluid.

ρ - density of the fluid.

r - radius of the fluid.

Reynold's work showed that all fluids, regardless of viscosity can transit from streamline to turbulent flow based on their velocity, density & radius.

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प्र. क्र. Q. No.

IV] ~~Define critical velocity & Reynold's number.~~
5] Derive an expression for Bernoullie's theorem.

→ Bernoullis theorem proposed by Domiel Bernoulli is a statement of the ~~two~~ law of conservation of energy for fluids. It states that the total mechanical energy of an incompressible, non-viscous fluids in streamline flow remains constant throught out the flow.

The theorem is mathematically expressed as.

$$p + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Where. p - Pressure energy
ρ = density of the fluid
v = velocity of the fluid.
g = acceleration due to gravity.
h = height above a reference point.

This equation is known as Bernoullis equation or Bernoullis principle.

consider an incompressible fluid flowing through a pipe with varying cross-sections and height. As the fluid moves through the pipe it experiences changes in pressure, velocity and height according to Bernoullis Theorem. the sum of pressure energy, kinetic energy.

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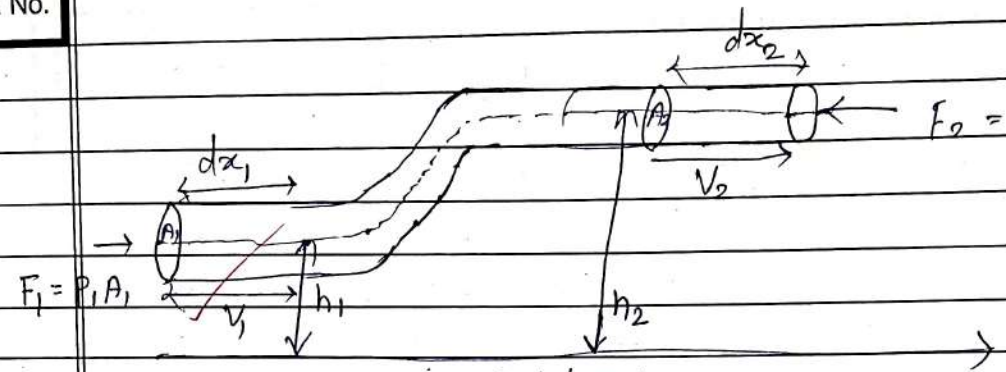
and potential energy per unit volume remains constant as the fluid flows.



fluid flow

The work done on the fluid at the enterance & exit of the pipe is:

$$dW = F_1 dx_1 - F_2 dx_2$$

where $F_1 = P_1 A_1$ & $F_2 = P_2 A_2$ are the forces at sections 1 & 2

Let A_1 & A_2 are the cross-sectional areas at the respective points.

$$dW = P_1 A_1 dx_1 - P_2 A_2 dx_2$$

The work done on the fluid can be expressed as

$$dW = (P_1 - P_2)\, dV \quad -(1)$$

where. $dV = A_1 dx_1 = A_2 dx_2$ = Volume of fluid flowing

This work done is the result of two energy change.

change in kinetic energy = $dK = \frac{1}{2} \rho (V_2^2 - V_1^2)$ -(2)

change in potential energy = $dU = \rho g (h_2 - h_1)$ -(3)

Total work done

$$dW = dK + dU \quad -(4)$$

Now by substituting equn (1), (2) & (3) in equation (4) we get

$$(P_1 - P_2) = \frac{1}{2} \rho (V_2^2 - V_1^2) + \rho g (h_2 - h_1) \quad \text{(for unit volume)}$$

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Re-arranging, we have

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

This show that the sum of pressure energy, Kinetic energy & Potential energy per unit volume remains constant along the flow.

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Roll No- 7251
BSc - fy

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(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

Signature of Jr. Super.

विवेकानंद कॉलेज, कोल्हापूर. (अधिकरप्रदत्त स्वायत्त)

_____ परीक्षेच्या _____ या विषयाच्या प्रयोग परीक्षा

Practical Examination in, _____

at the _____ Examination

उमेदवराचा आसन क्रमांक _____ विभाग _____
(Candidate's Seat No.) (Section)

उमेदवारांना सूचना

Very Good

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोटकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे क्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

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3. Before doing any electrical experiment, it is absolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form. It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible.
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

प्र. क्र. Q. No. 1.

1) → Some general chamcteristics of fluid flow are as follows.

i) Fluid flow is steady i.e. its velocity at each point in space is constant with time. The fluid flow can also be non-steady in which the velocity vary form point to point as well as from time to time.

Fluid flow can be rotational or irrotational depending upon whether there is an angular

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

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momentum of the fluid about any point. Irrotational flow is rather simple. Rotational flow includes vortex motion such as whirlpools or eddies.

iii) Fluid flow can be compressible or incompressible. Liquids can usually be considered as flowing incompressibly. But even a highly compressible gas may sometimes undergo unimportant changes in density. Its flow is then practically incompressible.

iv) The fluid flow can be viscous or nonviscous. Viscosity in fluids is an analog of friction in solids. Viscosity introduces tangential forces between layers of fluid in relative motion & results in dissipation of mechanical energy.

2) → Streamline flow & Turbulent flow.

In a stream line flow, each particle of the fluid travels along the same path as the preceding & hence the velocity at each point of the fluid remains constant, both in magnitude & direction. The actual path taken by a particle of the moving fluid is called a streamline. A streamline is a curve, the tangent to which at any point gives the direction of flow of the fluid at that point. A group or a bandle of streamlines having the same velocity over any cross-section perpendicular to the direction of the flow is called a tube of flow. Any particle in a tube of flow always remain

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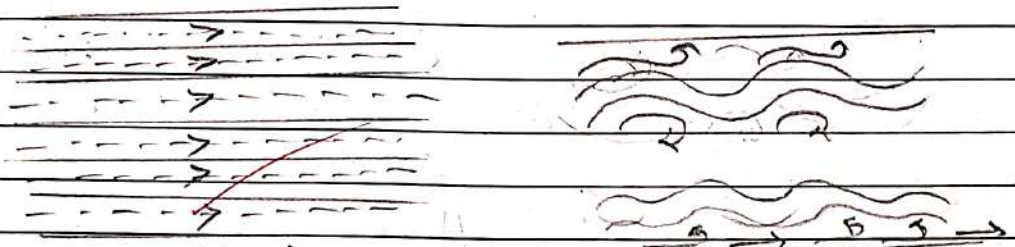
within the table of flow throught its motion & can not mix with the fluid in another tube.



streamline flow. Turbulent flow

when the velocity changes from particle to particle and hence the individual particle do not move in any particular direction or stream-line The fluid particles intermingle from one tube to another & the path taken by the particles is zig-zag. The zig-zag motion result in the formation of eddy cuments & consequently much energy is dissipated.

The two types of flows can be easily identified by injecting a jet of ink axially in a wider tube in which water is flowing axially. When the velocity of water is small, the ink moves in a straight line. when the velocity of water is increased beyond a certain value, the ink spreads out showing that the flow is turbulent.

3) → Equation of continuity

Consider a streamline flow of an incompressible fluid & tube of this flow of varying cross-section. Let AP & AQ be the area of cross-section of the tube & VP & AQ be the velocities of the flow at two points P & Q.

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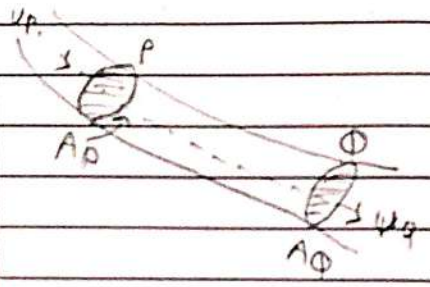

If ρ is the density of the incompressible fluid, then the mass of the fluid entering the cross-section AP in one second is.

$$m_P = A_P \cdot v_P \cdot \rho \quad \text{—①}$$

similarly, the mass of fluid passing thro the cross-section AQ in one second is.

$$m_Q = A_Q \cdot v_Q \cdot \rho \quad \text{—②}$$

In the steady state there can be no accumulation of fluid in any region of the tube & hence $m_P = m_Q$.

$\therefore$ eqⁿ ① = eqⁿ ②

$$A_P \cdot v_P \cdot \rho = A_Q \cdot v_Q \cdot \rho$$

$$\therefore A_P \cdot v_P = A_Q \cdot v_Q \quad \text{—③}$$

Cross-section x velocity of fluid is the volume of the fluid flowing through the cross-section area per-second. there eqⁿ (3) shows that the volume of the fluid entering the cross-section at P per second is equal to the volume of the fluid leaving the cross section at Q per second. Eqⁿ (3) is the equation of continuity for the steady flow of an incompressible fluid.

From eqⁿ (3), also we can write.

$$\frac{v_P}{v_Q} = \frac{A_Q}{A_P} \quad \text{or} \quad v \propto \frac{1}{A}$$

॥ ज्ञान, विज्ञान आणि सुंसस्कार यासाठी शिक्षण प्रसार ॥
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Rathi'te
Seat No. :	7251
Seat No. in words :	
Suppliment No. :	2
	47113
Centre	vck

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Q. No.

i.e velocity of the flow varies inversely as the area of cross-section of the tube of the flow Therefore at a narrowed position of a tube the velocity of flow increases.

4) → Critical velocity & Reynold's Number.

osborne Reynold's was the first to experimentally determine the critical velocity of a liquid flowing through a tube. The critical velocity of a fluid gives transition between streamline & turbulent flow.

"The maximum velocity at which a fluid flow remains streamline is known as the critical velocity (Vc)"

OR

"The minimum velocity above which the flow becomes turbulent is known as the critical velocity (V

If the velocity exceseds the critical velocity, the fluid flow becomes turbulent

The critical velocity (Vc) is given by

$$V_c = \frac{K\eta}{\rho r}$$

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Reynold's Number-

Reynold's ~~Number~~ work showed that all fluids, regardless of viscosity can transit from streamline to turbulent ~~to tur~~ flow based on their velocity, density, & the tube radius.

5) → Bernoulli's Theorem -

Bernoulli's theorem proposed by Daniel Bernoulli is a statement of the law of conservation of energy for fluids. It states that the total mechanical energy of an incompressible non-viscous fluid in streamline flow remains constant throughout the flow.

The theorem is mathematically ~~expressed~~ as

$$P = \frac{1}{2} \rho v^2 + \rho g h = \text{constant}$$

Where

P - Pressure energy
ρ - density of the fluid
v - velocity of the fluid
g - acceleration due to gravity.
h - height above a reference point.

This equation is known as Bernoullie's Equation or Bernoulli's principle.

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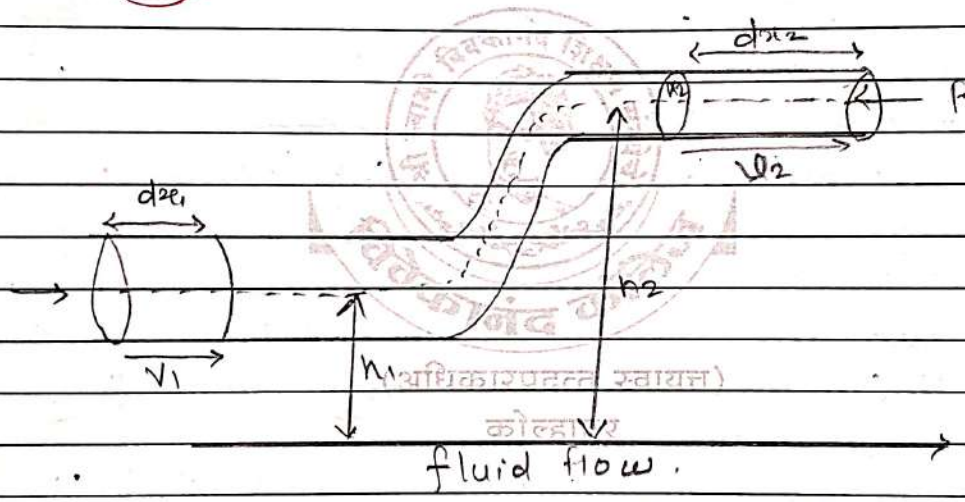
Consider an incompressible fluid flowing through a pipe with varfing cross-sections & height As the fluid moves through the pipe it experiences changes in pressure, velocity & height. According to Bernoulli's theorem, the sum of pressure energy kinetic energy, and potential energy per unit volume remains constant as the fluid flows.



The work done on the fluid at the entrance & exit of the pipe is:

$$dw = f_1 dx_1 - F_2 dx_2$$

Where $F_1 = P_1A_1$ & $F_2 = P_2A_2$ are the forces at sections 1 & 2 respectively.

Let A_1 & A_2 are the cross-sectional areas at the respective points, then.

$$dw = P_1A_1dx_1 - P_2A_2dx_2$$

Using this, the work done on the fluid can be expressed as.

$$dw = (P_1 - P_2)dV \quad \text{---(1)}$$

प्र. क्र. Q. No.

Where, $dV = A_1 dx_1 = A_2 dx_2$ = volume of fluid flowing.
This work done is the result of two energy changes

- change in kinetic energy = $dK = \frac{1}{2} \rho (V_2^2 - V_1^2)$ — ②

- change in potential energy = $dU = \rho g (h_2 - h_1)$ — ③

thus the total work done is.

$$dW = dK + dU \quad \text{— ④}$$

Now, by substituting eqn ① ② & ③ in eqn ④ we get.

$$(P_1 - P_2) = \frac{1}{2} \rho (V_2^2 - V_1^2) + \rho g (h_2 - h_1)$$ - for unit volume

Re-arranging, we have,

$$P_1 + \frac{1}{2} \rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho V_2^2 + \rho g h_2$$

This shows that the sum of pressure energy kinetic energy & potential energy per unit volume remains constant along the flow.