CHE 311

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MATRIC NO:-15/ENS01/004

ASSIGNMENT 1

=> Give a detailed illustration of the types of flow highlighted in class.

1. STEADY AND UNSTEADY FLOW

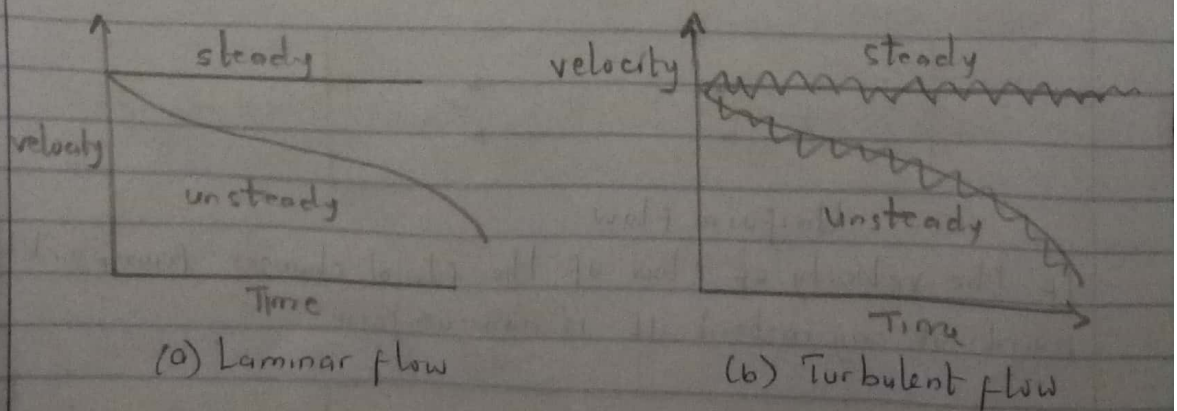
A flow is said to be steady if physical properties such as velocity, pressure or density do not change with time, at any point. That is

$$\frac{\partial V}{\partial t} = 0, \quad \frac{\partial \rho}{\partial t} = 0, \quad \frac{dp}{dt} = 0$$

If at any point, above characteristics, either one or some or all, change with time, then the flow will be defined as an unsteady flow. So

$$\frac{\partial V}{\partial t} \neq 0, \quad \frac{\partial \rho}{\partial t} \neq 0, \quad \frac{dp}{dt} = 0$$

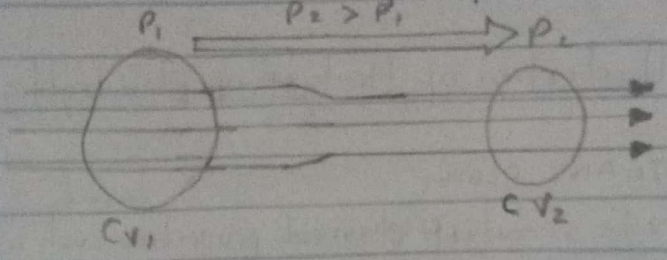
Tidal bore in a river is an example of natural unsteady flow. To determine whether a flow is steady or unsteady, influence of random fluctuations associated with turbulence is generally neglected and only general fluid motion is taken into consideration. The steady and unsteady flow at a point for Laminar and turbulent flow is shown below



(a) Laminar flow (b) Turbulent flow

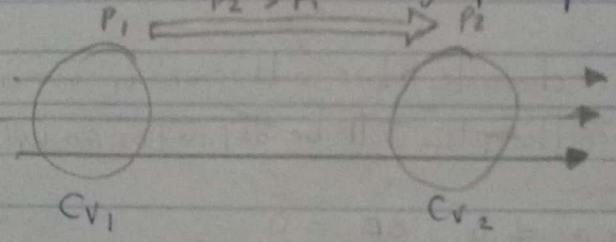
COMPRESSIBLE AND INCOMPRESSIBLE FLOW

A compressible flow is one where density of the fluid is not constant and varies from point to point



Compressible flow

An incompressible is one where the density of fluid is spatially invariant ie does not change from point to point

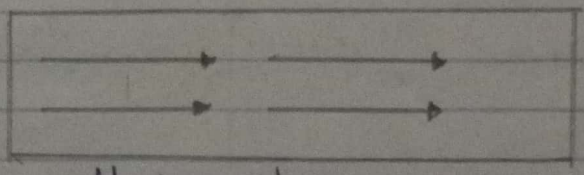


incompressible flow

UNIFORM AND NON-UNIFORM FLOW

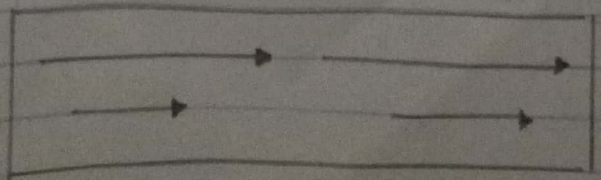
Uniform flow is one where at every point of the flow field, velocity is identical in magnitude and direction ie spatially invariant. So

$$\frac{\partial V}{\partial s} = 0$$



Uniform flow

If the velocity of flow of the fluid changes from point to point at any instant. It is non-uniform

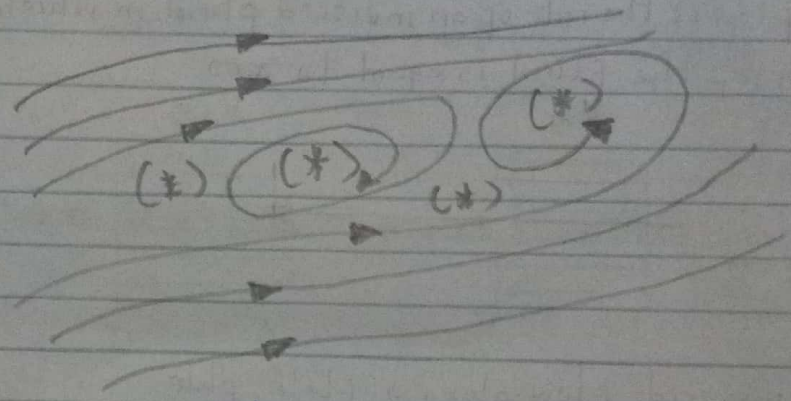


Non-Uniform flow

Uniform flow can combine to form steady uniform flow or unsteady uniform flow
While non-uniform can combine to form steady non-uniform flow and unsteady non-uniform flow.

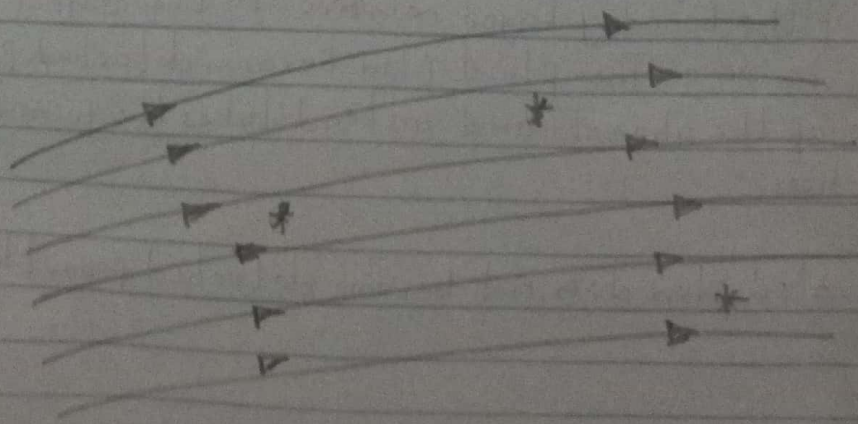
ROTATIONAL AND IRROTATIONAL FLOW

Rotational flow occurs when fluid particles, moving in the direction of flow, rotate about their mass centre.



Rotational flow

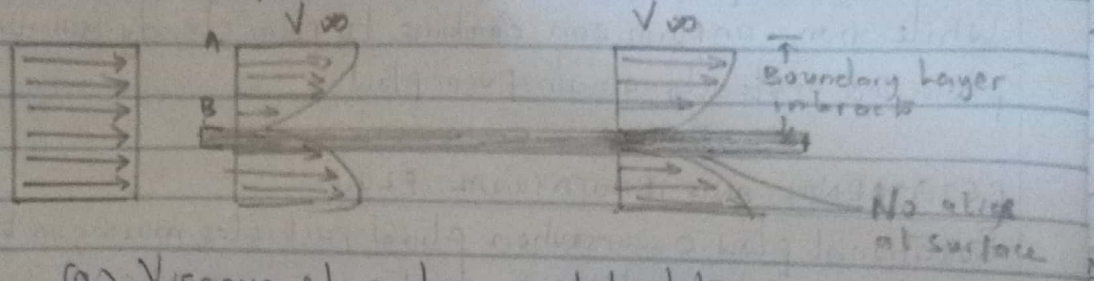
Irrotational flow occurs when fluid particles, moving in the direction of flow do not rotate about their mass centre.



irrotational flow

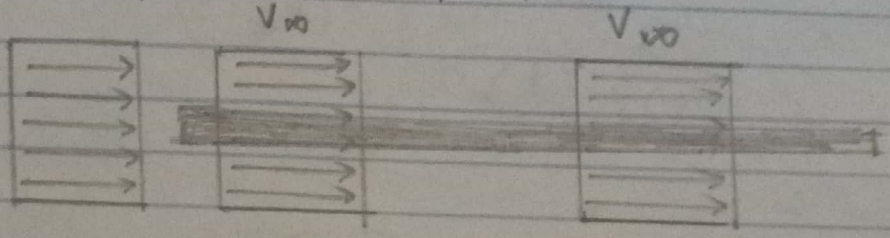
VISCOUS AND INVISCID FLOW

Viscous flows are always rotational because of shear stress that is exerted on the fluid element due to viscosity.



(a) Viscous flow along a flat plate

Inviscid flow is the rate of an inviscid fluid, in which the viscosity of the fluid is equal to zero



(b) inviscid flow along a flat plate

SEPERATED AND NON-SEPERATED FLOW

Seperated flow occurs when the boundary layer travels far enough against an adverse pressure gradient that the speed of the boundary layer relative to the object falls almost to zero. The fluid flow becomes detached from the surface of the object, and instead takes the form of eddies and vortices.

Unseperated flow does not become detached from the surface