Sheet (4)

Kinematics of fluid flow (continuity equation)

Problem One:

Find the acceleration and stream line function for the flows given below, then sketch the stream lines

(i) u=4, v=3
(ii) u=4, v=-3x
(iii) u=4y, v=-3x
(iv) u=4y, v=3x
(v) u=4y, v=-4x

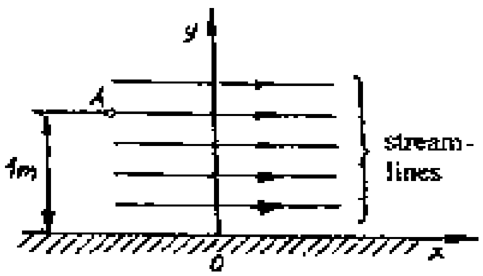
Problem two

Unsteady , two dimensional flow

Vy=0

$Vx=5yt^2$

Calculate the local and convective acceleration in point 'A' at **t=0.5 s**



Problem Three:

If the velocity distribution in a circular pipe of radius R is given by u= $\boldsymbol{U}\mathbf{max}\ (1-\frac{r^2}{R^2})$ where r is the radial distance from center and Umax is the maximum flow velocity at the center, find the drag force on a section of pipe 20cm long , 12cm diameter. Use **Umax=3m/s** and **μ=0.011 poise**. Sketch the velocity distribution

Problem four:

Unsteady , two dimensional flow

$u=5yt^2$

$v= -10xt$

(i) Calculate the local and convective acceleration at point **A (-1,1)** at **t= 2 sec**

(ii) Calculate the total acceleration at **(-1,1)** at **t= 2 sec**

(iii) Sketch the stream lines at **t=2 sec & 1 sec**

Problem Five:

Find and sketch the stream line for the given below and calculate the acceleration at **P (-1,2)**

(i) $u=x$, $v=-y$

(ii) $u=x$, $v=y$

(iii) $u=y^2$, $v=xy$

(iv) $u=y^2$, $v=-xy$

(v) $u=x$, $v=2y$

Problem Six:

A conical nozzle **2.5m** long converging from **0.2m** to **0.1m** diameter linearly is subjected to a constant flow rate of $1m^3/\boldsymbol{sec}$. Determine the acceleration at the mid-length of the nozzle. Assume uniform flow over each cross section.

Problem Seven:

For a laminar flow in a tube where the velocity distribution is given by $\boldsymbol{U = Umax\left(1 - \frac{r^2}{R^2}\right)}$ where **R** is the tube radius and **Umax** is the center line . Show that the mean velocity is half the center line velocity.

Problem Eight:

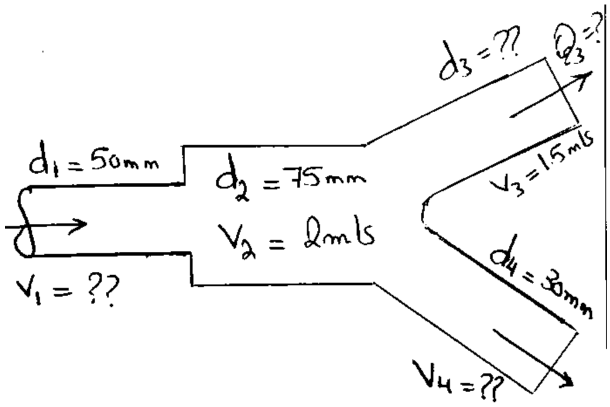
The velocity vector of a fluid particle is given by

$$u = x^2y + t^2,\;\; v = x^2 + y^2 + z^2 + 3t^4\,,\;\; w = x^3 + z^2 + t.$$

Calculate the velocity and acceleration of the particle at point **(2,3,1)** after **2 sec**

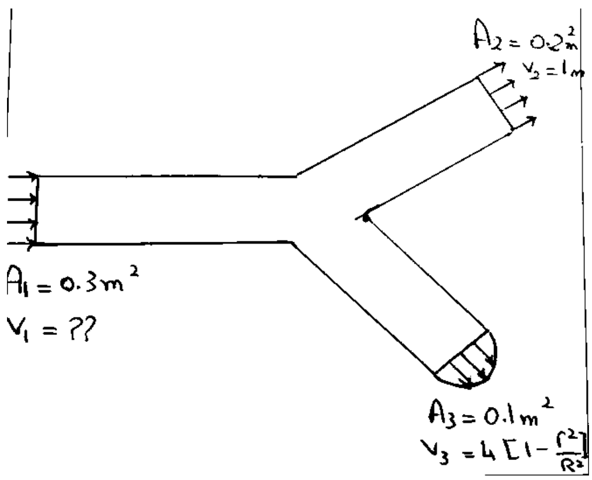
Problem Nine:

Water flows through the shown pipe system. Such that the discharge **Q2** divides so that **Q3=2Q4** . Calculate the values **Q1,Q2,Q3,Q4V1,V4** and **d3.**



Problem Ten:

An incompressible fluid flows steadily through a duct which has two outlets. The flow is one-dimension at section **(1) (2)**, but the velocity profile is Parabolic at section **(3). What** is the velocity **V1** ?

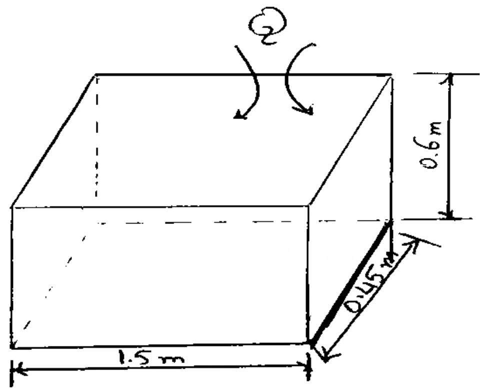


Problem Eleven:

An airplane moves forward at a speed of **971 Km/hr.** The frontal intake area of the jet engine is **0.8m²** and the entering air density is **0.736 Kg/m³**. A stationary observer estimates that relative to the earth, the jet engine exhaust gases moves away from the engine with speed of **1050 Km/hr**. The engine exhaust area is **0.558m²** and the exhaust gas density is **0.515 Kg/m³**. Estimate the mass flow rate of the fuel into the engine in **Kg/hr.**

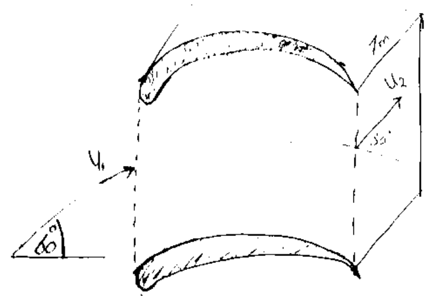
Problem Twelve:

A bathtub is being filled with water from a faucet. The rate of flow, **Q** From the faucet is steady at **0.0045m³/min**. The tub volume is approximated by a rectangular space. Determine the rate of change of the depth of water in the tub in **m/min** at any instant



Problem Thirteen:

An incompressible fluid flows steadily between a pair of vanes as shown in figure, the average velocity at entrance to the vane is **10m/s** .Determine the volumetric flow rate per unit depth between the vanes and the average velocity at outlet



Problem Fourteen:

Oil **(S=0.91)** enters at section **(1)** in the shown figure at a weight flow rate of **250N/hr** to lubricate the thrust bearing. Oil exits radial through the narrow clearance between thrust plates. Calculate the outlet volume flow rate and the outlet average velocity.