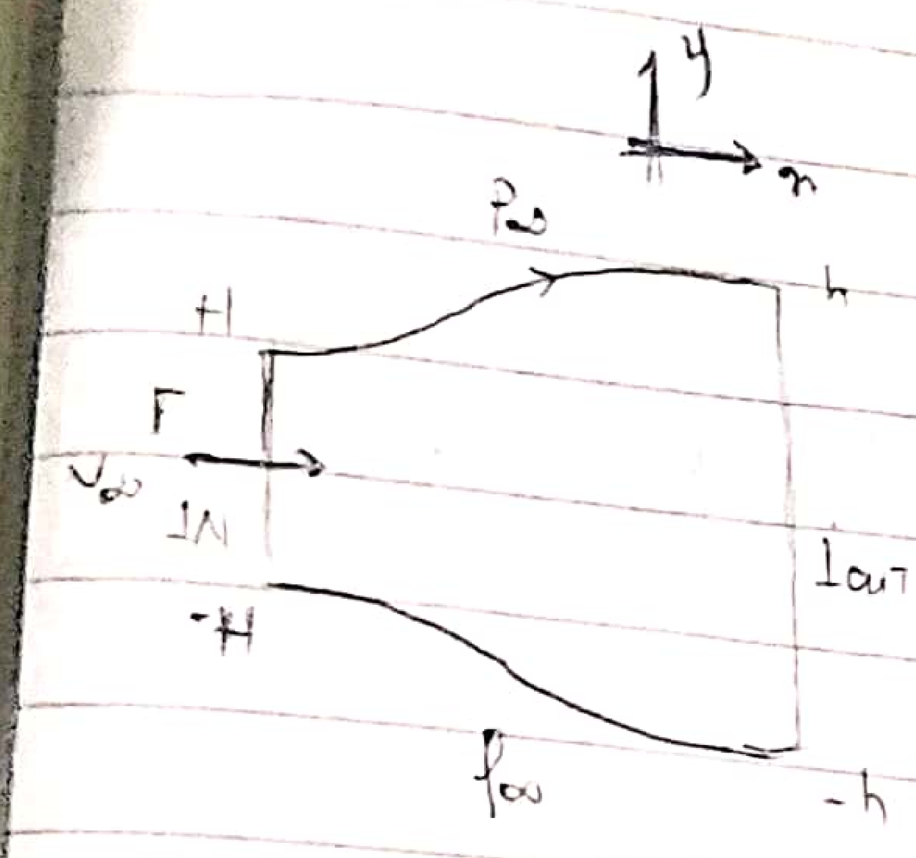
Index No: 9382917

Question One

Jet Propulsion Assignment 1



assumption

No flow goes through a streamline.

Due to Newton's 3rd law we can evaluate the force F as the Drag.

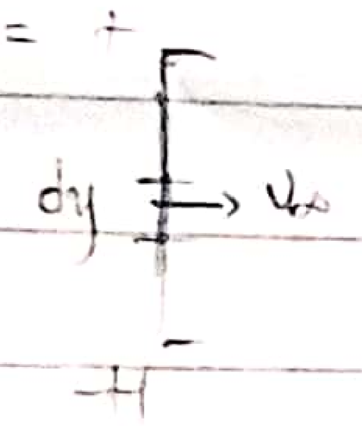
$F = -D$

Momentum Equation

$\Sigma F_x + I_{in} - I_{out} = 0$

$-D = \Sigma F_x$

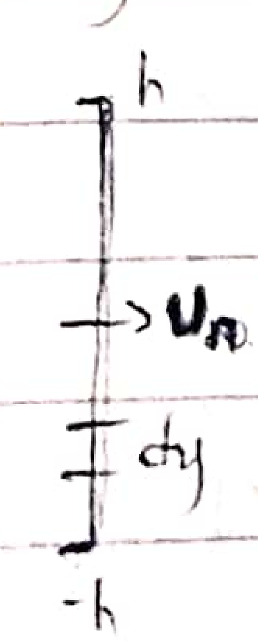
$I_{in} =$



$= \dot{m} = \int_{-H}^{H} \rho V_\infty \, dy$

$I_{in} = \int_{-H}^{H} \rho V_\infty^2 \, dy$

$I_{out} =$



$\dot{m} = \int_{-h}^{h} \rho u_n \, dy$

$I_{out} = \int_{-h}^{h} \rho u_n^2 \, dy$

$-D + \int_{-H}^{H} \rho V_\infty^2 \, dy - \int_{-h}^{h} \rho U_n^2 \, dy = 0$

$D = \int_{-H}^{H} \rho V_\infty^2 \, dy - \int_{-h}^{h} \rho U_n^2 \, dy$

$D = (V_\infty - V_n) \int_{-h}^{h} u \rho_\infty \, dy$;

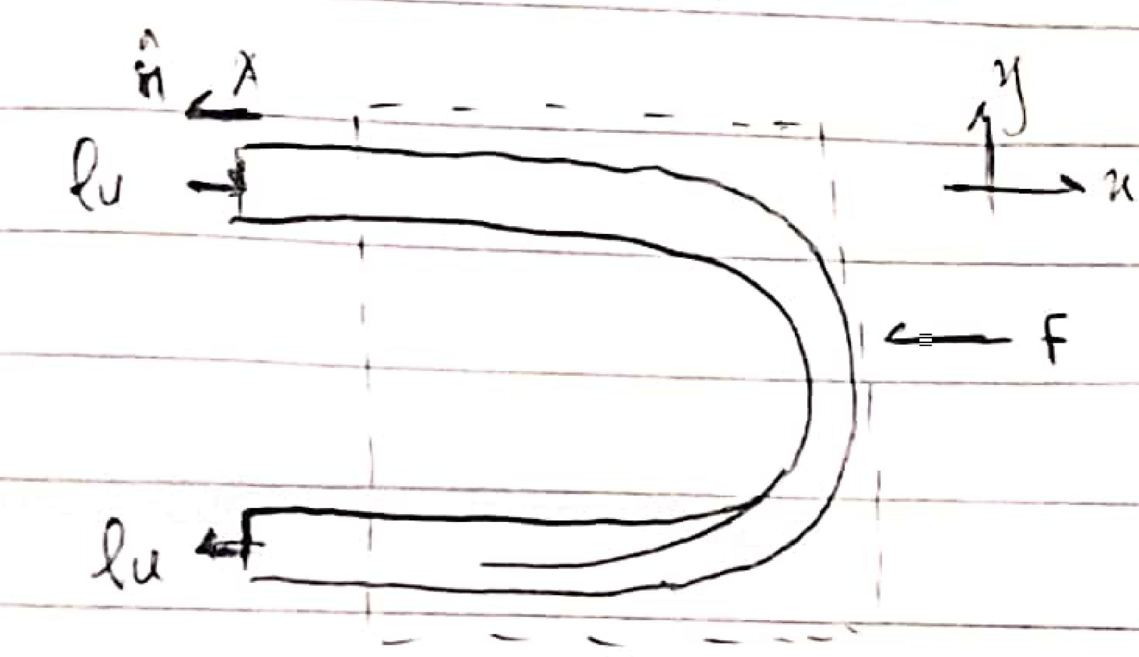
From continuity equation

$\int_{-H}^{H} V_\infty \rho_\infty \, dy = \int_{-h}^{h} u_n \rho_\infty \, dy$

Hence

$D = (V_\infty - V_n) \int_{-h}^{h} u_n \rho_\infty \, dy$

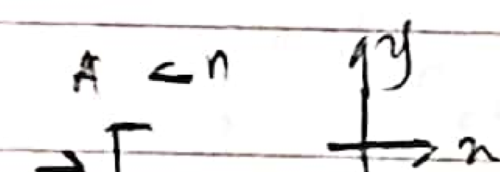
Question Two



$\Sigma F_x + I_{in} - I_{out} = 0$

$\Sigma F_x = -F$

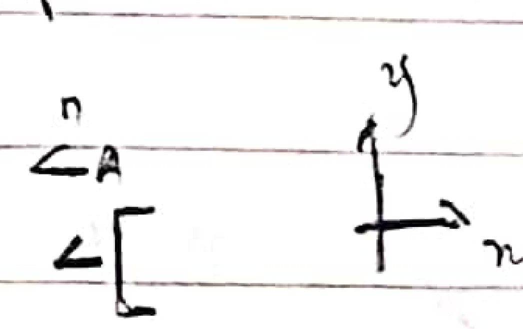
$I_{in} =$



$\dot{m} = \rho u A$

$I_{in} = \rho u^2 A$

$I_{out} =$



$\dot{m} = +\rho u A$

$I_{out} = -\rho u^2 A$

$F = -2 \rho u^2 A$

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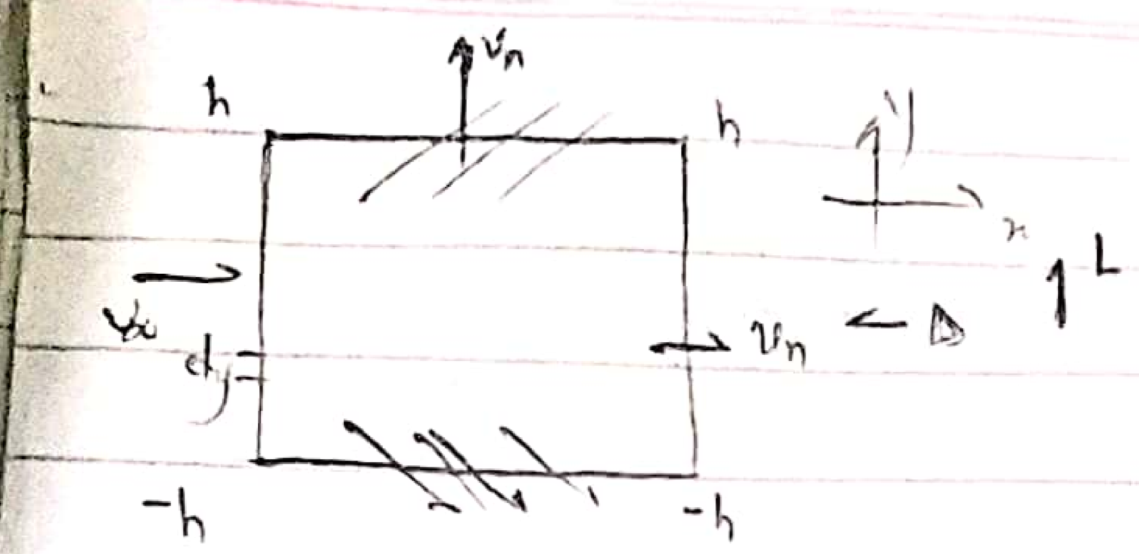
QUESTION THREE



Momentum equation

$\Sigma F_x + I_N - I_{OUT} = 0$

~~or~~

$\Sigma F_x + I_N - I_{OUT} = 0$

$\Sigma F_x = -\delta$

$I_N = \int_{-h}^{h} \rho V_\infty^2 \, dy$

$I_{out} = \int_{-h}^{h} \rho U_n^2 \, dy$

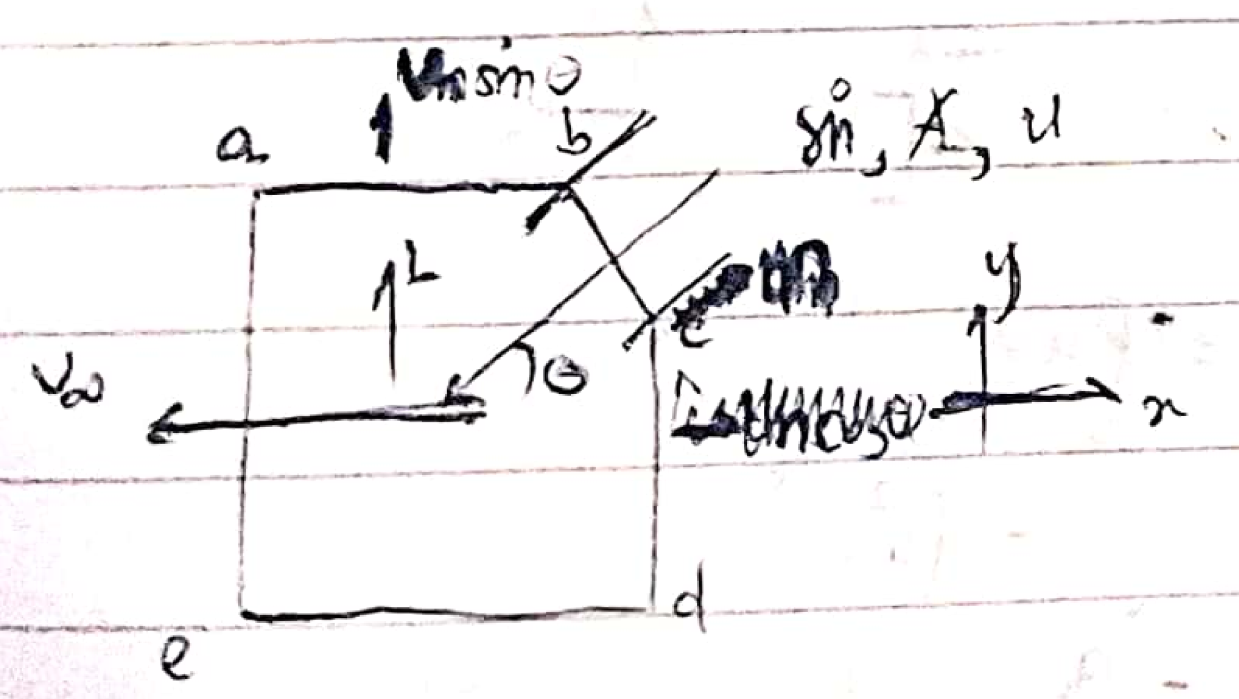
Continuity equation

$\int_{-h}^{h} \rho V_\infty^* \, dy = \int_{-h}^{h} \rho U_n^* \, dy$

$\Rightarrow -\delta + (V_\infty - U_n) \int_{-h}^{h} \rho U_n \, dy = 0$

$\delta = (V_\infty - U_n) \int_{-h}^{h} \rho U_n \, dy$

QUESTION FOUR



$\Sigma f_y + I_N - I_{OUT}$

$I_N = -\dot{m} \sin\theta \, U_n$

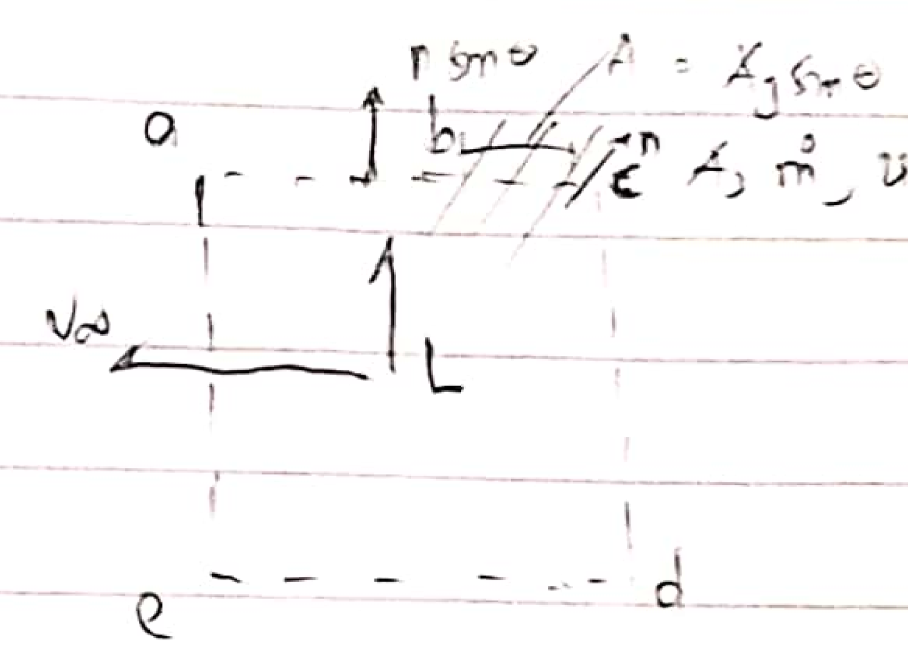
Assuming incompressible and steady conditions

$I_{OUT} = \int_a^b dx \, \rho U_n \sin^2\theta - \int_e^d dx \, \rho U_n \sin^2\theta$

$\Sigma f_y = L$

$L = \dot{m} \sin\theta \, U_n + \left[\int_a^b dx \, \rho U_n \sin^2\theta - \int_e^d dx \, \rho U_n \sin^2\theta \right]$

QUESTION FIVE



$\Sigma f_y + I_N - I_{OUT} = 0$

$\Sigma f_y = L$

$I_N = \rho U_n A_j \sin\theta \times -\dot{m}$

$- \dot{m} \sin\theta \, U_n$

$= -\dot{m} U_n \sin\theta$

$I_{OUT} = \left[\int_a^b dx \, U_n \rho \sin^2\theta - \int_e^d dx \, \rho U_n \sin^2\theta \right]$

$L = \dot{m} \sin\theta \, U_n + \left[\int_a^b dx \, \rho U_n \sin^2\theta - \int_e^d dx \, \rho U_n \sin^2\theta \right]$

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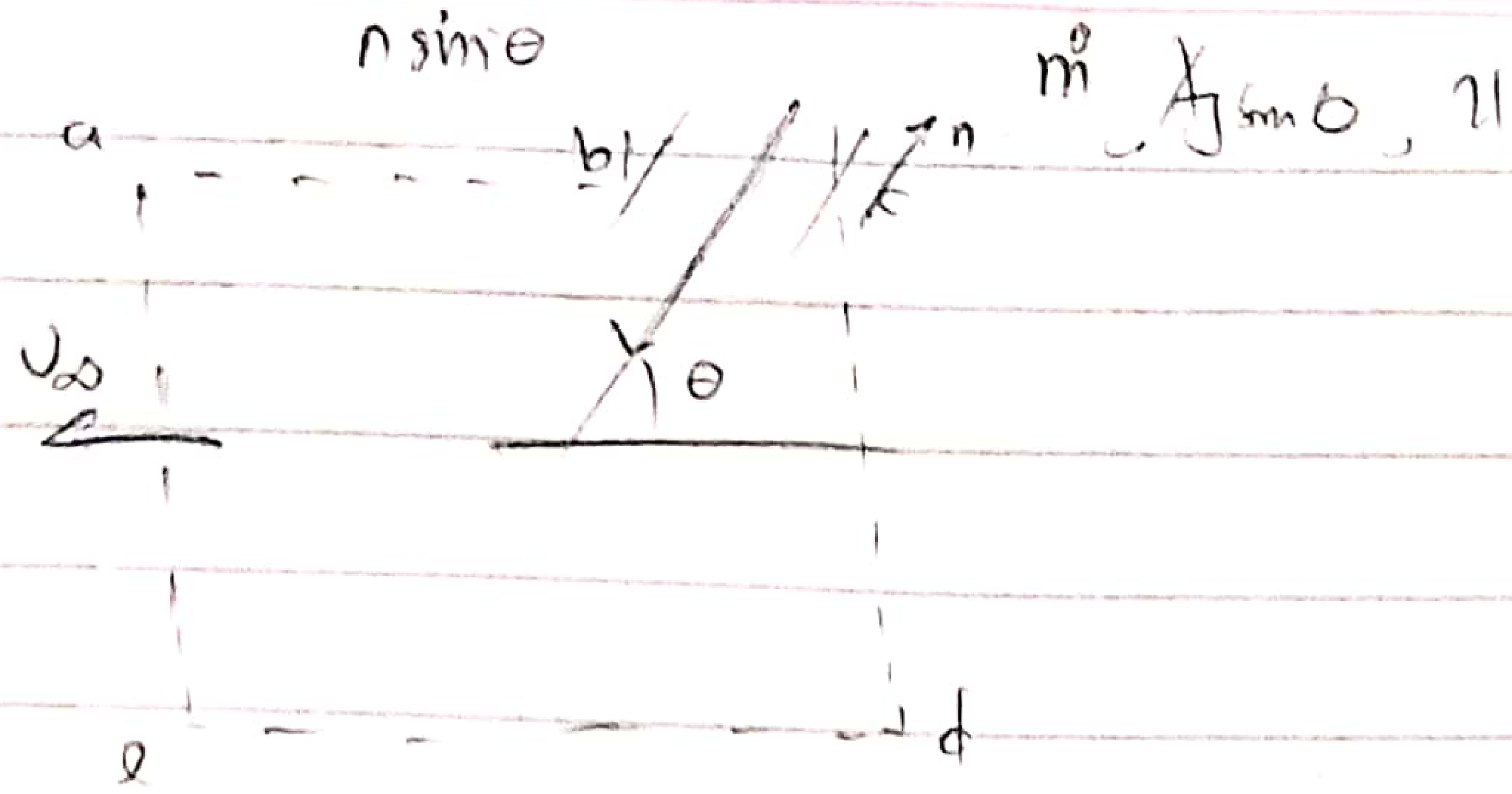
Question Six



$$\sum F_y + \dot{I}_{in} - \dot{I}_{out} = 0$$

$$\dot{I}_{in} = -\dot{m}\sin\theta\, u_n$$

$$\dot{I}_{out} = \left[\int_a^b \rho u_n \sin^2\theta \, dx - \int_e^d \rho u_n \sin^2\theta \, dx \right]$$

$$L = -\dot{I}_{in} + \dot{I}_{out}$$

$$= \dot{m}\sin\theta\, u_n + \left[\int_a^b \rho u_n \sin^2\theta \, dx - \int_e^d \rho u_n \sin^2\theta \, dx \right]$$