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# **MATRIC NUMBER: 17/ENG06/085**

# **DEPARTMENT: MECHANICAL ENGINEERING**

# **COURSE TITLE: FLUID MECHANICS II**

# **COURSE CODE: MEE322**

# **LECTURER(S) IN CHARGE: Engr. ROMINIYI**

# **ASSIGNMENT 1**

# QUESTION 1

* 1. The three conditions for a coutte flow are:
* Pressure gradient is constant
* The flow is uniform
* The flow is steady
	1. Four (4) conditions that can be used to determine the nature of flow are given by Reynolds experiment as:
* The diameter of the pipe(m)
* The density of the fluid passing through the pipe(kg/m3)
* The viscosity of the fluid(Ns/m2)
* The velocity of the flow(m/s)
	1. The differences between aero foil and hydrofoils are enlisted below:

|  |  |
| --- | --- |
| AEROFOIL | HYDROFOIL |
| * The aero foil is a lifting device mainly used in gaseous fluids(air in particular)
 | * The hydrofoil is a lifting device mainly utilized in liquid fluids( water)
 |
| * The aero foil is mainly used for lifting of airplanes and jets.
 | * The hydrofoil is mainly used to overcome drag and make machines move with a higher velocity in water.
 |

1. Given: µ= 0.9 centipoise= 0.9 x 10-2 poise = 0.9 x 10-3 Ns/m2

 U= 1m/s

 b= 10mm=0.01m

dp= 60 KN/m2

 dx= 60m

therefore the pressure difference gradient is = $\frac{∂p}{∂x}$ = $\frac{-60000}{60}$= -1 x 103 N/m3

* 1. Velocity distribution= u = $\frac{U\_{y}}{b}-\frac{1}{2μ}\left(\frac{∂p}{∂x}\right)\left(by-y^{2}\right)$

$$u=100y+5555.56y-555555.56y^{2}$$

$$u=\left(5.65556×10^{3}\right)y-(5.556×10^{5})y^{2}$$

* 1. Discharge per unit width = q= $\frac{Ub}{2}-\frac{b^{3}}{12μ}\left(\frac{∂p}{∂x}\right)$

$$q=0.005+0.09259=0.09759\frac{{m^{3}}/{s}}{m}$$

* 1. Shear stress at upper plate is located at y=b,

τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(b-2y\right)$

 τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(-b\right)$

$$τ=0.09-5=-4.91{N}/{m^{2}}$$

# QUESTION 2

Given: µ= 0.9Ns/m2

b= 10mm=0.01m

ρ= 1260kg/m3

P1= 250KN/m2

U= -1.5m/s

P2= 80KN/m2

$\frac{∂p}{∂x}$ = $\frac{-(P.1-P.2)}{Δx}$

But $P\_{.1}=P\_{1}+ρgh\left(piezometric\right)$

$$P\_{.1}=250000+\left(1260×9.81×1\right)=262.36{KN}/{m^{2}}$$

$$P\_{.2}=P\_{2}+ρgh\left(piezometric\right)$$

$$P\_{.2}=80000+\left(1260×9.81×0\right)=80{KN}/{m^{2}}$$

$$Δx$$

1m

1m

Because the two plates are aligned at an angle of 45 degrees, the above diagram can be used to calculate the change in x

By Pythagoras theorem,

$$∆x=\sqrt{1^{2}+1^{2}}=\sqrt{2}m$$

Therefore,

$\frac{∂p}{∂x}$ = $\frac{-(P.1-P.2)}{Δx}$ = $\frac{-\left(262⋅36-80\right)}{\sqrt{2}}$ = -128.948KN/m3

1. Velocity distribution= u = $\frac{U\_{y}}{b}-\frac{1}{2μ}\left(\frac{∂p}{∂x}\right)\left(by-y^{2}\right)$

$$u=-150y+716.38y-71637.8y^{2}$$

$$u=-\left(7.16378×10^{4}\right)y^{2}+ 565.62y$$

Shear distribution= τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(b-2y\right)$

$$τ=-135+644.74-128948y$$

$$τ=509.74-\left(1.289×10^{5}\right)y$$

1. Maximum flow velocity

At maximum flow velocity, $\frac{∂u}{∂y}=0$

$$0=-\left(1.4328×10^{5}\right)y+565.62$$

$$y=3.9476×10^{-3}m$$

$$u\_{max}=-\left(7.16378×10^{4}\right)(3.9476×10^{-3})^{2}+565.62(3.9476×10^{-3})$$

$$u\_{max}=1.12{m}/{s}$$

1. Shear stress at upper plate is located at y=b

Therefore, τ = 509.74 – (1.289 x 105 )y

$$τ=509.74-\left(1.289×10^{5}\right)(0.01)$$

$$τ=-779.26{N}/{m^{2}}$$