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**17/ENG01/027**

**MECHANICAL ENGINEERING**

**QUESTION 1a ANSWERS**

• The three conditions for a coutte flow are:

• Pressure gradient is constant

• The flow is uniform

• The flow is steady

• 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 viscousity of the fluid(Ns/m2)

• The velocity of the flow(m/s)

• The differences between aerofoil and hydrofoils are enlisted below:

AEROFOIL

HYDROFOIL

• The aerofoil 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 aerofoil 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.

**QUESTION 1b SOLUTION**

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= 60KN/m2

dx= 60m

therefore the pressure difference gradient is = = = -1 x 103 N/m3

• Velocity distribution= u =

u =100y + 5555.56y – 555555.56y2

u = (5.65556 x 103 )y – (5.556x 105 ) y2

• Discharge per unit width = q=

q = 0.005 + 0.09259 = 0.09759 m3/s/m

• Shear stress at upper plate is @y=b,

τ =

= τ =

τ = 0.09-5 = - 4.91 N/m2

**QUESTION 2 SOLUTION**

Given: µ= 0.9Ns/m2 b= 10mm=0.01m

ρ= 1260kg/m3 P1= 250KN/m2

U= -1.5m/s P2= 80KN/m2

=

But P.1= P1 + ρgz (piezometric)

= 250000 + (1260) \*(9.81) \*(1)

= 262.36KN/m2

And P.2= P2 + ρgz (piezometric)

= 80000 + (1260)\*(9.81)\*(0)

= 80KN/m2

1m

1m

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,

= = m

Therefore,

= = = -128.948KN/m3

• Velocity distribution= u =

u = -150y + 716.38y – 71637.8

u = -(7.16378 x 104 ) + 565.62y

• Shear distribution= τ =

τ = -135 + 644.74 – 128948y

τ = 509.74 – (1.289 x 105 )y

• Maximum flow velocity

At maximum flow velocity,

0= -(1.4328 x 105 )y + 565.62

y= 3.9476 x 10-3 m

umax= -(7.16378 x 104 ) + 565.62(3.9476 x 10-3)

umax= 1.12 m/s

• Shear stress at upper plate is @y=b

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

τ = 509.74 – (1.289 x 105 )( 0.01)

τ = -779.26 N/m2