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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