College of Engineering & Technology

Department: Mechanical Engineering Marks: 15
Lecturer: Dr. Rola Afify Time: 10:30 – 12:00
Course Code: ME362 Date: 13/3/2016

Name: **Model Answer** R.N.:

Answer the following questions:

Question one (10 marks)

A) Define:

- Fluid: It is a substance which deforms continuously under the action of shearing forces, however small they are. This deformation is permanent even of if the force is removed.

Specific weight : weight per unit volume

$$w = \frac{\text{weight}}{\text{volume}} = \frac{m * g}{V} = \rho g$$

Dim. $\frac{ML}{T^2} * \frac{1}{L^3}$, for water $w = 1000 * 9.8$ $\frac{N}{m^3}$

Specific volume : volume per unit mass

$$v = \frac{\text{volume}}{\text{mass}} = \frac{1}{\rho} \quad m^3/kg$$

For water $v = 0.001$ m^3/kg

B) Show whether the equation $Q = 3.09BH^{3/2}$ satisfies the principle of dimensional homogeneity. Where Q is the flow rate in m^3/s and B and H are lengths in meters.

$Q = 3.09\ B\ H^{3/2}$

$[L^3T^{-1}] \doteq [3.09][L][L]^{3/2}$

$[L^3T^{-1}] \doteq [3.09][L]^{5/2}$

Since each term in the equation must have the same dimensions the constant 3.09 must have dimensions of $L^{1/2}T^{-1}$ and is therefore not dimensionless. No.

Since the constant has dimensions its value will change with a change in units. No.

C) Discuss Newton's law of viscosity (mention the unit of each parameter).

$$F_{vis} = \mu A_{friction\ moving} \frac{du}{dy}$$ ← Newton's law of viscosity

F : viscous force

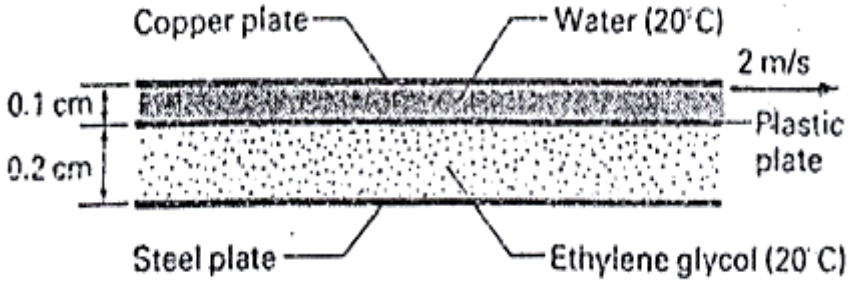
μ = coefficient of viscosity depends on type of fluid and its temperature

$\frac{du}{dy}$: rate of shear strain

A: Moving are in contact with oil.
u: velocity
y: distance between moving an fixed plates

Question one (5 marks)

Three large plates are separated by thin layers of ethylene glycol (μ_{eg} = 0.0199 N.s/m^2) and water (μ_w = 0.001 N.s/m^2), as shown in figure. The top plate moves to the right at 2 m/s. At what speed and in what direction must the bottom plate be moved to hold the centre plate stationary?



$F_{top} = F_{bottom}$

$\mu_w A \frac{du}{dy} = \mu_e A \frac{du}{dy}$

$0.001 * \frac{2}{0.1 * 10^{-2}} = 0.0199 * \frac{V}{0.2 * 10^{-2}}$

$V = \frac{0.001 * 2 * 0.2}{0.0199 * 0.1}$

$= 0.2$ m/s

in the opposite direction (to left)

2 m/sec →

0.1 cm $\mu_w = 0.001\ N \cdot s/m^2$ V = 0

0.2 cm $\mu_e = 0.0199\ N \cdot s/m^2$ V = ??