



## College of Engineering & Technology

Department: Mechanical Engineering  
Lecturer: Dr. Rola Afify  
Course Code: ME362

Marks: 15  
Time: 9:30 – 10:10  
Date: 20/3/2016

15

Name: **Model Answer**

R. N.:

**Answer the following questions:**

**Question one (15 marks)**

A) Define:

\* **Kinematic viscosity** ( $\nu$ ): is defined as the ratio of dynamic viscosity of water to density

$$\nu = \frac{\mu}{\rho} = \frac{Pa \cdot s}{kg/m^3} = \frac{kg \cdot m \cdot s^{-1} \cdot m^{-3}}{s^2 \cdot m^{-2} \cdot kg} = (m^2/s)$$

$$\nu = 0.01 \text{ cm}^2/s$$

$$= 0.01 \text{ stoke} \quad \text{as } \text{Stoke} = \text{cm}^2/s$$

$$= 1 \text{ centi stokes}$$

- Vapour Pressure of a liquid:

It is the pressure at which a liquid start to boil at working temperature.

Boiling temp increases by increasing pressure on liquid surface.

Boiling temp decreases by decreasing pressure on liquid surface.

B) Compare between Newtonian and Non-Newtonian Fluids.

$$\tau = \frac{F_{vis}}{A} = \mu \frac{du}{dy}$$

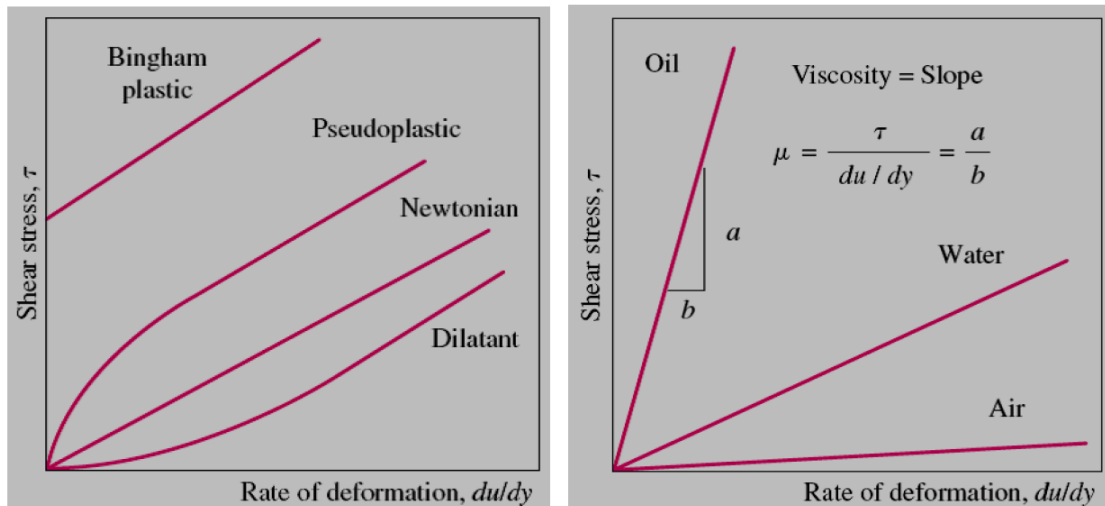
as  $\tau$ : Shear stress

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

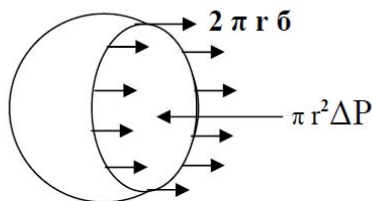
If  $\tau \propto \frac{du}{dy}$   $\therefore \mu = \text{const.}$   $\therefore$  It is a Newtonian fluid

$\mu = \text{const.}$   $\longrightarrow$  Newtonian fluid

$\mu = \uparrow \downarrow$   $\longrightarrow$  Non Newtonian



- C) A water bubble has a radius of 4mm. Determine the pressure difference between the inside and outside the droplet. Surface tension of water is  $\sigma = 7.34 \times 10^{-2}$  N/m.



Half of droplet

$$2 \pi r \sigma = \pi r^2 \Delta P$$

$$\Delta P = \frac{2 \pi r \sigma}{\pi r^2} = \frac{2 \sigma}{r} \quad \Delta P = 2 \times 7.34 \times 10^{-2} / (4 \times 10^{-3}) = 36.7 \text{ Pa}$$

- D) Two vertical parallel clean glass plates are spaced a distance of 2mm apart. If the plates are placed in water ( $\sigma = 7.34 \times 10^{-2}$  N/m), how high will the water rise between the plates due to capillary action?

For equilibrium in the vertical direction,

$$W = 2 (\sigma l \cos \theta)$$

Since,

$$W = \gamma h b l$$

$$\gamma h b l = 2 \sigma l \cos \theta$$

or,

$$h = \frac{2 \sigma \cos \theta}{\gamma b}$$

Thus, (for  $\theta = 0$ )

$$h = \frac{2 (7.34 \times 10^{-2} \frac{\text{N}}{\text{m}})(1)}{(9.80 \times 10^3 \frac{\text{N}}{\text{m}^3})(0.002 \text{ m})} = 7.49 \times 10^{-3} \text{ m} = \underline{\underline{7.49 \text{ mm}}}$$

The diagram shows a U-tube manometer. The left side is higher than the right side. The height of the water rise on the right side is labeled 'h'. The width of the plates is labeled 'b'. The contact angle between the water and the plates is labeled 'theta'. Below the diagram, it says '(l ~ width of plates)'. The diagram also shows surface tension forces  $\sigma l$  acting upwards at the contact points and a weight force 'W' acting downwards in the center of the U-tube.