1.Calculate the hydraulic radius for a water flowing through the irrigation ditch whose cross section is 5 feet wide, and 7 feet deep.

(a) the ditch is filled to a depth of 4 ft. (5)
(b) the ditch is filled to a depth of 7 ft without cover on the top. (5)
(c) the ditch is filled to a depth of 7 ft with cover on the top (5)

2 Consider steady, incompressible, laminar flow of Newtonian fluid that flows in the x direction between two infinite parallel plates, whose width is very large in the z direction when compared to their narrow gap in the y direction. The viscosity of fluid is μ, and the distance between these two plates is h. Derive the velocity profiles , and plot the velocity profiles with y for following cases,

(a) Poiseuille flow, in which an applied pressure difference (constant pressure gradient) cause fluid motion between stationary surface (10)
(b) Coutte flow, in which the top plate is moving at speed V, and the bottom plate is stationary without an applied pressure difference. (10)
(c) Coutte flow, in which the top plate is moving at speed V, and the bottom plate is stationary with an applied pressure difference (constant pressure gradient) cause fluid motion between stationary surface (15)

The following equations can be used for problem 2

Navier-Stokes equations in Cartesian coordinates

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)+\rho g_x$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right)+\rho g_y$$

$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}\right)=-\frac{\partial p}{\partial z}+\mu\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right)+\rho g_z$$

Continuity equation

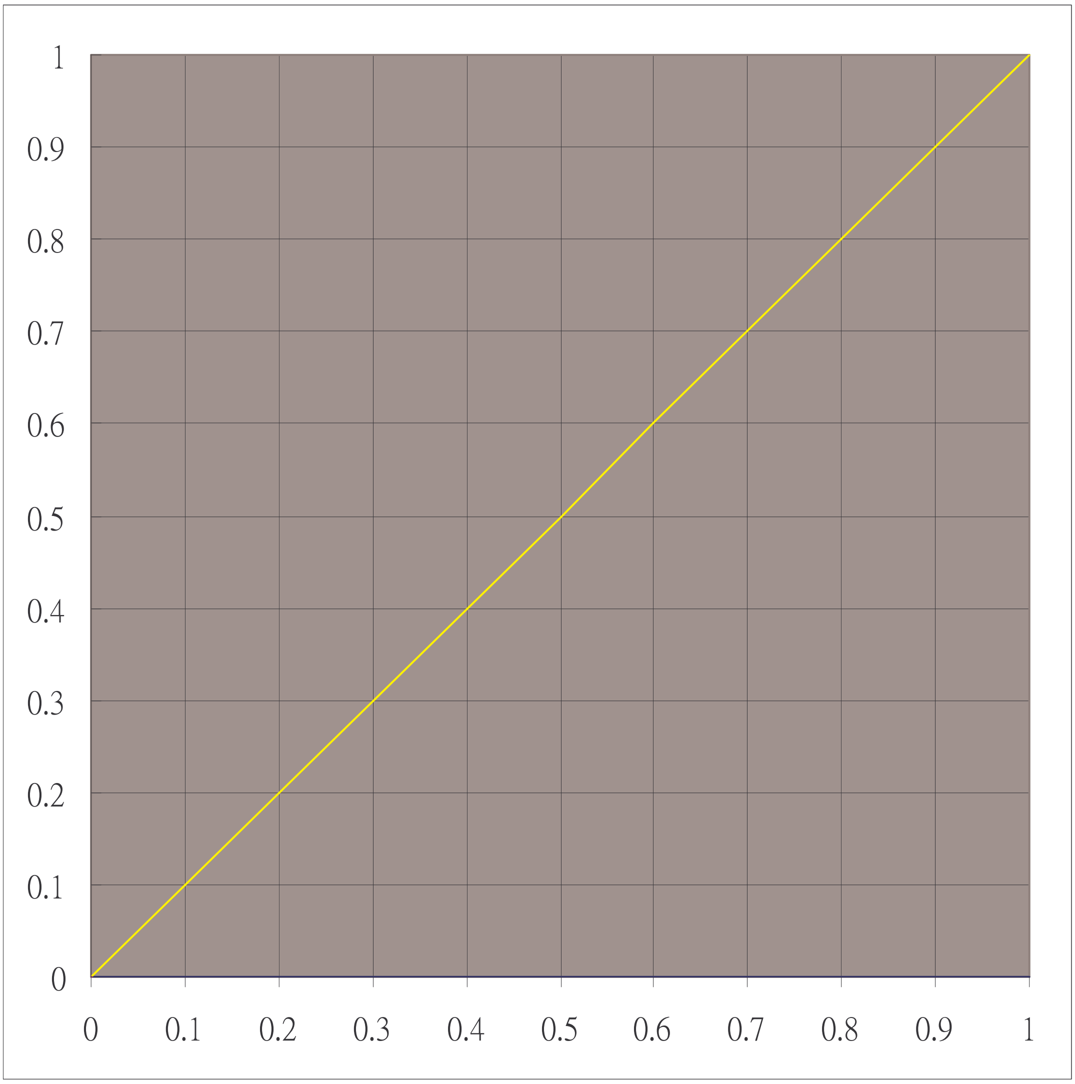
$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$$

3 A feed mixture of A and B, A is the most volatile component. The relative volatility is constant and equal to 3.5 at a pressure 1 atm. A distillation column is used to be separated the feed mixture containing 40% mole of A and 60% mole of B under 1 atm. Assume the feed to be saturated liquid, the overhead product should achieve a purity of 90% mole A ,and the bottom product a purity of 95% mole B.

(a) Construct a x-y diagram by use of attached graphy paper. (10)

(b) Estimate the minimum reflux ratio (5)

© Estimate the minimum number of plates (10)



4. Please draw the boiling curve (pool boiling) which is a plot of boiling heat flux versus the excess temperature (surface temperature - saturated temperature)

(a) identify four different boiling regimes (10)

(b) label the location of Leidenfrost point (5)

© which regime is the most desirable for chemical engineer in practice ? (5)

(d) which heat transfer mode is the reason for heat transfer rate increases with increasing excess temperature beyond Leidenfrost point: (choose one from followings) (5)

(1) conduction

(2) convection

(3) radiation