Practice Problem Set-3 Answers

P1. (a) m=0.530kg/s   (b) exit area=38.7cm^2

P2. (a) $\dfrac{\partial \rho}{\partial t} = -1440 kg/m^3 s$ (b) $\rho(t) = \rho_o \left(\dfrac{1}{1 + Vt/L_o} \right)$

P3. (a) 11/4   (b) 11/4

P4. $\vec{V} = \omega r \dfrac{z}{h} \hat{e}_\theta$

P5. (a) $\psi = -C \ln r + C_1$ (b) Q = -0.0547 m^3/s.m

P6. $u = U - \left(\dfrac{\omega \sin \omega t}{2 - \cos \omega t} \right) x$

P8. (a) $V_y = e^{-x} \sinh y, \psi = e^{-x} \sinh y + y + const$

(b) $V_y = V_o \left(\dfrac{y^2}{ax^2} - \dfrac{2y^3}{3a^2 x^3} \right), \psi = V_o \left(\dfrac{y^2}{ax} - \dfrac{y^3}{3a^2 x^2} \right) + const$

P9. (a) Yes   (b) $p = p_a - \dfrac{1}{2} \rho (2x^2 y^2 + x^4 + y^4)$

P11. $w = \dfrac{\rho g}{2\mu} (h^2 - x^2)$

P12. (a) $u_x^A = \dfrac{\mu_B V}{\mu_A H_B + \mu_B H_A} y$ (b) $u_x^B = V - \dfrac{\mu_A V}{\mu_A H_B + \mu_B H_A} (H_A + H_B - y)$

P13. (a) $C = \dfrac{\rho g \sin \theta}{2\mu}$ (b) $Q = \dfrac{\rho g h^3 \sin \theta}{3\mu}$

P14. Velocity profile and Pressure gradient

$u = -\dfrac{h^2}{\mu} \dfrac{dp}{dx} (y' - \dfrac{1}{2} y'^2) + \dfrac{Ch}{\mu} y', where \ y' = y/h$

$\dfrac{dp}{dx} = \dfrac{3}{2} \dfrac{C}{h}$

P15. Velocity profile for water and oil are:

$$V_{y,w} = \rho_w g(\mathrm{x}h - \mathrm{x}^2/2)/\mu_w + \rho_o ghx/\mu_w$$

$$V_{y,o} = \rho_o g(2\,\mathrm{x}h - \mathrm{x}^2/2)/\mu_o + \rho_o gh^2(\frac{1}{2}\mu_o\rho_w/\mu_w\rho_o + \mu_o/\mu_w - \frac{3}{2})/\mu_o$$

P16. Velocity profile:

$$\left(\rho g/2\mu\right)\left[(R-h)^2 \ln R/r - (\mathrm{R}^2 - r^2)/2\right]$$

P17. Velocity profile:

$$\left(\rho g R^2/4\mu\right)\left[\left(1 - r^2/R^2\right) + 2(R_1/R)^2 \ln(r/R)\right]$$

P18. Velocity profile

$$u_\theta = \frac{R_i^2 \omega_i}{R_o^2 - R_i^2}\left(\frac{R_o^2}{r} - r\right)$$