Fluid Mechanics Assignment #1 omar Ebrahim 1100766[illegible]

1) Given: $m_f = 0.369\ kg$ $W_e = 0.153\ N$ $\forall = 355 \times 10^{-6}\ m^3$

Req: [specific weight γ, density ρ, specific gravity SG]

$$\gamma = \frac{W_f - W_e}{\forall} \quad \text{where } W_f = m_f \times g = 0.369 \times 9.81 = 3.62\ N$$

$$\gamma = \frac{3.62 - 0.153}{355 \times 10^{-6}} = 9770\ N/m^3$$

$$\rho = \frac{\gamma}{g} = \frac{9770}{9.81} = 996\ kg/m^3$$

$$SG = \frac{\rho}{\rho_w} = \frac{996}{1000} = 0.996$$

∴ the specific weight is $9770\ N/m^3$

∴ the density is $996\ kg/m^3$

∴ the specific gravity is 0.996

2) Given: $d = 3\,m$ $L = 15\,m$ $\sigma = 10\,MPa$ $T = 15°C$

$\rho_1 = 1000\,kg/m^3$ $K = 2.10 \times 10^9\,Pa$

Req: the amount of additional water. m

$$K = \frac{\Delta P}{\frac{\Delta \rho}{\rho}} ; \frac{\rho_2 - \rho_1}{\rho_1} = \frac{\Delta P}{K}$$

$$\rho_2 = \rho_1 \left(1 + \frac{\Delta P}{K}\right) = (1000)\left(1 + \frac{10 \times 10^6}{2.10 \times 10^9}\right) = 1004.76\,kg/m^3$$

$$m = \forall \Delta \rho = \frac{\pi D^2}{4} L \Delta \rho = \frac{\pi (3)^2}{4}(15)(1004.8 - 1000) = 505\,kg$$

$\therefore$ the amount of additional water is 505 kg

3) Given: $u(y) \simeq U\sin\frac{2\pi y}{2\delta}$, $0 \le y \le \delta$

$T = 20^0C$ $\Delta P = 1atm$ $R = 2077\, m^2/s^2K$ $\mu = 1.97 \times 10^{-5} kg/ms$

$U = 10.8\, m/s$ $\delta = 3\, mm$

Rtf: (a) Wall shear stress τ_w, b) Position of boundary layer

$$\tau_w = \mu\frac{du}{dy} = \mu\left(U\frac{\pi}{2\delta}\cos\frac{\pi y}{2\delta}\right) = \frac{\pi\mu U}{2\delta}$$

$$\tau_w = \frac{\pi(1.97\times10^{-5})(10.8)}{2(0.003)} = 0.11\, Pa$$

b) $$\tau(y) = \frac{2\pi\mu U}{2\delta}\cos\frac{\pi y}{2\delta} = \tau_w\cos\frac{\pi y}{2\delta} = \frac{\tau_w}{2} \text{ if } \frac{\pi y}{2\delta} = \frac{\pi}{3}$$

$$y = \frac{2\delta}{3}$$

$\therefore$ the wall shear stress is 0.11 Pa

$\therefore$ the position of boundary layer is $y = \frac{2\delta}{3}$

288K

4) Given: $R = 286.9$ J/kg K $T_1 = 15°C$ $P = 210$ KPa

$\forall = 5\ m^3$ $T_2 = 30°C = 303\ K$

Rtf: mass of air to remove m

$$m_1 = \frac{P_1 \forall}{R T_1} = \frac{210 \times 5}{0.2869 \times 288} = 12.7071\ kg$$

$$m_2 = \frac{P_2 \forall}{R T_2} = \frac{210 \times 5}{0.2869 \times 303} = 12.0786\ kg$$

$m = m_1 - m_2 = 12.7071 - 12.0786 = 0.63\ kg$

$\boxed{\therefore \text{the mass of air to remove is } 0.63\ kg}$