EQUATION SHEET – EXAM #2

Miscellaneous

$$v = \frac{1}{\rho} \qquad \gamma = \rho g \qquad SG = \frac{\rho}{\rho_{\mathrm{H_2O}}} \qquad p_{gage} = p_{absolute} - p_{atm} \tag{1}$$

Quality (using v as the relevant property)

$$v = (1-x)v_f + xv_g = v_f + x(v_g - v_f) \tag{2}$$

Ideal Gas Law

$$p = \rho RT \qquad pv = RT \qquad p\overline{v} = \overline{R}T \qquad pV = mRT \qquad pV = n\overline{R}T \tag{3}$$

$$\overline{R} = 8.314\mathrm{kJ/kmol\cdot K} \qquad \overline{R} = 1545\mathrm{ft\cdot lbf/lbmol\cdot^{\circ} R} \tag{4}$$

Fluid Statics

$$-\nabla p - \gamma\hat{\mathbf{k}} = \rho\mathbf{a} \tag{5}$$

With a = 0

$$\nabla p + \gamma\hat{\mathbf{k}} = 0 \tag{6}$$

in component form

$$\frac{\partial p}{\partial x} = 0 \quad \frac{\partial p}{\partial y} = 0 \quad \frac{\partial p}{\partial z} = -\gamma \tag{7}$$

therefore

$$\frac{dp}{dz} = -\gamma \tag{8}$$

Inviscid, Incompressible, Steady Flow

$$p + \frac{1}{2}\rho V^2 + \gamma z = \text{constant} \quad \text{along} \quad \text{streamline} \tag{9}$$

$$p + \rho\int\frac{V^2}{\mathbf{R}}dn + \gamma z = \text{constant} \quad \text{across} \quad \text{streamline} \tag{10}$$

where R is the radius of curvature.

Conservation of Energy - Closed System

$$E = KE + PE + U \qquad \Delta E = Q - W \qquad \frac{dE}{dt} = \dot{Q} - \dot{W} \tag{11}$$

Conservation of Energy - Control Volume

$$\frac{dE_{C.V.}}{dt} = \dot{Q}_{C.V.} - \dot{W}_{C.V.} + \sum_i \dot{m}_i (h_i + \frac{V_i^2}{2} + gz_i) - \sum_e \dot{m}_e (h_e + \frac{V_e^2}{2} + gz_e) \tag{12}$$

Efficiencies and Coefficients of Performance

$$\eta = \frac{W_{cycle}}{Q_{in}} \text{(power cycle)} \qquad \beta = \frac{Q_{in}}{W_{cycle}} \text{(refrigeration cycle)} \qquad \gamma = \frac{Q_{out}}{W_{cycle}} \text{(heat pump cycle)} \tag{13}$$

Reynolds Transport Theorem

$$\frac{DB_{sys}}{Dt} = \frac{\partial}{\partial t} \int_{CV} \rho b d\forall + \int_{CS} \rho b \vec{V} \cdot \hat{n} dA \tag{14}$$

Conservation of Mass (Continuity)

$$0 = \frac{\partial}{\partial t} \int_{CV} \rho d\forall + \int_{CS} \rho \vec{V} \cdot \hat{n} dA \tag{15}$$

Conservation of Momentum

$$\frac{\partial}{\partial t} \int_{CV} \vec{V} \rho d\forall + \int_{CS} \vec{V} \rho \vec{V} \cdot \hat{n} dA = \Sigma \vec{F} \tag{16}$$
