EG3029 Tutorial Solution Hints, AY2013/14

Tutorial 1

Problem 1:

$$PV = RT$$

Problem 2:

energy balance: $\Delta U + \Delta E_{kin} + \Delta E_{pot} = 0$

$$\Delta U = mC_p \Delta T$$

Problem 3:

mass flow rate: $\dot{m} = \rho u A$

cross sectional area: $A = \frac{\pi}{4} D^2$

Problem 4:

electrical power: $P_{el} = UI$

energy (power) balance: $P_{el} = \dot{W}_{mech} + \dot{Q}$

Problem 5:

reversible: $W = -\int_{V_1^t}^{V_2^t} P dV^t$

suddon: $W = -P_2 \Delta V^t$

Tutorial 2

Problem 1:

$$F = mg$$

$$F = PA$$

$$W = F\Delta l$$

Problem 2:

$$PV = RT$$

$$W_{rev,isotherm} = -RTN \int \frac{dV}{V}$$

Problem 3:

$$\Delta U = C_V \Delta T$$

$$\Delta H = C_P \Delta T$$

$$\gamma = \frac{C_P}{C_V}$$

$$PV^{\gamma} = const$$

Tutorial 3

Problem 1:

$$\eta_{Carnot} = 1 - \frac{T_C}{T_H} = \frac{\left|\dot{W}\right|}{\left|\dot{Q}_H\right|}$$

Problem 2:

$$\Delta S = -R \ln\left(\frac{P_2}{P_1}\right)$$

$$\dot{B}_{lost} = T_0 \dot{S}$$

Problem 3:

integrate the EOS given

$$dH = C_P dT + (1 - \beta T) V dP$$

$$H = U + PV$$

$$dS = C_P \frac{dT}{T} - \beta V dP$$

Problem 4:

total differential

Tutorial 4

Problem 1:

steam tables, interpolation

$$x = \frac{S - S^{liq}}{S^{vap} - S^{liq}}$$

Problem 2:

iterative approach with ideal gas value as starting point

Tutorial 5

Problem 1:

$$P = \frac{P_1^{sat} + P_2^{sat}}{2}$$

$$y_i P = x_i P_i^{sat}$$

Problem 3:

$$y_i P = \gamma_i x_i P_i^{sat}$$

determine $\frac{P_1^{sat}}{P_2^{sat}}$

Problem 4:

$$y_i P = x_i P_i^{sat}$$

$$y_i P = x_i \mathrm{H}_i$$

Tutorial 6

Problem 1:

$$V = \sum_i x_i \overline{V}_i$$

$$n = \frac{V^t}{V}$$

Problem 2:

$$PV = RT$$

$$\Delta S = -nR \sum_i x_i \ln x_i$$

Tutorial 7

Problem 1:

Gibbs/Duhem: $x_1 \frac{d\overline{M}_1}{dx_1} + x_2 \frac{d\overline{M}_2}{dx_1} = 0$

Problem 2:

$$V^E = V - \sum_i x_i V_i$$

$$n = \frac{V^t}{V}$$

Tutorial 8

$$\nu = \sum_i \nu_i$$

$$n_0 = \sum_i n_{i,0}$$

$$y_i = \frac{n_i}{n}$$

$$n = n_0 + \nu\varepsilon$$

Tutorial 9

Problem 1:

$$\nu = \sum_i \nu_i$$

$$n_0 = \sum_i n_{i,0}$$

$$y_i = \frac{n_i}{n}$$

$$n = n_0 + \nu\varepsilon$$

$$\prod_i y_i^{\nu_i} = \left(\frac{P}{P^\circ}\right)^{-\nu} K$$

Problem 2:

$$G = \sum_i y_i G_i + RT \sum_i y_i \ln y_i$$

$$n\frac{dG}{d\varepsilon} + G\frac{dn}{d\varepsilon} = 0$$