Problem 1

(a)

$$r_1 = k_1 C_{to}{}^2 F_t{}^{-2} F_A F_H (\frac{P}{P_o})^2 (\frac{T_0}{T})^2$$

$$r_2 = k_1 C_{to}{}^2 F_t{}^{-2} F_A F_H (\frac{P}{P_o})^2 (\frac{T_0}{T})^2$$

$$r_3 = k_3 C_{to}{}^2 F_t{}^{-2} F_C F_M (\frac{P}{P_o})^2 (\frac{T_0}{T})^2$$

$$r_4 = k_4 C_{to} F_t{}^{-1} F_C (\frac{P}{P_o})(\frac{T_0}{T})$$

$$F_t = F_A + F_B + F_C + F_D + F_H + F_M$$

$$\frac{dF_A}{dV} = -r_1 - r_2 + r_3$$

$$\frac{dF_B}{dV} = 3r_1$$

$$\frac{dF_C}{dV} = r_2 - r_3 - r_4$$

$$\frac{dF_D}{dV} = 2r_4$$

$$\frac{dF_M}{dV} = r_2 - r_3$$

$$\frac{dF_H}{dV} = -r_1 - r_2 + r_3$$

(b)

$$\frac{dP}{dV} = -\alpha(\frac{P_0}{P})(\frac{F_t}{F_{t0}})(\frac{T}{T_0})$$

(c)

$$\frac{dT}{dV} = \frac{Ua(T_a - T) - r_1 \Delta H_1 - r_2 \Delta H_2 - r_3 \Delta H_3 - r_4 \Delta H_4}{F_A Cp_A + F_B Cp_B + F_C Cp_C + F_D Cp_D + F_H Cp_H + F_M Cp_M}$$

(d)

5   global $k_1\, k_2\, k_3\, k_4\, P_0\, T_o\, T_a\, Ua\, C_{to}$

5     $F_t = F(1) + F(2) + F(3) + F(4) + F(5) + F(6)$

5

$$r_1 = k_1 * C_{t0}^{\;2} * F_t^{\;-2} * F(1) * F(5) * (\frac{F(7)}{P_o})^2 * (\frac{T_0}{F(8)})^2$$

$$r_2 = k_2 * C_{t0}^{\;2} * F_t^{\;-2} * F(1) * F(5) * (\frac{F(7)}{P_o})^2 * (\frac{T_0}{F(8)})^2$$

$$r_3 = k_3 * C_{t0}^{\;2} * F_t^{\;-2} * F(3) * F(6) * (\frac{F(7)}{P_o})^2 * (\frac{T_0}{F(8)})^2$$

$$r_4 = k_4 * C_{t0} * F_t^{\;-1} * F(3) * (\frac{F(7)}{P_o}) * (\frac{T_0}{F(8)})$$

5

$$dF\_dV(1) = -r_1 - r_2 + r_3$$
$$dF\_dV(2) = 3r_1$$
$$dF\_dV(3) = r_2 - r_3 - r_4$$
$$dF\_dV(4) = 2r_4$$
$$dF\_dV(5) = -r_1 - r_2 + r_3$$
$$dF\_dV(5) = r_2 - r_3$$

5

$$dF\_dV(7) = -\alpha * (\frac{P_0}{F(7)}) * (\frac{F_t}{F_{t0}}) * (\frac{F(8)}{T_0})$$

$$dF\_dV(8) = \frac{Ua * (T_a - F(8)) - r_1 * \Delta H_1 - r_2 * \Delta H_2 - r_3 * \Delta H_3 - r_4 * \Delta H_4}{F(1)*Cp_A + F(2)*Cp_B + F(3)*Cp_C + F(4)*Cp_D + F(5)*Cp_H + F(6)*Cp_M}$$

Problem 2

(a). Given this information, What species MUST be feed into the reactor to CREATE E? (6 pts)
We must feed either G+D or A+B+D

(b). Assuming E is easy to separate from the product stream, list all the species you would CHOOSE to
feed into the reactor to MAXIMIZE E? Explain your answer in a sentence or two. (10 pts)

We would add A,B,D and G.   D is necessary to create E.   The addition of G pushes the reaction equilibrium, allowing more C to form E rather than G.

(c) Again, assuming E is easy to separate, which species would you consider adding in EXCESS if you
wanted the PFR to MAXIMIZE the amount of E produced? Explain your reasoning? (10 pts)

We would add excess D and G.   Excess D ensures that available C will have reactant available.   Excess G, as stated in B shifts the reaction equilibrium.

Problem 3

(a) Which figure had $k1 = k2 = k3 = k4 = 0.1$ s–1 ? (6 pts)
Figure 1

(b) Which figure had $k1 = k2 = k3 = 0.1$ s–1 , and $k4 = 0.01$ s–1 ? (6 pts)
Figure 4

(c) Which figure had $k1 = k2 = k4 = 0.1$ s–1 , and $k3 = 1$ s–1 ? (6 pts)
Figure 3

(d) Which figure had $k1 = k3 = k4 = 0.1$ s–1 , and $k2 = 1$ s–1 ? (6 pts)
Figure 2