

1) $\frac{dx}{dt} = -(x-1)(x-4)(x-7)(x-8) \quad x = 1, 4, 7, 8$

x	$\frac{dx}{dt}$	Direction	Stability
0.5	-0000	→	UNSTABLE
1.1	-0000	↑	
3.5	-0000	↑	STABLE
4.1	-0000	→	
6.5	-0000	↓	UNSTABLE
7.1	-0000	↑	
7.5	-0000	↑	STABLE
8.1	-0000	↓	

$x = 4 \text{ \& } 8$
ARE STABLE

2)

$$1 - \frac{3x}{1+x+2} = 0$$

$$3x = 1+x+2$$

$$1 - \frac{3y}{1+x+2} = 0$$

$$3y = 1+x+2$$

$$1 - \frac{3z}{1+x+y} = 0$$

$$3z = 1+x+y$$

$$x=1, y=1, z=1$$

$$J = \begin{bmatrix} -\frac{2}{1+y+2} & \frac{3x}{(1+y+2)^2} & \frac{3x}{(1+y+2)^2} \\ \frac{3y}{(1+x+2)^2} & -\frac{3}{1+x+2} & \frac{3y}{(1+x+2)^2} \\ \frac{3z}{(1+x+y)^2} & \frac{3z}{(1+x+y)^2} & -3 \end{bmatrix}$$

$$J_{(1,1)} = \begin{bmatrix} -1 & \frac{1}{3} & \frac{1}{3} \\ \frac{1}{3} & -1 & \frac{1}{3} \\ \frac{1}{3} & \frac{1}{3} & -1 \end{bmatrix}$$

$$\lambda_1 = -4/3 \quad \lambda_2 = -4/3 \quad \lambda_3 = -1/3 < 1$$

STABLE EQUILIBRIUM
POINT $E_3(1,1,1)$

HW 17

3

$$1 - \frac{x}{1+y+2} = 0$$

$$x = 1+y+2$$

$$1 - \frac{y}{1+x+2} = 0$$

$$y = 1+x+2$$

$$1 - \frac{z}{1+x+y} = 0$$

$$z = 1+x+y$$

$$x=1, y=1, z=1$$

$$J = \begin{bmatrix} \frac{-1}{1+y+2} & \frac{-x}{(1+y+2)^2} & \frac{-x}{(1+y+2)^2} \\ \frac{-y}{(1+x+2)^2} & \frac{-1}{1+x+2} & \frac{-y}{(1+x+2)^2} \\ \frac{-2}{(1+x+y)^2} & \frac{-2}{(1+x+y)^2} & \frac{-1}{1+x+y} \end{bmatrix}$$

$$J_{(1,1,1)} = \begin{bmatrix} -1/3 & -1/9 & -1/9 \\ -1/9 & -1/3 & -1/9 \\ -2/9 & -2/9 & -1/3 \end{bmatrix}$$

$$\lambda_1 = 3, \lambda_2 = 0, \lambda_3 = 0$$

No STABLE EQUILIBRIUM POINTS

4

$$\text{Eq. P}(\text{CHEM STAT}(N, C, 2, 5)[N, C]) = \begin{pmatrix} 0, 5 \\ 8, 1 \end{pmatrix}$$

$$\text{SEQUP}(\text{CHEM STAT}(N, C, 2, 5)[N, C]) = (8, 1)$$