## Mathematics 172 Homework

The solution for these problems are after the last problem.

1. For the system of differential equations

$$
\begin{aligned}
& \frac{d x}{d t}=.4 x\left(\frac{100-x-.4 y}{100}\right) \\
& \frac{d y}{d t}=.6 x\left(\frac{200-x-.8 y}{200}\right)
\end{aligned}
$$

draw the phase plane (which for us is just a fancy term for the first quadrant of the $x-y$ plane) showing
(a) The lines where $\frac{d x}{d t}=0$,
(b) The lines where $\frac{d y}{d t}=0$,
(c) The coordinates of all the equilibrium points in the first quadrant.
2. For the system of differential equations

$$
\begin{gathered}
\frac{d x}{d t}=.23 x\left(\frac{100-x-1.5 y}{100}\right) \\
\frac{d y}{d t}=.07 x\left(\frac{150-x-4 y}{150}\right)
\end{gathered}
$$

draw the phase plane showing
(a) The lines where $\frac{d x}{d t}=0$,
(b) The lines where $\frac{d y}{d t}=0$,
(c) The coordinates of all the equilibrium points in the first quadrant.
3. For the system of differential equations

$$
\begin{gathered}
\frac{d x}{d t}=.15 x\left(\frac{300-x-.7 y}{300}\right) \\
\frac{d y}{d t}=.2 x\left(\frac{250-x-4 y}{250}\right)
\end{gathered}
$$

draw the phase plane showing
(a) The lines where $\frac{d x}{d t}=0$,
(b) The lines where $\frac{d y}{d t}=0$,
(c) The coordinates of all the equilibrium points in the first quadrant.
4. For the system of differential equations

$$
\begin{gathered}
\frac{d x}{d t}=.14 x\left(\frac{100-x-3 y}{100}\right) \\
\frac{d y}{d t}=.3 x\left(\frac{80-x-.4 y}{80}\right)
\end{gathered}
$$

draw the phase plane showing
(a) The lines where $\frac{d x}{d t}=0$,
(b) The lines where $\frac{d y}{d t}=0$,
(c) The coordinates of all the equilibrium points in the first quadrant.

Solution to 1:

(a) The $d x / d t=0$ lines are in red. (b) The $d y / d x=0$ lines are in blue. The equilibrium points are $(0,0),(100,0),(0,200)$, and $(29.41,176.5)$.

Solution to 2:

(a) The $d x / d t=0$ lines are in red. (b) The $d y / d x=0$ lines are in blue. The equilibrium points are $(0,0),(100,0),(0,150)$, and $(25.00,50.00)$.

Solution to 3:

(a) The $d x / d t=0$ lines are in red. (b) The $d y / d x=0$ lines are in blue. The equilibrium points are $(0,0),(300,0)$, and $(0,250)$.

Solution to 4:

(a) The $d x / d t=0$ lines are in red. (b) The $d y / d x=0$ lines are in blue. The equilibrium points are $(0,0),(100,0)$, and $(0,80)$.

