Math 0290 - RUBIN **PHASE PLANES** - Feb. 20, 2009

For each of the following systems, produce a phase portrait that includes critical points, clearly labeled nullclines, the directions of flow in each region, and a representative collection of trajectories (solution curves).

1.

$$\begin{aligned} x' &= x^3 - x \\ y' &= -4y \end{aligned}$$

2.

$$\begin{aligned} x' &= y(ax - b) \\ y' &= x(cy - d),\ a, b, c, d > 0 \end{aligned}$$

3.

$$\begin{aligned} x' &= x(2 - x - y) \\ y' &= x - y \end{aligned}$$

4. Competition model:

$$\begin{aligned} x' &= x(1 - y) \\ y' &= y(p - x),\ p > 0 \end{aligned}$$