d) $x' = x - y$
$y' = x + y$

$$A = \begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$$

$$\det(A - \lambda I_2) = \begin{vmatrix} 1-\lambda & -1 \\ 1 & 1-\lambda \end{vmatrix} = (1-\lambda)^2 + 2 = 1 - 2\lambda + \lambda^2 + 2 = \lambda^2 - 2\lambda + 3 = 0 \Rightarrow 1 - \lambda = \pm i$$
$$\lambda = \mp i - 1$$

2. $\begin{cases} x' = x(1-x) = x - x^2 = f_1 \\ y' = y(3-y) = 3y - y^2 = f_2 \end{cases}$

$\begin{cases} x - x^2 = 0 \Rightarrow x_1 = 0 \text{ or } x_2 = 1 \\ 3y - y^2 = 0 \Rightarrow y_1 = 0 \text{ or } y_2 = 3 \end{cases}$

$\Rightarrow$ eq. points $(0,0)$ $(1,0)$ $(0,3)$ $(1,3)$

$$J = \begin{pmatrix} \frac{\partial f_1}{\partial x} & \frac{\partial f_1}{\partial y} \\ \frac{\partial f_2}{\partial x} & \frac{\partial f_2}{\partial y} \end{pmatrix} = \begin{pmatrix} 1-2x & 0 \\ 0 & 3-2y \end{pmatrix}$$

$$\boxed{X' = J_f(x^*, y^*) X}$$

For $(0,0) \Rightarrow J_f = \begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix} \Rightarrow \begin{vmatrix} \lambda_1 = 1 \\ \lambda_2 = 3 \end{vmatrix} \Rightarrow \operatorname{sgn}(\lambda_1) = \operatorname{sgn}(\lambda_2) > 0 \Rightarrow$ global atractor

$(1,0) \Rightarrow J_f = \begin{pmatrix} -1 & 0 \\ 0 & 3 \end{pmatrix} \Rightarrow \begin{vmatrix} \lambda_1 = -1 \\ \lambda_2 = 3 \end{vmatrix} \Rightarrow \operatorname{sgn}(\lambda_1) \neq \operatorname{sgn}(\lambda_2) \Rightarrow$ saddle point (unstable)

$(0,3) = J_f = \begin{pmatrix} 1 & 0 \\ 0 & -3 \end{pmatrix} \Rightarrow \begin{matrix} \lambda_1 = 1 \\ \lambda_2 = -3 \end{matrix} \Rightarrow$ saddle

$(1,3) = J_f = \begin{pmatrix} -1 & 0 \\ 0 & -3 \end{pmatrix} \Rightarrow \begin{vmatrix} \lambda_1 = -1 \\ \lambda_2 = -3 \end{vmatrix}$ $\operatorname{sgn}(\lambda_1) = \operatorname{sgn}(\lambda_2) \Rightarrow$ attractor