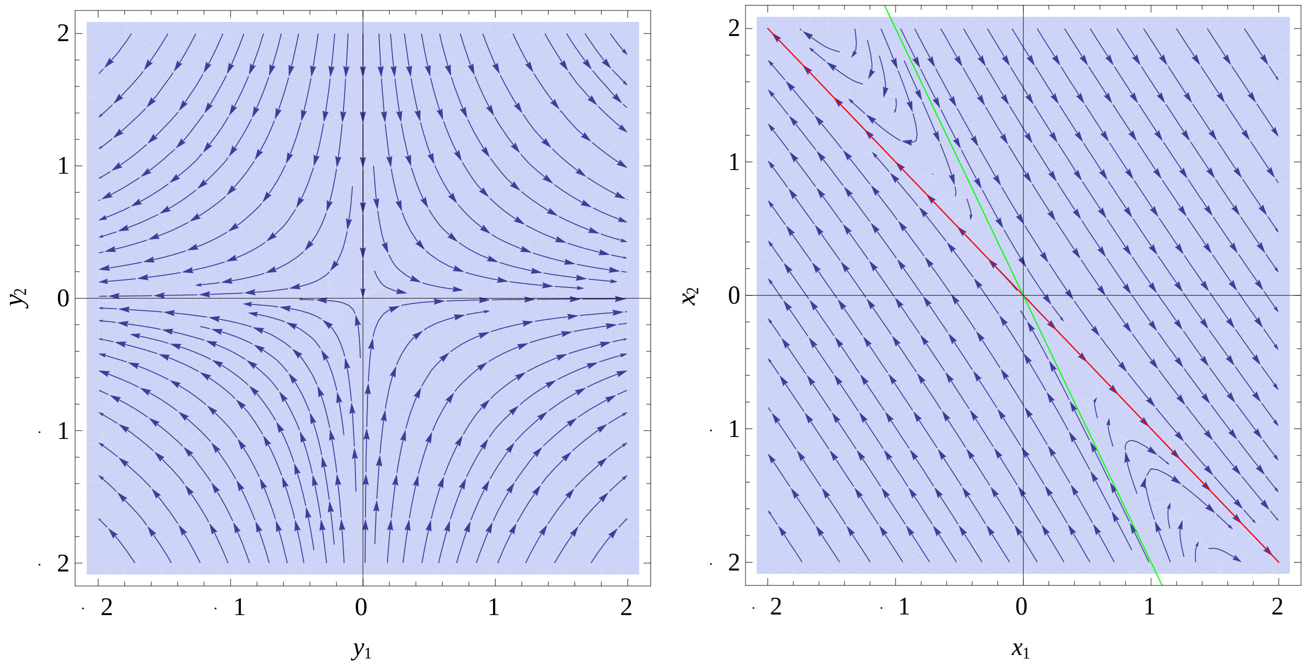
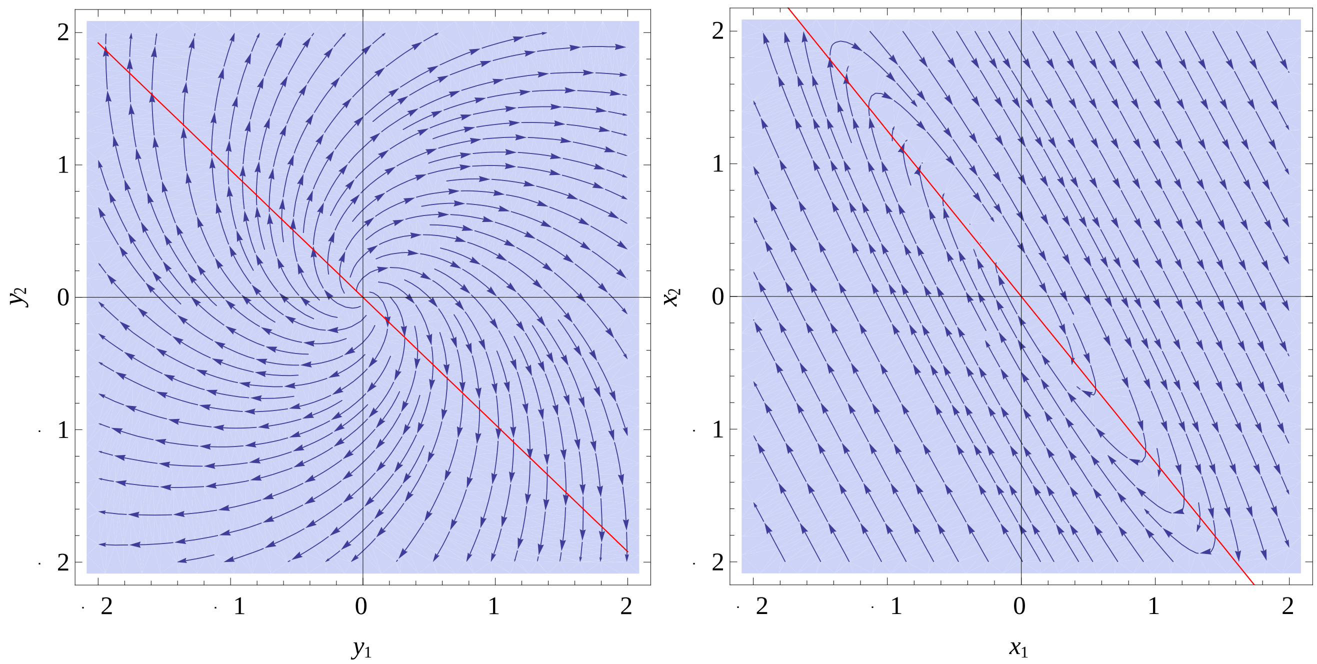
Figure1: Phase diagrams for question 2(a)



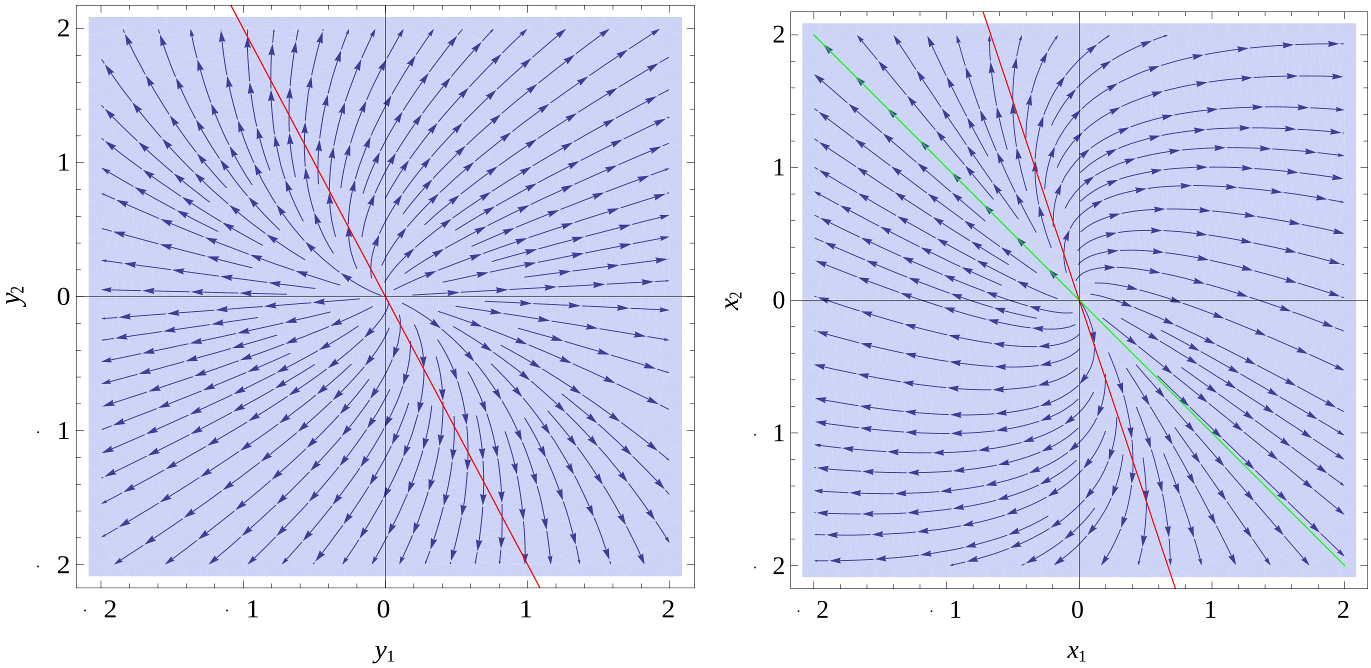

The first picture is the phase diagram in the canonical coordinates. This is a standard saddle diagram. The second diagram is a deformation of the first where the role played by the coordinate axes in the first picture, is now played by the eigenvector directions, indicated by the red and blue lines.

Figure 2: phase diagrams for question 2(b)




The first picture is the phase diagram in the canonical coordinates, corresponding to an unstable focus. The main features of the diagram are that the trajectories spiral out in a clockwise direction and the line at which trajectories become vertical (that is the red line in the picture). Whether trajectories spiral out in clockwise or anticlockwise direction can be determined (before drawing the diagram) by studying the sign of $\dot{y}_1$. For example, from the equations it follows that $\dot{y}_1 = \sqrt{39}y_2$ at $y_1 = 0$. This means that $\dot{y}_1 > 0$ for $y_2 > 0$ thus the trajectories crossing the $y_2$ positive axis move in the direction of increasing $y_1$. This implies a clockwise movement. The trajectories are vertical whenever $\dot{y}_1 = 6y_1 + \sqrt{39}\,y_2$=0, that is along the red line above. A very similar analysis can be carried out to deduce the features of other diagram. The red line again indicates the place where trajectories become vertical. It is given by $x_2 = -5\,x_1/4$ or $\dot{x}_1 = 0$.

Figure 3: phase diagrams for question 2(c)




In both diagrams trajectories flow away from the origin, since the eigenvalue is positive. The red lines in both diagrams are the places where trajectories become vertical. They correspond to $\dot{y}_1 = 2y_1 + y_2 = 0$ in the first diagram and to $\dot{x}_1 = 3x_1 + x_2$=0 in the second diagram. In addition, the green line in the second diagram is the direction of the eigenvector. The trajectories tend to align with the eigenvector at the origin.