- Van der Pol equation:

$$y'' = y'(1 - y^2) - y$$

Let $q_1 = y'$ and $q_2 = y$, then we have

$$\begin{cases} q_1' = q_1(1 - q_2^2) - q_2 \\ q_2' = q_1 \end{cases}$$

- Blasius equation:

$$y''' = -yy''$$

Let $q_1 = y''$ and $q_2 = y', q_3 = y$, then we have

$$\begin{cases} q_1' = -q_3 q_1 \\ q_2' = q_1 \\ q_3' = q_2 \end{cases}$$

- Newton's Second Law of Motion for two-body problem:

$$\begin{cases} y_1'' = -GMy_1(y_1^2 + y_2^2)^{3/2} \\ y_2'' = -GMy2(y_1^2 + y_2^2)^{3/2} \end{cases}$$

Let $q_1 = y_1'$ and $q_2 = y_1, q_3 = y_2', q_4 = y_2$, then we have

$$\begin{cases} q_1' = -GMq_2/(q_2^2 + q_4^2)^{3/2} \\ q_2' = q_1 \\ q_3' = -GMq_4/(q_2^2 + q_4^2)^{3/2} \\ q_4' = q_2 \end{cases}$$