

Q4:

(1) Van der Pol equation:

$$\text{Let } y_1 = y, \quad y_2 = y'$$

$$\frac{d}{dt} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} y_2 \\ y_2 (1 - y_1^2) - y_1 \end{bmatrix}$$

(2) Blasius equation:

$$\text{Let } y_1 = y, \quad y_2 = y', \quad y_3 = y''$$

$$\frac{d}{dt} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} y_2 \\ y_3 \\ -y_1 y_3 \end{bmatrix}$$

(3) Newton's Second Law of Motion for two-body problem.

$$\text{Let } y_1 = y_1, \quad y_2 = y_2, \quad y_3 = y_1', \quad y_4 = y_2'$$

$$\frac{d}{dt} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} y_3 \\ y_4 \\ -GM y_1 / (C y_1^2 + y_2^2)^{3/2} \\ -GM y_2 / (C y_1^2 + y_2^2)^{3/2} \end{bmatrix}$$