

## **Newton's method for solving the system of equations:**

There are several different methods of solving the resulting nonlinear system of equations. The most popular is known as the Newton–Raphson method. This method begins with initial guesses of all unknown variables (voltage magnitude and angles at Load Buses and voltage angles at Generator Buses). Next, a Taylor Series is written, with the higher order terms ignored, for each of the power balance equations included in the system of equations. The result is a linear system of equations that can be expressed as:

$$\begin{bmatrix} X_{n+1} \\ Y_{n+1} \end{bmatrix} = \begin{bmatrix} X_n \\ Y_n \end{bmatrix} - \begin{bmatrix} \frac{\partial f_1}{\partial x} & \frac{\partial f_1}{\partial y} \\ \frac{\partial f_2}{\partial x} & \frac{\partial f_2}{\partial y} \end{bmatrix}^{-1} * f \left( \begin{bmatrix} X_n \\ Y_n \end{bmatrix} \right)$$

So the Jacobian is inverted and evaluated at the point  $(x_n, y_n)$  and then multiplied by  $f$ . Note that the matrix is being multiplied on the left. And then you can generalize this to any dimension in exactly the same manner.