# DELHI TECHNOLOGICAL UNIVERSITY

# SCIENTIFIC COMPUTING (MC-204)

## PRACTICAL FILE

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# EXPERIMENT 6

## AIM

Write the MATLAB program to solve the system of non-linear equation with the help of Newton-Raphson Method.

## THEORY

Given an initial value for vector $\mathbf{x}$, i.e., $\mathbf{x}^{(0)}$, we have, in general, that $\mathbf{f}\left(\mathbf{x}^{(0)}\right) \neq \mathbf{0}$. Thus, we need to find $\Delta\mathbf{x}^{(0)}$ so that $\mathbf{f}\left(\mathbf{x}^{(0)} + \Delta\mathbf{x}^{(0)}\right) = \mathbf{0}$. Using the first-order Taylor series, $\mathbf{f}\left(\mathbf{x}^{(0)} + \Delta\mathbf{x}^{(0)}\right)$ can be approximately expressed as:

$$\mathbf{f}\left(\mathbf{x}^{(0)} + \Delta\mathbf{x}^{(0)}\right) \approx \mathbf{f}\left(\mathbf{x}^{(0)}\right) + \mathbf{J}^{(0)}\Delta\mathbf{x}^{(0)}, \tag{A.8}$$

where $\mathbf{J}$ is the $n \times n$ Jacobian:

$$\mathbf{J} = \begin{bmatrix} \dfrac{\partial f_1(\mathbf{x})}{\partial x_1} & \dfrac{\partial f_1(\mathbf{x})}{\partial x_2} & \cdots & \dfrac{\partial f_1(\mathbf{x})}{\partial x_n} \\ \dfrac{\partial f_2(\mathbf{x})}{\partial x_1} & \dfrac{\partial f_2(\mathbf{x})}{\partial x_2} & \cdots & \dfrac{\partial f_2(\mathbf{x})}{\partial x_n} \\ \vdots & \vdots & \ddots & \vdots \\ \dfrac{\partial f_n(\mathbf{x})}{\partial x_1} & \dfrac{\partial f_n(\mathbf{x})}{\partial x_2} & \cdots & \dfrac{\partial f_n(\mathbf{x})}{\partial x_n} \end{bmatrix}. \tag{A.9}$$

Since we seek $\mathbf{f}\left(\mathbf{x}^{(0)} + \Delta\mathbf{x}^{(0)}\right) = \mathbf{0}$, from Eq. (A.8) we can compute $\Delta\mathbf{x}^{(0)}$ as:

$$\Delta\mathbf{x}^{(0)} \approx -\left[\mathbf{J}^{(0)}\right]^{-1}\mathbf{f}\left(\mathbf{x}^{(0)}\right). \tag{A.10}$$

Then, we can update vector $\mathbf{x}$ as:

$$\mathbf{x}^{(1)} = \mathbf{x}^{(0)} + \Delta\mathbf{x}^{(0)}. \tag{A.11}$$

In general, we can update vector $\mathbf{x}$ as:

$$\mathbf{x}^{(\nu+1)} = \mathbf{x}^{(\nu)} - \left[\mathbf{J}^{(\nu)}\right]^{-1}\mathbf{f}\left(\mathbf{x}^{(\nu)}\right), \tag{A.12}$$

where $\nu$ is the iteration counter.

# SOURCE CODE

```
clear all;
close all;

%newton raphson method
%the function
syms x y;
f(x,y)= x^2 + y^2 + x*y-7;
g(x,y)=x^3 + y^3 -9;
F(x,y)=[f(x,y);g(x,y)];

disp("The systen of non-linear equations: ")
disp(F)

J(x,y) = jacobian(F(x,y),[x,y]);
J(x,y)=J^-1;

%starting point
X0=[0.5;1.5];
X1=[0;0];

%applying the recurrence relation
for i=1:6
    M = J(X0(1),X0(2))*F(X0(1),X0(2));
    X1=X0-M;
    X0=X1;
end
disp("The values of x and y respectively are: ")
disp(double(X1))
```

# OUTPUT

```
>> newton_raphson_system
The systen of non-linear equations:
x^2 + x*y + y^2 - 7
      x^3 + y^3 - 9
symbolic function inputs: x, y


The values of x and y respectively are:
     1
     2
```