

### Patch Test for 4 element required some Analytical values of  
displacements and relaxed strain at the boundary and inner nodes.  
So, here we use this equation to get the analytical values.

```
import numpy as np
```

```
New_boundary = []  
New_strain_boundary = []  
New_inner = []  
New_universe = []
```

### Analytical Equations for displacements  $u_1$  and  $u_2$  of nodes :

```
def Displacement(x,y):  
    u1 = -0.005*x*x + 0.01*y*y  
    u2 = -0.01*x*x+0.005*y*y  
    return [u1,u2]
```

### Analytical Equations for relaxed strain  $\psi_{11}, \psi_{21}, \psi_{12}$  and  $\psi_{22}$  of nodes :

```
def Relaxed_Strain(x,y):  
    psi_1 = -0.01*x  
    psi_2 = 0.02*y  
    psi_3 = -0.02*x  
    psi_4 = 0.01*y  
    return [psi_1,psi_2,psi_3,psi_4]
```

### X and Y coordinates of the all boundary nodes of the Element :

```
x_boundary = np.array([0,0.25,0.5,0.75,1,1,1,1,1,0.75,0.5,0.25,0,0,0,0])  
y_boundary = np.array([0,0,0,0,0,0.25,0.5,0.75,1,1,1,1,1,0.75,0.5,0.25])
```

### X and Y coordinates of all boundary corner nodes of the Element :

```
x_strain_boundary = np.array([0,0.5,1,1,1,0.5,0,0])  
y_strain_boundary = np.array([0,0,0,0.5,1,1,1,0.5])
```

### X and Y coordinates of the all inner nodes of the Element :

```
x_inner = np.array([0.25,0.5,0.75,0.25,0.5,0.75,0.25,0.5,0.75])  
y_inner = np.array([0.25,0.25,0.25,0.5,0.5,0.5,0.75,0.75,0.75])
```

### X and Y coordinates of the nodes which is occurred in all elements :

```
x_universe = 0.5  
y_universe = 0.5
```

### Find the new coordinates of the deformed nodes at boundary:

```
New_boundary = Displacement(x_boundary,y_boundary)
```

### Find the relaxed strain values at corner nodes at boundary :

```
New_strain_boundary = Relaxed_Strain(x_strain_boundary,y_strain_boundary)
```

### Find the new coordinates of the deformed nodes at inner side:

```
New_inner = Displacement(x_inner,y_inner)
```

### Find the relaxed strain values at corner nodes at inner side :

```
New_universe = Relaxed_Strain(x_universe,y_universe)
```

### Print the Old values of the nodes coordinates at boundary:

```
print("The old values of boundary nodes coordinates x_old :")  
print(x_boundary)  
print()  
print("The old values of boundary nodes coordinates y_old :")  
print(y_boundary)  
print()  
print()
```

### Print the New values of the displaced nodes coordinates at boundary:

```
print("The New values of displaced nodes coordinates x_new and y_new :")  
print(New_boundary)  
print()
```

```
print()

### Print the relaxed strain values of the nodes at the boundary :
print("The values of displaced nodes relaxed strain psi11,psi21,psi12,psi22 :")
print(New_strain_boundary)
print()
print()

### Print the Old_values of the nodes coordintes at innerside :
print("The old values of innerside nodes coordintes x_old :")
print(x_inner)
print()
print("The old values of innerside nodes coordintes y_old :")
print(y_inner)
print()
print()

### Print the New_values of the displaced nodes coordintes at inner side:
print("The New values of displaced nodes coordintes x_new and y_new :")
print(New_inner)
print()
print()

### Print the relaxed strain values of the nodes at the middle :
print("The values of displaced nodes relaxed strain psi11,psi21,psi12,psi22 :")
print(New_universe)
```