Exercises 5.2

5. For the quadrilateral element shown below, given the vector of nodal displacements U, find the strain components at point(ξ,η) = (−1√3,1√3). U = [0.0 0.0 0.01 0.01 0.015 0.015 0.0 0.015]

```
clear all
clc
```

```
syms xi eta epsilon
x = -1/sqrt(3);
y = 1/sqrt(3);
C = [0 0; 4 2; 4 4; 0 2];
U = [0.0  0.0  0.01  0.01  0.015  0.015  0.0  0.015];
b = compute_B(C, xi, eta);
```

```
B = subs(b, [xi eta], [x y]);
d =  B * U';
D = vpa(d, 5)
```

D =

$$\begin{pmatrix} 0.0032217 \\ 0.0064434 \\ -0.0021651 \end{pmatrix}$$

```
function B = compute_B(C, xi, eta)
nnodes = size(C, 1);
ndof = 2;
dN   = quad4_derivs(xi, eta);
J    = C'*dN;
dNdX = dN/J;
    for i = 1: nnodes
    c = (i-1) * ndof;
    B(1, c+1) = dNdX(i,1);
    B(2, c+2) = dNdX(i,2);
    B(3, c+1) = dNdX(i,2);
    B(3, c+2) = dNdX(i,1);
    end
end

function dN = quad4_derivs (xi, eta)
n = [1.0/4.0 * (1 - xi) * (1 - eta)
     1.0/4.0 * (1 + xi) * (1 - eta)
     1.0/4.0 * (1 + xi) * (1 + eta)
     1.0/4.0 * (1 - xi) * (1 + eta)];
dN = [diff(n, xi) diff(n, eta)];
end
```