**Programming assignment #9**

Write a MATLAB function that implements shape functions and their gradients for the 4-node (bilinear) and 8-node (quadratic) two-dimensional quadrilateral elements in terms of *parent coordinates*.
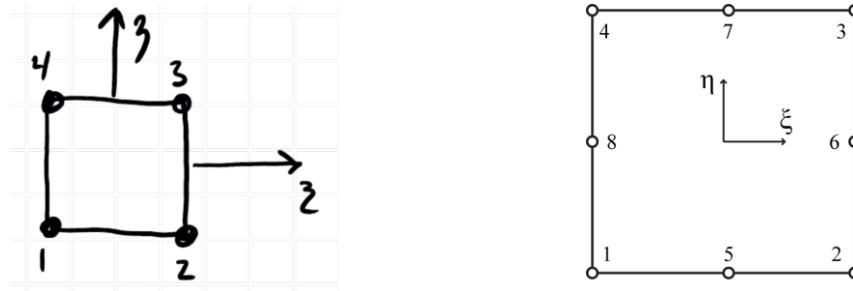


**Figure 1** – Node ordering of the QUAD4 and QUAD8 elements.

**Instructions for programming and assignment submission:**

- The order of the input variables and output variables must not be changed.
- **The input variables are:**
  - **p**: [2×1] matrix containing the parent coordinates ($p = [\xi; \eta]$).
  - **xe:** [2×nne] matrix containing the element nodal coordinates.
- **The output variable is:**
  - **N:** [nne×1] matrix of the shape functions evaluated at the given parent coordinates.
  - **dNdp:** [nne×2] matrix of the shape functions with respect to the parent coordinates.
  - **dNdx:** [nne×2] matrix of the shape functions with respect to the global coordinates.

**Template code for programming assignment**

```
function [N, dNdp, dNdx] = asurite_hw9(xe, p)
    nne = length(xe);
    if nne == 4
        [N, dNdp] = shape_quad4(p);
    else if nne == 8
        [N, dNdp] = shape_quad8(p);
    end
    dNdx = zeros(nne, 2);
end

function [N, dNdp] = shape_quad4(p)
% SHAPE_QUAD4 returns the shape functions and their gradients for a 4-node element.
  N = zeros(4,1);     % replace with correct expression.
  dNdp = zeros(4,2);  % replace with correct expression.
end

function [N, dNdp] = shape_quad8(p)
% SHAPE_QUAD8 returns the shape functions and their gradients for a 8-node element.
  N = zeros(8,1);     % replace with correct expression.
  dNdp = zeros(8,2);  % replace with correct expression.
end
```