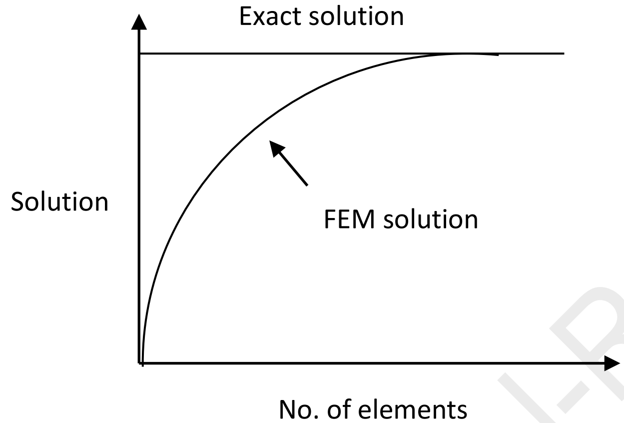
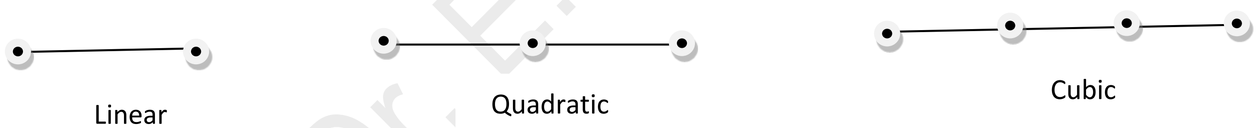
Note:

The domain Ω of the problem is divided into a set of line elements called the finite element mesh. The mesh is a nonuniform mesh because the elements are not of equal length. The intersection points are called the global nodes. The number of elements used in a problem depends mainly on the elements type and accuracy desired.

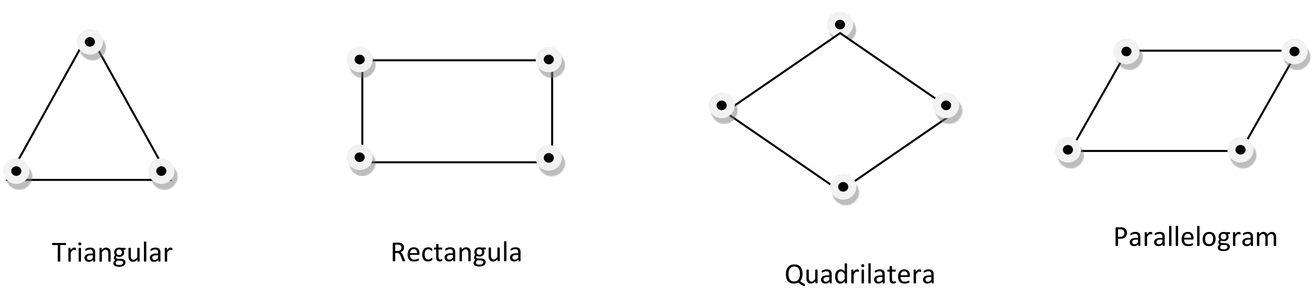


The type of elements:

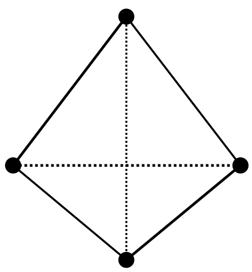
1- One-dimensional element



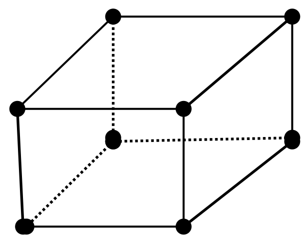
2- Two- dimensional element



3- Three-dimensional element



Tetrahedron



Hexahedron

Natural (Normal) coordinates:

We use the transformation from the global coordinate system x to a local coordinate system ξ which has the origin at the central of the element and ξ=-1 at the left end node and ξ=1 at the right end node.

The transformation is

$$\xi = \frac{2x-(x_e-x_{e+1})}{h_e}$$

Where x_e *and* x_{e+1} are global coordinates of the left and right end nodes, respectively, of element e and h_e is the element length. The coordinate ξ is called normal or natural coordinate to imply that it is a normalized (nondimensional) coordinate whose values are between -1 and 1

$$x_e \le x \le x_{e+1} \longrightarrow -1 \le \xi \le 1$$

Isoparametric elements:

Isoparametric elements are those which can be used for the description of both the geometry of the element and the variation of dependent variable. The global coordinates x, y inside the element domain can be described as:

$$x = \sum_{i=1}^{n} x_i \, N_i \qquad \text{and} \qquad y = \sum_{i=1}^{n} y_i \, N_i$$

Where $N_i = N_i(\xi, \eta)$ are the element interpolation function in natural coordinate (ξ, η).

Shape function (Interpolation function):

Interpolation function depend on the no. of nodes in the element and the shape of the element.it is called an isoparametric function because these function can be used for description of both the geometry of the element and the special variation of the dependent variables

$$x = \sum_{i=1}^{n} x_i \, N_i \quad , \quad y = \sum_{i=1}^{n} y_i \, N_i$$

And $u = \sum_{i=1}^{n} u_i \, N_i$, where $N_i = N_i(\xi, \eta)$

1- $N_i^e(x_j) = \begin{Bmatrix} 0 & if & i \neq j \\ 1 & if & i = j \end{Bmatrix}$

2- $\sum_{i=1}^{n} N_i^e(x_j) = 1$

Isoparametric mapping trans. from undistorted element to distorted element, i.e. trans. from global coordinate to curvilinear coordinate