Chapter Six

Finite Elements Method

The finite element method is a piecewise application of a variational method, it depends on numerical method in solution and variational method in formulation.

The variational methods of application are:

1- Ritz method
2- Galerkin method
3- Least square method
4- Collocation method
5- Characteristic F.E.M.
6- Mixed F.E.M.
7- Kind of partial upwind F.E.M.

In (variational method) we assume a solution equation then find its constants.

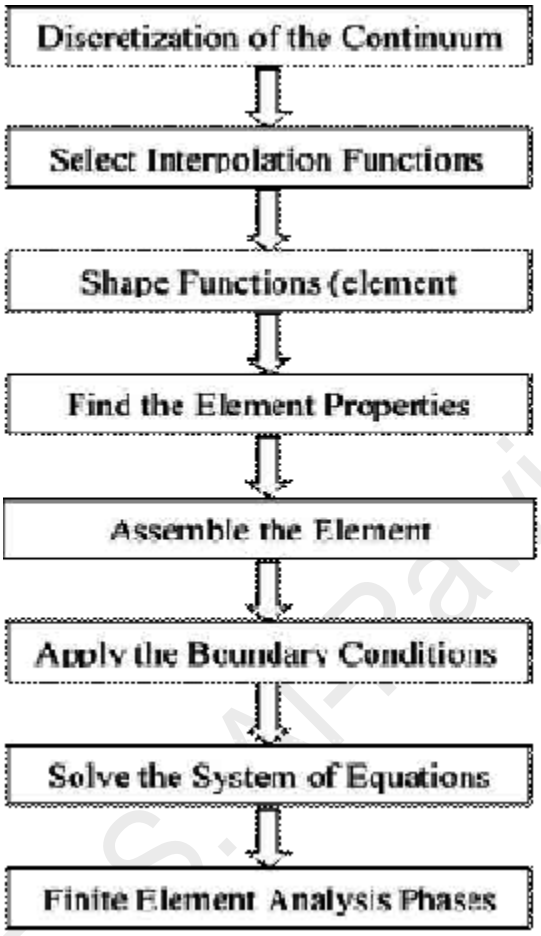
Steps involved in the F.E. analysis of a typical problem:

1- Discretization of the given domain into a collocation of preselected finite element.
   a- Construct the finite element mesh of presented elements.
   b- Number the nodes and elements.
   c- Generate the geometric properties (e.g. coordinates, cross-sectional areas, etc.) needed for the problem.

2- Derivation of element equations for all typical elements in the mesh.
   a- Construct the variational formulation of the given differential equation over the typical element.
   b- Assume that a typical dependent variable (solution) u is of the form $u = \sum_{i=1}^{n} u_i N_i$, and substitute it into step(2a) to obtain element equations.
   c- Derivation of the approximate function for an element.

3- Assembly of element equations to obtain the equations of the whole problem.
   a- Identify the interelement continuity conditions among the primary variables (relationship between the local degrees of freedom and the global degrees of freedom connectivity of elements) by relating element nodes to global nodes.
   b- Identify the equilibrium conditions among the secondary variables (relationship between the local source or force components and the globally specified source components).
   c- Assume element equations using steps (3a) and (3b) and the superposition property.

4- Imposition of the boundary conditions of the problem.
5- Solution of the assembled equations.
6- Post processing of the results.


Discretization of the Continuum
Select Interpolation Functions
Shape Functions (element
Find the Element Properties
Assemble the Element
Apply the Boundary Conditions
Solve the System of Equations
Finite Element Analysis Phases