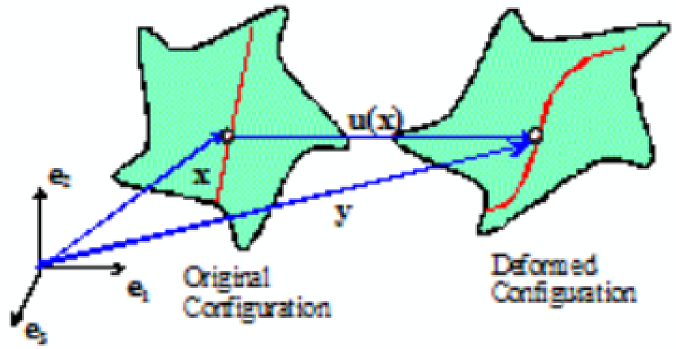
EN2340 2017 Computational methods in solids

2) Overview of FEA in solids

- FEA is a general method for finding approx solutions to a PDE



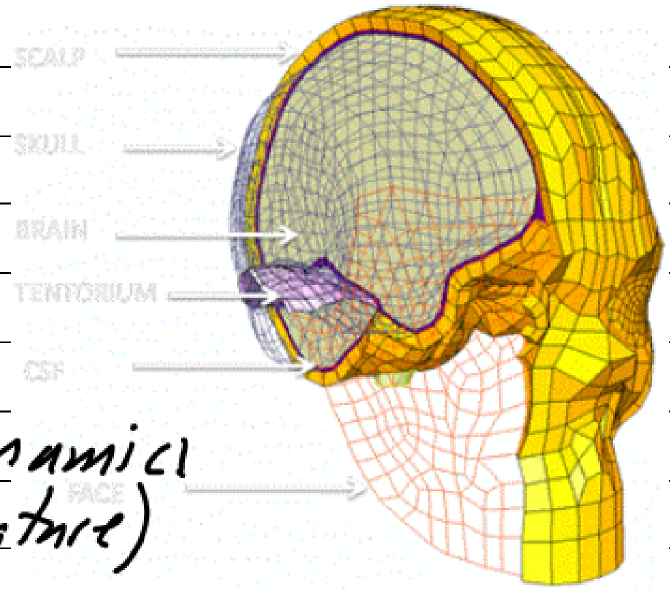
- In solid mechanics our goal is to calculate a displacement field

$$\underline{u}(\underline{x}, t) = \underline{y}(\underline{x}, t) - \underline{x}$$

Given: (1) Shape of solid
(2) Constitutive model, properties
(3) Initial conditions; Loading

- Governing equation: $\underline{F} = \underline{0}$; $\underline{F} = m\underline{a}$

Setting up an FEA problem



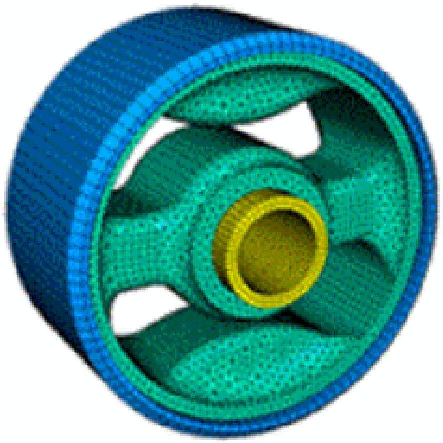
Specify:

(1) Geometry : Mesh
(2) Material model
(3) Contact & interfaces
(4) Loading, prescribed BCs
(5) Initial conditions for dynamics
(6) Other fields (eg temperature)
(7) Output variables

Solution procedure:

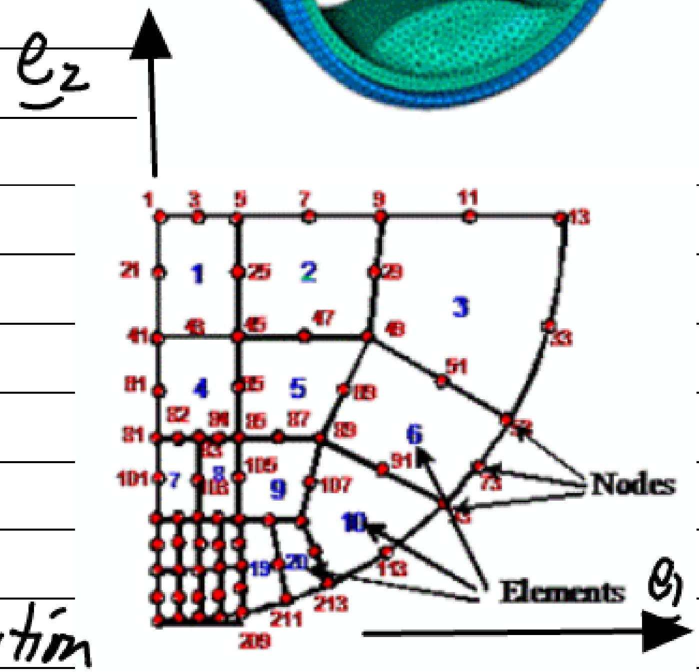
(1) Statics or dynamics
(2) Linear , or nonlinear
(3) Account for large shape changes (NLGEOM)
(4) Special procedures ~ buckling , fracture etc

2.1 Finite element mesh



- 3D: subdivide solid into sub-volumes

- 2D: subdivide area



3 types: Plane stress $\sigma_{3i} = 0$

Plane strain

$\underline{u} = u_\alpha(x_1, x_2)\,\underline{e}_\alpha$

Axisymmetry

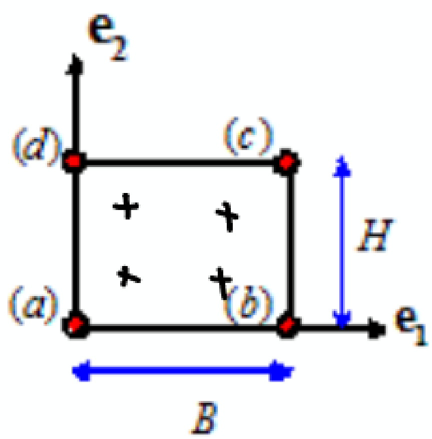
$\underline{e}_2$ is axis of revolution in ABAQUS

Other reduced-order models exist

2.1.1 Nodes : Discrete points in solid

- Properties : (1) Integer identifier
  (2) Coordi
  (3) Degrees of freedom
  - always includes displacements
  - some special elements have rotational DOF
  (4) Field variables

2.1.2 Elements: sub-divide solid



- Properties: (1) Nodes on element
  "Connectivity"
  (2) Integration points - special points in element
  (3) Interpolation scheme