

NUMERICKÁ OPTIMALIZACE DŘEVAŘSKÉHO VÝROBKU

Jan Tippner, LDF MENDELU

Úvod do Metody Konečných Prvků -Finite Element Method



PDE > FEM & FEA

Finite Element Method (FEM), Finite Element Analysis (FEA)

- numerical technique for finding approx. solutions,

- principle: discretization of continuum into finite count of elements - unknown parameters are solved in nodes,

- advantages of discretization: accurate **representation of complex geometry and material properties,** representation of global solution & capture of local effects.



1) dividing domain into subdomains, with each subdomain represented by a set of element equations to the original problem (PDE),

2) recombining all sets of elem. equations into a global system of eqs. for final calculation.



1.Preprocessing

- 2.Solution
- 3.Postprocessing

Model building:

Geometry building

FE model (discretization)

Physical model:

- phenomena (PDE)
- constants (material)
- initial conditions
- boundary conditions

Tools for FEA – proprietary, free & opensource













Open√FOAM













Nastran





Advantages & Disadvantages of FEM

1. handle very complex problems (geometry, material, loading)

2. universal for problems from "field theory" = described by PDE

3. well-studied, **implemented in many software packages**, wide-spread around the world

4. effective with computers and clouds = quick computation of set of simple processes



1. approximate solution (accuracy depends on discretization, more elements give: a) more time for computation, b) better approximation, c) higher numerical error)

2. has "inherent" errors:

a) modeling error (geometry, material, loading & boundary conditions, type of analysis)

b) discretization error (type of elements, mesh density, geometry accuracy - order)

c) numerical error (integration, round-off error, matrix conditioning)

3. wrong input = wrong output; wrong results still produce also "nice pictures"

4. FEM can be **"difficult"**, harder to program & with requirements for skilled users (engineers, mathematicians, physicists, programmers)