Femap Advanced Thermal Solver

Finite volume FE-based thermal solver technology to efficiently simulate complex heat transfer phenomena

fact sheet

Siemens PLM Software

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▶ **Summary**

Femap® software's Advanced Thermal module is an add-on to Femap Thermal and includes a complete set of solver capabilities to treat complex heat transfer problems. The additional thermal and heat transfer capabilities offer high fidelity numerical predictions and address additional thermal analysis requirements in many industries. The Femap Advanced Thermal solver can also be seamlessly coupled with Femap Flow, the Femap CFD solution, for fully coupled advanced thermo-fluid simulations.

Benefits

Allows for investigation of multiple "what-if" scenarios involving complex assemblies

Allows for building of assemblies by modeling heat flow between unconnected parts and components

Enables the user to simulate strong and fully-coupled thermo-fluid interactions, including proper treatment of radiative heat transfer

Supports mapping results to a Nastran FE model for thermo-elastic analysis

Features

Thermal couplings for joining disjoint solid or surface meshes within an assembly

Thermo-fluid and thermo-elastic interactions when coupled with Femap Flow or NX Nastran software

Fast and accurate FE-based finite volume thermal and heat transfer solver

The most complete toolset for advanced thermal radiation modeling

Electrical heating

Diurnal environmental and solar heating

Material phase changes including latent heat and thermal ablation modeling


The Femap Thermal solver features high order finite volume FE-based technology to accurately and efficiently simulate heat transfer phenomena. It combines the versatility of FE-based analysis with the accuracy and efficiency of a finite-difference scheme. The Femap Thermal solver technology allows simulation of Femap parts and assemblies within complex thermal environments. The solver and modeling features include:

Solver capabilities
- Steady-state (linear and nonlinear)
- Transient (linear and nonlinear)
- Material nonlinear thermal properties
- Axis-symmetric modeling
- Cyclic thermal simulation
- High speed rotational effects
- Iterative conjugate gradient solver technology
- Fully coupled conduction, radiation and convection heat transfer simulation
- Electrical joule heating
- Ray-tracing including ray extinction and heat dissipation within participating media
- Latent heat of material phase changes and thermal ablation modeling
- 1D hydraulic networks for explicit thermo-fluid couplings

Thermal couplings technology for modeling thermal contacts within Femap assemblies
- Thermally connect disjoint and dissimilar mesh faces and edges
- Surface-to-surface, edge-to-edge and/or edge-to-surface contact modeling between parts: constant time or temperature-dependent coefficient of heat transfer, resistances or conductance

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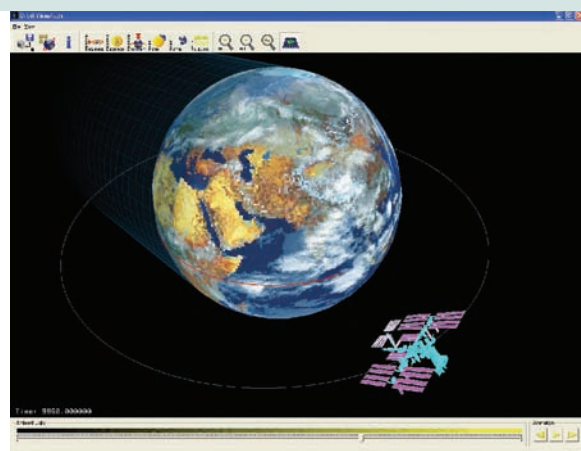
- Radiative exchange between disjoint part faces and faces within a single part
- Interface modeling between connected parts: constant, time or temperature dependent coefficient of heat transfer, resistance or conductance
- Convective exchange correlations between faces: parallel plates, concentric spheres or cylinders

Applied heat loads

- Constant and time-dependent heat loads
- Constant and time-dependent heat flux
- Constant and time-dependent heat generation
- All applied loads can be controlled with temperature-controlled thermostat conditions or PID controllers

Temperature boundary conditions

- Constant temperature for steady-state or transient
- Time varying for transient and for nonlinear steady-state
- Thermostat temperature controls

Conduction heat transfer

- Handles large conduction heat transfer models (memory efficient data scheme)
- Temperature-dependent conductivity
- Temperature-dependent specific heat
- Orthotropic conductivity
- Heat of formation at phase change temperature

Convection heat transfer

- Constant, time and temperature-dependent heat transfer coefficients
- Parameter and nonlinear temperature gradient functions
- Free convection
- Correlation-based free convection to ambient for inclined plates, cylinders and spheres
- Forced convection
- Correlation-based convection for plates, spheres and cylinders in forced fluid flow

Radiation heat transfer

- Constant and temperature-dependent emissivity
- Multiple radiation enclosures
- Diffuse view factor calculations with shadowing
- Net view factor calculations
- Adaptive scheme for view factor sum optimization
- Hemicube-based view (form) factors calculation using graphics card hardware
- Radiation patch generation to condense large element-based radiation models
- Sub-modeling capabilities
- Radiation matrix controls and parameters
- Advanced optical properties (wavelength dependent, etc.)
- Monte Carlo method for advanced ray tracing and scattering in participating media

Initial conditions
- Starting temperatures for both steady-state and transient
- Starting temperatures from previous solution results, from file

Solver and solution attributes
- Restart conditions, cyclic convergence criteria
- Direct access to solver parameters
- Solver convergence criteria and relaxation factors
- Solver monitor with solution convergence and attributes
- Intermediate results display and recovery directly from solver progress monitor
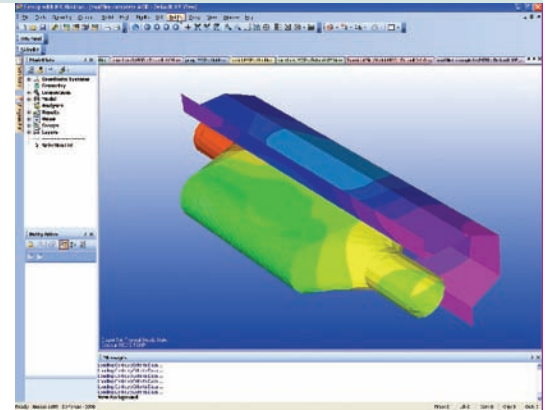
Other features
- Results Reporter
- Summary of results to Excel worksheets
- Heat flow calculation between groups
- Heat maps
- Complete or partial deactivation of selected elements (for radiation form factors calculations)
- Temperature mapping for Nastran FE models with dissimilar mesh
- User sub-routines

Simulation results
- Temperatures
- Temperature gradients
- Total loads and fluxes
- Conductive fluxes
- Convective fluxes
- Convection coefficients
- Residuals
- Heat maps
- View factors sums

Features
Thermal couplings for joining disjoint solid or surface meshes. Thermal couplings provide a powerful and efficient capability for building assemblies by modeling heat flow between unconnected parts, components or even dissimilar meshes. Multiple what-if scenarios and positioning of parts within an assembly can be investigated by defining the thermal coupling parameters between unconnected parts only once. Heat transfer paths are automatically created between elements on opposing parts at runtime. These conductances are established based on proximity, and they account for overlap and mismatch between disjoint and dissimilar meshes exchanging heat, allowing parts to be moved freely within the assembly prior to running the analysis. Thermal coupling types include conductive, radiative, convective and interface couplings. Thermal couplings can also be defined as varying with different model parameters such as temperatures or heat loads.

Thermo-fluid and thermo-elastic interactions. The adavanced heat transfer modeling capabilities can be explicitly combined with the Femap Flow computational fluid dynamics (CFD) solution. This combination allows a user to simulate strong and fully-coupled thermo-fluid interactions problems, including complex radiative heat transfer. When licenses of Femap Flow and Femap Thermal and Femap Advanced Thermal are purchased together, the thermo-fluid solver is automatically turned on at no additional cost, offering both conduction and radiation modeling to be fully coupled with 3D fluid flow. Furthermore, Femap Advanced Thermal temperature results can be mapped to a dissimilar Nastran FE model for thermo-elastic analysis (NX™ Nastran® solver licenses are sold separately).

Integrated thermal and heat transfer solution. Femap Advanced Thermal is integrated within the Femap portfolio and takes full advantage of the Femap advanced simulation environment. The Femap integrated application allows both skilled engineers and thermal specialists to avoid any additional transfer of input files or geometry conversions and manipulations breaking the associative link between Femap geometry and FE tasks.

The Femap interface provides Femap Advanced Thermal users with a broad set of tools for creating thermal models and analysis-ready geometry. A user can automatically (or manually) remove unnecessary geometrical features. The user can refine the mesh in critical areas and selectively control mesh density, minimizing or optimizing model size for rapid and accurate solution.

By virtue of being native to the Femap environment, Femap Advanced Thermal provides the ability to model, catalog and share parts and material libraries among the design team, thereby minimizing tedious rework and potentially costly modeling errors.

Product availability
Femap Advanced Thermal is a module in the suite of advanced simulation applications available within the Femap product configuration. When used with Femap Flow, Femap Advanced Thermal provides a coupled multi-physics solution for complex fluid flow and complex thermal interaction applications.

▶ **For more information, contact your local Velocity Series™ portfolio representative:**

▶ **Contact**
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