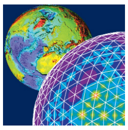
product option

LUSAS
Finite Element Analysis

Thermal / Field Analysis



The LUSAS Thermal / Field option contains extensive facilities for both simple and advanced steady state, and transient thermal / field analyses. By combining the LUSAS Thermal / Field option with other appropriate LUSAS options, heat transfer due to conduction, convection and radiation can be analysed. In addition, the effects due to phase change of material may be also included.

Thermal Analysis

The Thermal / Field option offers a powerful set of thermal link elements for solving analyses which include the following material characteristics:

- Isotropic materials
- Orthotropic materials
- Specific heat
- Convective heat transfer coefficient.
- Radiative heat transfer coefficient
- Rate of internal heat generation
- Latent heat flow due to phase change
- Temperature dependence

Loading

A large selection of boundary conditions and loadings are also available and include:

- Prescribed temperature
- Heat flux or rate of heat generation or absorption
- Convection between surfaces or to the environment
- Radiation between surfaces or to environment
- Environmental or initial temperatures
- Impermeable boundaries for seepage flow
- Temperature dependent properties

Thermal Surfaces

Thermal surfaces are used to model heat transfer across gaps; heat transfer by contact when a gap closes; heat transfer to the general environment, and heat transfer by radiation exchange. Gap and contact heat transfer is modelled with a thermal gap that is defined by thermal properties and thermal surfaces.

Conduction and Convection

The Thermal / Field option enables conduction and convection to take place by specifying an environmental temperature and a heat transfer coefficient on any surface. Unlike many other systems there is no need to use complex nodal links to define the convective surface. In LUSAS, a face load is applied to a chosen surface in a single action.

Radiation

When the LUSAS Nonlinear and Thermal / Field options are combined gap radiation can be modelled. Radiation exchange may be modelled using a radiation surface defined by any number of thermal surfaces. Planes of symmetry that cut through the radiation enclosures may be defined and obviate the requirement to model the whole structure. Radiation surfaces also allow for the calculation of diffuse view factors.

View Factors

View factors are used to express the fraction of radiative energy leaving an emissive segment of a thermal surface which is incident on a receiving segment. Surface emissivity can also be defined in accordance with the material used.

Phase Changes

When a material changes state it is accompanied by either a liberation or absorption of latent heat. Thermal modelling of the transition state is done in LUSAS using the latest enthalpy approach ensuring that the temperature at a point does not pass through the phase change temperature without including the effect of the phase change in the analysis.

Transient Analysis

For both linear and nonlinear analyses, LUSAS allows variable time stepping to be used in transient thermal problems providing efficient and accurate results. A choice of time integration schemes is available.

Temperature Dependent Material Properties

The solution of problems involving temperature dependent material properties and loading is possible when either a LUSAS Nonlinear option is used to set a nonlinear control or a LUSAS Dynamic option is used to set a dynamic, viscous, or transient control. Temperature dependent material properties are defined in a table in which any of the material parameters may vary with temperature. LUSAS linearly interpolates the material parameters from the table at the required temperature for each integration point within each element.

Coupled Analysis

In some types of problem the temperature distribution may significantly affect the material properties. This will occur when a material undergoes a phase change or the material yield stress is reduced as the temperature increases. In such problems the temperature distribution evaluated from a thermal analysis must be coupled to a structural analysis. When the Dynamic and Thermal / Field options are combined, semi or fully coupled analyses can be carried out.

Semi-coupled Analysis

A semi-coupled analysis is carried out when the thermal solution will not be significantly affected by any changes in geometry. In this type of problem the thermal and structural analyses are run separately. Structure temperatures at pre-defined time steps are defined, and a

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stress analysis, based upon these temperature loadings, is performed to obtain the final results.

Fully-coupled Analyses

Fully coupled analyses are carried out by running the thermal and structural analyses simultaneously. A fully coupled analysis ensures that the correct material parameters are used at the iterative level which is required for particularly sensitive problems. In a fully coupled analysis the temperatures from a thermal analysis are used as input to the stress analysis and the displacements from the stress analysis are used to update the geometry in the thermal analysis.

Other Capabilities

The LUSAS Thermal / Field option uses a solution method that is applicable to a wide variety of thermal and field analysis enabling a number of problems including electro magnetics and torsion to be solved.

Results Processing

In addition to the powerful contouring, graphing and plotting features in LUSAS Graphics, a large number of specific thermal results processing features are available including:

- Total flow history
- Gap and environmental flow
- Radiation flow between segments
- Radiation flow to environment
- Total nodal flow

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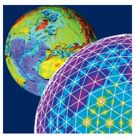
- Steady state heat conduction / convection / radiation
- Transient thermal analysis with a general two point recurrence theme
- Conduction / convection / gap radiation
- Temperature dependent thermal properties
- Temperature dependent nonlinear heat conduction / convection / radiation
- Variable time step selection
- Time dependent boundary conditions and loading
- Diffuse radiation using view factors with option to account for symmetry boundary conditions
- Full and semi thermal-structural coupling



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