Task №4
3D STRUCTURAL, THERMAL and THERMOELASTIC ANALYSES

Individual tasks – bodies in the shape of letters.

Consider a 3D domain in the shape of the given letter from practical assignment 2 and table 1. The objective is to perform different types of analyses, namely, structural or thermal, and thermoelastic (separately). A 3D domain should be created by rotation, parallel transfer or extrusion (parallel transfer with scale change) of a plane domain along given line. Take the geometrical dimensions of the letter similar to those of the example problem. If possible, take advantage of symmetry when building the domain. Consider the body to be made of any elastic isotropic material.

Analysis A1. **Thermal analysis and thermoelastic analysis** (solve thermal conductivity problem and coupled thermoelastic problem, calculate temperature and heat flux distribution and thermal stresses). Boundary conditions for thermal analysis: the bottom edges of the letter are subjected to heating with prescribed temperature and the top edges are be subjected to heat transfer. Boundary conditions for coupled thermoelastic analysis: take the same thermal boundary conditions and additionally rigidly fix the bottom edges of the letter. Be sure to use proper finite elements for each analysis. Compare the results of temperature distribution and heat flux distribution in pure thermal and thermoelastic analyses. Calculate thermal stresses and provide results on the stress-strain state of the domain: deformed shape, displacements (ux, uy, uz), axial stresses (σ_{xx}, $\sigma_{yy,}$ σ_{zz}) and stress intensity.

Analysis A2. **Structural analysis and thermoelastic analysis** (solve linear elasticity problem and coupled thermoelastic problem, calculate stress-strain state and thermal stresses). Boundary conditions for structural analysis: the bottom edges of the letter are rigidly fixed and the top edges are stretched by distributed load (pressure). Boundary conditions for coupled thermoelastic analysis: take the same structural boundary conditions and additionally set prescribed temperature to the bottom edges of the letter and heat transfer to the top edges. Be sure to use proper finite elements for each analysis. Compare the results on the stress-strain state obtained for structural and thermoelastic analyses: deformed shape, displacements (ux, uy, uz), axial stresses (σ_{xx}, $\sigma_{yy,}$ σ_{zz}) and stress intensity. Calculate temperature and heat flux distribution.

Perform computations in ANSYS and analyze the results. Compare results for tetrahedral mesh (10-node tetrahedron with midside nodes) and hexahedral mesh (consider both linear 8-node and quadratic 20-node hexahedrons). Additionally compare computation time (see attached file with relevant commands).

Requirements to the report

The report should contain the name of the student, the full description of the problem and the results obtained in ANSYS. Text of input files should be also included in the report.

Provide the following computation results:

- finite element mesh with boundary conditions
- nodal degree of freedom solution (temperature for thermal analysis; displacements for structural analysis; temperature and displacements for thermoelastic analysis)
- pictures of the distribution of the heat flux vector and its magnitude (for thermal and thermoelastic analyses)
- pictures of the distribution of the displacement vector and its magnitude (for structural and thermoelastic analyses)
- pictures of the axial stresses distribution (for structural and thermoelastic analyses)
- picture of the stress intensity distribution (for structural and thermoelastic analyses)

Table 1. **Suggestions for domain shape**

Here R is rotation (VROTAT command); D is parallel transfer (VDRAG command); E is extrusion, or parallel transfer with scale change (VEXT command).

Odd task numbers correspond to analysis A1. Even task numbers correspond to analysis A2.

Table 1. Suggestions for domain shape.

Variant No.	Way to construct 3D structure	Domain shape	Student name
1	D	α	Бобовников Николай Алексеевич
2	R	β	Габричидзе Лука
3	E	δ	Гбамметон Шарль Жюдикаель (Charles Gbammeton)
4	R	ε	Гладкова Ксения
5	D	θ	Дремов Егор Алексеевич
6	E	ω	Ермаков Марк Михайлович
7	D	λ	Пересыпкин Станислав
8	E	μ	Шевченко Мария
9	R	ρ	Цао Цзыхэн
10	D	σ	Е Чэнпин
11	E	τ	Зезекало Виктор Анатольевич