Spectral and numerical analysis for a thermoelastic problem with double porosity and second sound.

Summary: We study some spectral and numerical properties of the solutions to a thermoelastic problem with double porosity. The model includes Cattaneo-type evolution law for the heat flux to remove the physical paradox of infinite propagation speed of the classical Fourier’s law. Firstly, we prove that the operator determined by the considered problem has compact resolvent and generates a $C_0$-semigroup in an appropriate Hilbert space. We also show that there is a sequence of generalized eigenfunctions of the linear operator that forms a Riesz basis. By a detailed spectral analysis, we obtain the expressions of the spectrum and we deduce that the spectrum determined growth condition holds. Therefore we prove that the energy of the considered problem decays exponentially to a rate determined explicitly by the physical parameters. Finally, some numerical simulations based on Chebyshev spectral method for spatial discretization are given to confirm the exponential stability result and to show the distribution of the eigenvalues and the variables of the problem.

MSC:

35Q74 PDEs in connection with mechanics of deformable solids
74L10 Soil and rock mechanics
74B10 Linear elasticity with initial stresses
35P15 Estimates of eigenvalues in context of PDEs
35A01 Existence problems for PDEs: global existence, local existence, non-existence
35A02 Uniqueness problems for PDEs: global uniqueness, local uniqueness, non-uniqueness
65N35 Spectral, collocation and related methods for boundary value problems involving PDEs
74S25 Spectral and related methods applied to problems in solid mechanics
80A19 Diffusive and convective heat and mass transfer, heat flow
35Q79 PDEs in connection with classical thermodynamics and heat transfer

Keywords: thermoelasticity; double porosity; well-posedness; spectral analysis; numerical simulations

Full Text: DOI

References:
