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The main focus of this paper is to analyze the behavior of a numerical solution of the Timoshenko system coupled with Thermoelasticity and incorporating second sound effects. In order to address this target, we employ the Physics-Informed Neural Networks (PINNs) framework to derive an approximate solution for the system. Our investigation delves into the extent to which this approximate solution can accurately capture the asymptotic behavior of the discrete energy, contingent upon the stability number ξ . Interestingly, the PINNs overcome the major difficulties encountered while using the standard numerical methods.