INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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Thesis Title: Interplay of Topology, Localization, and Non-Hermiticity in Low-dimensional Systems realized through Electrical Circuits

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SHORT ABSTRACT

Topology has revolutionized the understanding of condensed matter systems by revealing phases of matter characterized by global invariants rather than local order parameters. The inclusion of non-Hermiticity, arising from gain, loss, and non-reciprocal interactions, enriches this framework by introducing unique phenomena such as exceptional points, non-Hermitian skin effects, generalized Brillouin zones, and modified bulk-boundary correspondence. In parallel, topolectrical circuits have emerged as a versatile and experimentally accessible platform for realizing and probing such topological systems.

This thesis investigates the interplay between topology, non-Hermiticity, and localization in a range of one- and two-dimensional lattice models and their corresponding topolectrical circuit realizations. We uncover diverse non-Hermitian phenomena, including exceptional points, symmetry-dependent skin effects, and unconventional localization behaviour arising from the competition between disorder-induced Anderson localization and boundary accumulation. We further demonstrate how non-Hermitian perturbations can induce competition between first- and higher-order topological phases, leading to novel topological transitions and the emergence of hybrid-skin topological states with dynamically stable corner modes. To facilitate experimental realization, equivalent topolectrical circuits are proposed for all studied models using standard electrical components. These circuit implementations successfully capture the essential signatures of the underlying non-Hermitian topological phases and localization phenomena.