Resistance Distance, Kirchhoff Index /Network Criticality and Foster's Theorems: Generalization and Unification

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The emerging area of network science and engineering is concerned with the study of structural characteristics of networks, their impact on the dynamical behavior of systems as revealed through their topological properties, random evolution of networks, and information spreading along a network etc. This area spans a wide range of applications in different disciplines. A topic of great interest in this area is the notion of network criticality. Most measures of network criticality are defined by the paths that flow through the nodes or edges. Since computing all the paths is computationally intractable only shortest paths are usually used for computing criticality metrics. So, measures that implicitly capture the impact of all the paths will be useful. The recently introduced concepts of resistance distance and Kirchhoff Index are two such measures. These measures capture the behavior of random walks in net works. In this talk, we introduce these metrics and present several results that extend, generalize, and unify earlier works reported in the literature. In particular we define the notion of cutset Laplacian matrix which generalizes the notion of treditional Laplacian matrix. and study resistance distance and Kitchhoff Index using. this new matrix. We also relate our works to Foster’s theorems that find wide applications (Chemical Graph theory and computer science), and present a generalization that captures and retains the circuit theoretic elegance of Foster' original result.