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Graphs and Matrices

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Preface

This book is concerned with results in graph theory in which linear algebra and matrix theory play an important role. Although it is generally accepted that linear algebra can be an important component in the study of graphs, traditionally, graph theorists have remained by and large less than enthusiastic about using linear algebra. The results discussed here are usually treated under *algebraic graph theory,* as outlined in the classic books by Biggs [20] and by Godsil and Royle [39]. Our emphasis on matrix techniques is even greater than what is found in these and perhaps the subject matter discussed here might be termed *linear algebraic graph theory* to highlight this aspect.

After recalling some matrix preliminaries in the first chapter, the next few chapters outline the basic properties of some matrices associated with a graph. This is followed by topics in graph theory such as regular graphs and algebraic connectivity. Distance matrix of a tree and its generalized version for arbitrary graphs, the resistance matrix, are treated in the next two chapters. The final chapters treat other topics such as the Laplacian eigenvalues of threshold graphs, the positive definite completion problem and matrix games based on a graph.

We have kept the treatment at a fairly elementary level and resisted the temptation of presenting up to date research work. Thus several chapters in this book may be viewed as an invitation to a vast area of vigorous current research. Only a beginning is made here with the hope that it will entice the reader to explore further. In the same vein, we often do not present the results in their full generality, but present only a simpler version that captures the elegance of the result. Weighted graphs are avoided, although most results presented here have weighted, and hence more general, analogs.

The references for each chapter are listed at the end of the chapter. In addition, a master bibliography is included. In a short note at the end of each chapter we indicate the primary references that we used. Often, we have given a different treatment, as well as different proofs, of the results cited. We do not go into an elaborate description of such differences.

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