PREFACE

The purpose of this volume is to draw the attention of mathematical community to rapidly growing applications of the theory of graph spectra. Besides classical and well documented applications to Chemistry and Physics, we are witnesses of the appearance of graph eigenvalues in Computer Science in various investigations. There are also applications in several other fields like Biology, Geography, Economics and Social Sciences. A monograph with a comprehensive treatment of applications of graphs spectra is missing at the present.

The present book contains five chapters: an introductory chapter with a survey of applications by representative examples and four case studies (one in Computer Science and three in Chemistry).

We quote particular chapters and indicate their contents.

Applications of Graph Spectra: An Introduction to the Literature (D. Cvetković). This introductory text provides an introduction to the theory of graph spectra and a short survey of applications of graph spectra. There are four sections: 1. Basic notions, 2. Some results, 3. A survey of applications, 4. Selected bibliographies on applications of the theory of graph spectra.

Multiprocessor Interconnection Networks (D. Cvetković, T. Davidović). Well-suited multiprocessor interconnection networks are described in terms of the graph invariant called tightness which is defined as the product of the number of distinct eigenvalues and maximum vertex degree. Load balancing problem is presented.

Selected Topics from the Theory of Graph Energy: Hypoenergetic Graphs (S. Majstorović, A. Klobučar, I. Gutman). The energy E of a graph G is the sum of the absolute values of the eigenvvalues of G. The motivation for the introduction of this invariant comes from Chemistry, where results on E were obtained already in the 1940's. The chemical background of graph energy is outlined in due detail. Then some fundamental results on E are given.

A graph G with n vertices is said to be "hypoenergetic" if $E(G) < n$. In the main part of the chapter results on graph energy, pertaining to the inequalities $E(G) < n$ and $E(G) \geq n$ are presented. Most of these were obtained in the last few years.

Nullity of Graphs (B. Borovićanin, I. Gutman). The nullity η of a graph G is the multiplicity of the number zero in the spectrum of G. In the 1970s the nullity of graphs was much studied in Chemistry, because for certain types of molecules, $\eta = 0$ is a necessary condition for chemical stability. The chemical background of this result is explained in a way understandable to mathematicians. Then the main early results on nullity are outlined.

In the last 5–10 years there is an increased interest to nullity in mathematics, and some 10 papers on this topic appeared in the mathematical literature. All these results are outlined too.

The Estrada Index (H. Deng, S. Radenković, I. Gutman). If λ_i, $i = 1, 2, \ldots, n$, are the eigenvalues of the graph G, then the Estrada index EE of G is the sum of the terms $\exp(\lambda_i)$. This graph invariant appeared for the first time in year 2000, in a paper by Ernesto Estrada, dealing with the folding of protein molecules. Since then a remarkable number of other chemical and non-chemical applications of EE were communicated.

The mathematical studies of the Estrada index started only a few years ago. Until now a number of lower and upper bounds were obtained, and the problem of extremal EE for trees solved. Also, a number of approximations and correlations for EE were put forward, valid for chemically interesting molecular graphs.

All relevant results on the Estrada index are presented in the chapter.

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