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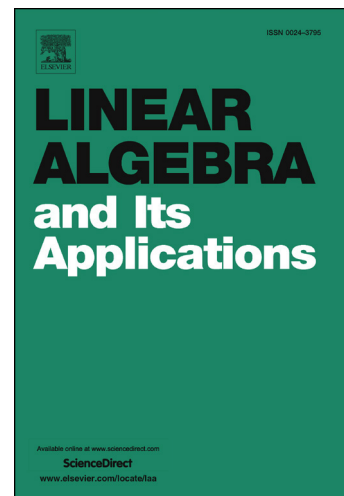
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# Constructing graphs with given spectrum and the spectral radius at most 2

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## Abstract

Two graphs are cospectral if their spectra coincide. The set of all graphs that are cospectral to a given graph, including the graph by itself, is the cospectral equivalence class of the graph. We say that a graph is determined by its spectrum, or that it is a DS-graph, if it is a unique graph having that spectrum. Given  $n$  reals belonging to the interval  $[-2, 2]$ , we want to find all graphs on  $n$  vertices having these reals as the eigenvalues of the adjacency matrix. Such graphs are called Smith graphs. Our search is based on solving a system of linear Diophantine equations. We present several results on spectral characterizations of Smith graphs.

**Key words:** Adjacency spectrum, cospectral graphs, DS-graph, cospectral equivalence class, Diophantine equation.

**2010 Mathematics Subject Classification:** 05C50

## 1 Introduction

In this paper, we consider only finite undirected simple graphs, i.e. graphs without loops or multiple edges. Let  $G$  be a simple graph on  $n$  vertices (or a graph of order  $n$ ), and with the adjacency matrix  $A$ . The *characteristic polynomial*  $P_G(x) = \det(xI - A)$  of  $G$  is the characteristic polynomial of its adjacency matrix  $A$ . The eigenvalues of  $A$ , in non-increasing order, are denoted by  $\lambda_1(G), \dots, \lambda_n(G)$ . They are called the *eigenvalues* of  $G$  and they form the *spectrum* of  $G$ . The multiplicity  $k$  of the eigenvalue  $\lambda_i$  in the spectrum of  $G$  will be denoted by  $[\lambda_i]^k$ . Since  $A$  is real and symmetric, the spectrum of  $G$  consists of reals. In particular,  $\lambda_1(G)$ , as the largest eigenvalue of  $G$ , is called the *spectral radius* (or *index*) of  $G$ .

The spectrum of  $G$  (as a multi-set or family of reals) will be denoted by  $\widehat{G}$ . The *disjoint union* of graphs  $G_1$  and  $G_2$  will be denoted by  $G_1 + G_2$ , while for the union of their spectra (i.e. the spectrum of  $G_1 + G_2$ ) we will use the following mark  $\widehat{G}_1 + \widehat{G}_2$ . In the similar manner,  $kG$  ( $k\widehat{G}$ ) stands for the union of  $k$  copies of  $G$  (the spectrum of  $kG$ ). In this sense, we shall also use linear combinations of graphs and of their spectra.

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