

Accepted Manuscript

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PII: S0024-3795(17)30667-5
DOI: <https://doi.org/10.1016/j.laa.2017.12.005>
Reference: LAA 14406

To appear in: *Linear Algebra and its Applications*

Received date: 5 June 2017
Accepted date: 4 December 2017

Please cite this article in press as: Z. Wang, D. Wong, The characteristic polynomial of lexicographic product of graphs, *Linear Algebra Appl.* (2018), <https://doi.org/10.1016/j.laa.2017.12.005>

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The characteristic polynomial of lexicographic product of graphs

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Abstract

Let G and H be two simple graphs. In this paper, the characteristic polynomial of $G[H]$, the lexicographic product of G and H , is determined. As an application, the characteristic polynomial and the spectrum of $G[H]$ are obtained explicitly when H has exactly one or two main eigenvalues.

Keywords: Lexicographic product, Main eigenvalue, Characteristic polynomial, Spectrum

2000 MSC: 05C50

1. Introduction

The characteristic polynomial of a graph is defined as the characteristic polynomial of its adjacency matrix. The spectrum, eigenvalues, eigenvectors and eigenspaces of a graph are defined similarly. Let G be a graph with $\{1, 2, \dots, m\}$ as its vertex set, let H_1, H_2, \dots, H_m be m disjoint graphs. The generalized lexicographic product, denoted by $G[H_1, H_2, \dots, H_m]$, is formed by taking H_1, H_2, \dots, H_m , and then joining every vertex of H_i to every vertex of H_j whenever i is adjacent to j in G . When $H_1 = H_2 = \dots = H_m = H$, the generalized lexicographic product $G[H_1, H_2, \dots, H_m]$ is reduced to the lexicographic product $G[H]$. The lexicographic product of graphs is a binary operation which can generate new graphs from old ones. Different from other binary operations such as Cartesian product and strong product of graphs [6], lexicographic product of graphs does not satisfy commutative law and its characteristic polynomial can not be determined by that of the two constituent graphs in general.

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¹Supported by the National Natural Science Foundation of China (No. 11571360).

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