

# Wiener index of the composition of two planar graphs

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**Abstract**—The Wiener index, is the first, and also one of the most important topological indices of chemical graphs. In addition to this, there are many situations in communication, facility location, cryptology, architecture etc, where the Wiener index of the corresponding graph or the average distance is of great interest. One of the problems, for example, is to find a spanning tree with minimum average distance. In this paper we are going to present the composition of two planar graphs, through some examples and, in the end, we going to focalize to calculate the Wiener index for the composition of two cycle planar graphs  $W(C_{n_1} \circ C_{n_2})$  and the Wiener index for the composition of cycle planar graph and path planar graph  $W(C_{n_1} \circ P_{n_2})$  using our's theorem.

**Keywords:** The corona two graphs, the cycle planar graph, index Wiener, the path planar graph.

## I. INTRODUCTION

The first investigations into the Wiener index were made by Harold Wiener in 1947 who realized that there are correlations between the boiling points of paraffin and the structure of the molecules in particular. He mentions in his article that the boiling point  $t_B$  can be quite closely approximated by  $t_B = aw + bp + c$ , where  $w$  is the Wiener index,  $p$  the polarity number and  $a$ ,  $b$  and  $c$  are constants for a given isomeric group. Since then it has become one of the most frequently used topological indices in chemistry, as molecules are usually modeled as undirected graphs, especially trees. For example, in the drug design process, the aim is the construction of chemical compounds with certain properties, which not only depend on the chemical formula but also strongly on the molecular structure, as one can easily see when considering cocaine and scopolamine, both having the chemical formula  $C_{17}H_{21}NO_4$ .

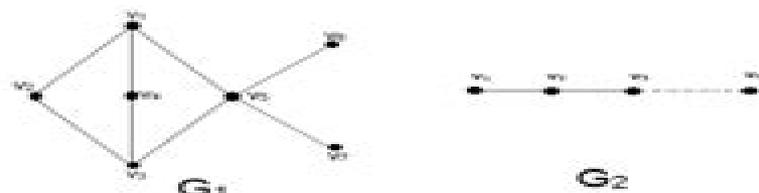
A graph  $G$  is a triplet consisting of a vertex set  $V(G)$ , an edge set  $E(G)$ , and a relation that associates with each edge two vertices called its endpoints. We denote  $n = |V(G)|$  is the vertex number of  $G$  and  $m = |E(G)|$  is the edges number of  $G$ . A path is a simple graph whose vertices can be ordered so that two vertices are adjacent if and only if they are consecutive in the list. A graph  $G$  is connected if each pair of the vertices in  $G$  belongs to a path. The degree of vertex  $v$  in a graph  $G$ , which is written  $deg(v)$ , is the number of edges

incident to  $v$ , except that each loop at  $v$  counts twice, and we call distance between two distinct vertices of graph  $G$ ,  $u$  and  $v$ , the smallest length of a path between  $u$  and  $v$  in  $G$ . The diameter of  $G$ , denoted by  $D(G)$ , is defined as the maximum distance between any two vertices of  $G$ , that is,  $D(G) = \max\{d(u, v) : \forall(u, v) \in V(G)^2\}$ , we call  $d_G(k)$  the number of pairs of vertices of  $G$  that are at distance  $k$ , note that  $d_G(0)$  and  $d_G(1)$  represent the number of vertices and edges, respectively. The Wiener index of the graph  $G$  equals to the sum of distances between all pairs of vertices of the respective molecular graph, i.e.  $W(G) = \sum_{\{u,v\} \subseteq V(G)} d(u, v)$ , and we define the index Wiener of a vertex  $u$  in the graph  $G$  as  $w(u, G) = \sum_{v \in V(G)} d(u, v)$ , for more information about Wiener index and its properties we can see [1,2,3,4].

## II. THE COMPOSITION OF TWO GRAPHS

Starting from the 1970, the composition ( the corona ) of two graphs gained much popularity and, since then, new results related to it are constantly being reported. Mr Frucht and Harary in [5,6] gave the definition and some results for the composition of two graphs.

Let  $G_1$  and  $G_2$  be two graphs on disjoint sets of  $n_1$  and  $n_2$  vertices, respectively :



The composition  $G_1 \circ G_2$  of  $G_1$  and  $G_2$  is defined as the graph obtained by taking one copy of  $G_1$  and  $n_1$  copies of  $G_2$ , and then joining  $i^{th}$  vertex of  $G_1$  to every vertex in the  $i^{th}$  copy of  $G_2$  (see Fig. 1)[5,6,7].

# Wiener Index Of A Graph And Chemical Applications

**Yijin Wang**



## **Wiener Index Of A Graph And Chemical Applications:**

### **HyperGraph and SuperHyperGraph Theory with Applications (V)** Takaaki Fujita, Florentin

Smarandache, 2026-01-01 Hypergraphs extend traditional graph theory by allowing edges to connect arbitrary non empty subsets of a vertex set By recursively applying the powerset construction we derive nested higher order objects known as SuperHyperGraphs In this framework both vertices and edges possess multi layered set valued structures offering unparalleled expressive capacity for modeling complex systems Topological indices serve as critical numerical invariants that translate structural features such as degree sequences distance metrics and connectivity into quantitative data used to analyze and compare network properties Despite the potential of SuperHyperGraphs a systematic theory of their structural parameters remains underdeveloped This volume extends a diverse range of topological indices from classical graph and hypergraph settings to the SuperHyperGraph domain Expanding upon the research foundation established in previous works we investigate how these indices characterize the intrinsic properties of higher order nested networks

### **Graph-Theoretical Matrices in Chemistry** Dusanka Janezic, Ante Milicevic, Sonja Nikolic, Nenad Trinajstic, 2015-04-22

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### **Topological Modelling of Nanostructures and Extended Systems** Ali Reza Ashrafi, Franco Cataldo, Ali Iranmanesh, Ottorino

Ori, 2013-05-19 Topological Modelling of Nanostructures and Extended Systems completes and expands upon the previously published title within this series The Mathematics and Topology of Fullerenes Vol 4 2011 by gathering the latest research and advances in materials science at nanoscale It introduces a new speculative area and novel concepts like topochemical reactions and colored reactive topological indices and provides a better understanding of the physical chemical behaviors of extended systems Moreover a charming new family of space filling fullerene crystals is here analyzed for the first time Particular attention is given to the fundamental influences exercised by long range connectivity topological mechanisms on the chemical and physical properties of carbon nanostructures Systems consisting in graphenic layers with structural and topological defects are investigated in their electronic and magnetic behaviors also in presence of metallic particles More specifically the book focuses on Electronic Properties of low dimensional nanostructures including negatively curved carbon surfaces Pariser Parr Pople model hamiltonian approach to graphene studies Topochemistry and Toporeactivity of extended sp<sup>2</sup> nanocarbons PAH fullerenes nanoribbons Moebius like nanoribbons nanotubes and grapheme Novel class of crystal networks arising from spanning fullerenes Nanostructures and eigenvectors of matrices and an extended treatise of topological invariants Enumeration hetero fullerenes by Polya theory Topological Modelling of Nanostructures and Extended Systems represents a valuable resource to advances graduates and researchers working in mathematics chemistry physics

and material science     *The Mathematics and Topology of Fullerenes* Franco Cataldo, Ante Graovac, Ottorino Ori, 2011-12-01  
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combinatorics related to computing. Submissions to the conference this year were conducted electronically. A total of 114 papers were submitted of which 52 were accepted. The papers were evaluated by an international program committee consisting of Nina Amenta, Tetsuo Asano, Bernard Chazelle, Zhixiang Chen, Francis Chin, Kyung Yong Chwa, Robert Cimikowski, Anne Condon, Michael Fellows, Anna Gal, Michael Hallett, Daniel Huson, Naoki Katoh, D. T. Lee, Bernard Moret, Brendan Mumey, Gene Myers, Hung Quang Ngo, Takao Nishizeki, Cindy Phillips, David Sanko, Denbigh Starkey, Jie Wang, Lusheng Wang, Tandy Warnow, and Binhai Zhu. It is expected that most of the accepted papers will appear in a more complete form in scientific journals. The submitted papers were from Canada 6, China 7, Estonia 1, Finland 1, France 1, Germany 8, Israel 4, Italy 1, Japan 11, Korea 22, Kuwait 1, New Zealand 1, Singapore 2, Spain 1, Sweden 2, Switzerland 3, Taiwan 7, the UK 1, and the USA 34. Each paper was evaluated by at least three Program Committee members, assisted in some cases by subreviewers. In addition to selected papers, the conference also included three invited presentations by Jon Bentley, Dan Gusfield, and Joel Spencer.

**Advances in Computational Science and Computing** Ning Xiong, Zheng Xiao, Zhao Tong, Jiayi Du, Lipo Wang, Maozhen Li, 2018-11-14. This book includes papers on the recent advances in state of the art computational science and computing presented at the 2018 International Symposium on Computational Science and Computing ISCSC 2018 held in Huangshan, China from 28 to 29 July 2018. All the papers were rigorously peer reviewed by experts in the area. It is a valuable resource for researchers, professors, graduate students, as well as R & D staff in the industry with a general interest in computational science and computing. *Graph Theory Notes of New York*, 2004. **Molecular Topology** Mircea V. Diudea, Ivan Gutman, Lorentz Jantschi, 2001. Most yet not all chemical substances consist of molecules. The fact that molecules have a structure is known since the middle of the 19th century. Since then one of the principal goals of chemistry is to establish the relationships between the chemical and physical properties of substance and the structure of the corresponding molecules. Countless results along these lines have been obtained and presented in different publications in this field. One group uses so called topological indices. About 20 years ago there were dozens of topological indices but only a few with noteworthy chemical applications. Over time their numbers have increased enormously. At this moment there is no theory that could serve as a reliable guide for solving this problem. This book is aimed at giving a reasonable comprehensive survey of the present finite state of art theory and practice of topological indices. *Arhiv za hemiju i tehnologiju*, 1997.

**Nanotechnology and Its Applications** Yousef I. Salamin, 2007. Among the topics discussed were nanoscience and nanotechnology including synthesis and characterization of nanomaterials, environmental applications, computational theory and simulation of nanostructures. **Journal of the Indian Chemical Society** Indian Chemical Society, 2000. **Match**, 2008. **Zeitschrift Für Naturforschung**, 2007. **Indian Journal of Chemistry**, 2008. *Product Graphs* Wilfried Imrich, Sandi Klavžar, 2000-04-11. A comprehensive introduction to the four standard products of graphs and related topics. Addressing the growing usefulness of current methods for recognizing product graphs, this new work presents a much

needed systematic treatment of the Cartesian strong direct and lexicographic products of graphs as well as graphs isometrically embedded into them Written by two leading experts in this rapidly evolving area of combinatorics Product Graphs Structure and Recognition compiles and consolidates a wealth of information previously scattered throughout the literature providing researchers in the field with ready access to numerous recent results as well as several new recognition algorithms and proofs The authors explain all topics from the ground up and make the requisite theory and data structures easily accessible for mathematicians and computer scientists alike Coverage includes The basic algebraic and combinatorial properties of product graph Hypercubes median graphs Hamming graphs triangle free graphs and vertex transitive graphs Colorings automorphisms homomorphisms domination and the capacity of products of graphs Sample applications including novel applications to chemical graph theory Clear connections to other areas of graph theory Figures exercises and hundreds of references *Journal of the Chinese Chemical Society* ,1993 *Bulletin of the Korean Chemical Society* ,2005

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