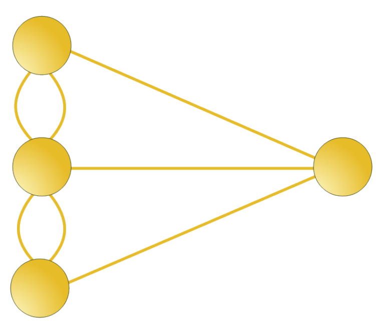
The Third Gdańsk Workshop on Graph Theory

List of participants and abstracts



Gdańsk, September 16-18, 2015

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COLOURINGS OF PLANAR GRAPHS

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We study different kinds of colourings for sets of planar graphs and determine, in particular, upper or lower bounds for these chromatic numbers. Some conjectures and open problems will be presented.

The main topics of the talk are not covered by the Borodin's survey: "Coloring of plane graphs, Discrete Math. 313 (2013) 517–539."

UPPER BOUNDS ON THE GAME DOMINATION AND GAME TOTAL DOMINATION NUMBERS

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In this talk, we discuss the domination game and its total version. The domination game is played on a graph G by two players, named Dominator and Staller. They alternately take turns choosing vertices of G such that each chosen vertex dominates at least one vertex not dominated by the vertices previously chosen. The game ends when the set of vertices chosen becomes a dominating set in G. Dominator wishes to end the game with a minimum number of vertices chosen, and Staller wishes to end the game with as many vertices chosen as possible. The game domination number, $\gamma_g(G)$, of G is the minimum possible number of vertices chosen when Dominator starts the game and both players play according to the rules. Kinnersley, West, and Zamani posted the 3/5-Conjecture that if G is an isolate-free graph of order n, then $\gamma_g(G) \leq \frac{3}{5}n$. We prove this conjecture for graphs with minimum degree at least 2. The total version of the domination game is defined analogously except that each chosen vertex totally dominates at least one vertex not totally dominated by the vertices previously chosen. The game total domination number, $\gamma_{tg}(G)$, of G is the number of vertices chosen when Dominator starts the game and both players play according to the rules. We determine exactly the game total domination number played on a path or a cycle. More generally, we prove that if G is a graph on n vertices in which every component contains at least three vertices, then $\gamma_{tg}(G) \leq \frac{4}{5}n$.

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LARGEST UNION-INTERSECTING FAMILIES

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János Körner asked the following question. Let $[n] = \{1, 2, \ldots, n\}$ and let $\mathcal{F} \subset 2^{[n]}$ be a family of its subsets. It is called union-intersecting if $(F_1 \cup F_2) \cap (F_3 \cup F_4)$ is non-empty whenever $F_1, F_2, F_3, F_4 \in \mathcal{F}$ and $F_1 \neq F_2, F_3 \neq F_4$. What is the maximum size of a union-intersecting family? This question is answered in the present paper. The optimal construction when n is odd consists of all subsets of size at least $\frac{n-1}{2}$ while in the case of even n it consists of all sets of size at least $\frac{n}{2}$ and sets of size $\frac{n}{2} - 1$ containing a fixed element, say 1. We also proved some extensions, variants and analogues of this statement. The following one is an example. Suppose that $\mathcal{F}$ is a union-intersecting family of k-element subsets of $[n]$. We found that the optimal construction for this problem consists of all k-element subsets of size k containing the element 1, and one more additional set, if for $n > n(k)$. The results were jointly achieved with Dániel T. Nagy.

SOME COMPUTATIONAL AND THEORETICAL PROBLEMS CONCERNING RAMSEY NUMBERS

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We discuss some computational challenges and related open questions concerning classical Ramsey numbers. This talk overviews known constructive bounds for the difference between consecutive Ramsey numbers and presents what is known about the most studied cases including $R(5,5)$ and $R(3,3,4)$. Although the main problems we discuss are concerned with concrete cases, and they involve significant computational approaches, there are interesting and important theoretical questions behind each of them.

K-DOMINATING AND K-INDEPENDENT GRAPHS OF SPECIFIC GRAPHS

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Let $G = (V, E)$ be a graph. A set $S \subseteq V(G)$ is a dominating set of G, if every vertex in $V(G)\backslash S$ is adjacent to at least one vertex in S. The *domination number* $\gamma(G)$ is the minimum cardinality of a dominating set in G. Suppose that $k \geq \gamma(G)$. The k-dominating graph of G, $D_k(G)$, is defined to be the graph whose vertices correspond to the dominating sets of G that have cardinality at most k. Two vertices in $D_k(G)$ are adjacent if and only if the corresponding dominating sets of G differ by either adding or deleting a single vertex. Similar to k-dominating graph of G, we consider independent sets of G and introduce the k-independent graph of G, $I_k(G)$, for $k \leq \alpha(G)$, where $\alpha(G)$ is the independence number of G. In this talk, we present some new results on these two kind of graphs.

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NEIGHBOR RUPTURE DEGREE OF HARARY GRAPHS

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The vulnerability shows the strength of the network until the communication decay after the corruption of certain stations or communication links. If a station or an agent is exposed in a spy network, then the adjacent stations will be deceived and are therefore unuseful in the network. A network can be modeled by a graph, then the some graph parameters can be used to obtain the vulnerability of a spy network. A vulnerability parameter which concerns the neighborhoods is the neighbor rupture degree. The neighbor rupture degree of a noncomplete connected graph G is defined to be

$$Nr(G) = \max\{w(G/S) - |S| - c(G/S) : S \subset V(G), w(G/S) \geq 1\}$$

where S is any vertex subversion strategy of G, $w(G/S)$ is the number of connected components in G/S, and $c(G/S)$ is the maximum order of the components of G/S. In this paper, the neighbor rupture degree of Harary graphs which have the maximum possible connectivity with the minimum number of edges are obtained.

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RAMSEY NUMBERS FOR PATHS VERSUS SELECTED GRAPHS

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Let F and H be two graphs. The *Ramsey number* $R(F, H)$, is defined as the least integer n such that for every graph G of order n either G contains F or $\overline{G}$ contains H as a subgraph, where $\overline{G}$ is the complement of G. We study $R(F, H)$ with F isomorphic to a path and H belonging to a family of graphs. We show some new results concerning Ramsey numbers for paths versus selected graphs.

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HOW TO COUNT HARMONIOUS COLOURINGS OF GRAPHS?

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A λ-*harmonious colouring* of a graph G is a mapping from $V(G)$ into $\{1, \ldots, \lambda\}$ that assigns colours to the vertices of G such that each vertex has exactly one colour, adjacent vertices have different colours, and any two edges have different colour pairs. The *harmonious chromatic number* $h(G)$ of a graph G is the least positive integer λ, such that there exists a λ-harmonious colouring of G.

Let $h(G, \lambda)$ denote the number of all λ-harmonious colourings of G. In this work we analyse the expression $h(G, \lambda)$ as a function of a variable λ. We observe that this is a polynomial in λ of degree $|V(G)|$ with a zero constant term. Moreover, we present a reduction formula for calculating $h(G, \lambda)$. Using reducing steps we show the meaning of some coefficients of $h(G, \lambda)$ and prove the Nordhaus-Gaddum type theorem, which states that for a graph G with diameter greater than two

$$h(G) + \frac{1}{2}\chi(\overline{G^2}) \leq |V(G)|,$$

where $\chi(\overline{G^2})$ is the chromatic number of the complement of the square of a graph G. Also the notion of harmonious uniqueness is discussed.

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COMPETITIVE GRAPH COLORING

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The *r-coloring game* is played between two players, Alice and Bob, on a finite graph G with a set X of r colors. In this game, a color $\alpha \in X$ is *legal* for a vertex v, if v does not have a neighbor colored with α. Play begins with Alice coloring an uncolored vertex with a legal color, and progresses with Alice and Bob alternating turns coloring uncolored vertices with legal colors from X. If at any point there is an uncolored vertex that does not have a legal color available, Bob wins. Otherwise, Alice will win once every vertex becomes colored. The *game chromatic number* of a graph G, denoted $\chi_{\mathrm{g}}(G)$, is the least r such that Alice has a winning strategy when the r-coloring game is played on G. In this presentation, we will examine variations of this coloring game in which the definition of *legal* is varied. In addition, we consider variations of the game in which edges and/or vertices are colored. For each version of the game, we will find bounds on the associated parameter for certain classes of graphs, such as trees, forests, outerplanar graphs, and planar graphs.

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HAMILTONIAN CYCLES THROUGH SPECIFIED EDGES

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We consider only finite graphs without loops and multiple edges. Let $k \geqslant 1$. We shall call a set of k independent edges a *k-matching.* We call S *a path system of length k* if the connected components of S are independent paths whose sum of lengths is equal k. By the *claw* we mean the complete bipartite graph $K_{1,3}$. A graph G is said to be *claw-free* if it does not contain an induced subgraph that is isomorphic to the claw $K_{1,3}$.

Several results concerning hamiltonian cycles through specified edges of a graph G will be presented. In particular we characterize for every $k \geqslant 1$ all $(l+3)$-connected graphs G on $n \geqslant 3$ vertices satisfying: $\mathrm{d}(x, y) = 2 \;\Rightarrow\; \max\{\mathrm{d}(x), \mathrm{d}(y)\} \geqslant \frac{n+k}{2}$, for each pair of vertices x and y in $V(G)$, such that there is a path system S of length k with l internal vertices such that S is not contained in any hamiltonian cycle of G and a degree sum condition for triples of independent vertices under which every matching of a claw-free graph is contained in a hamiltonian cycle will be presented.

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CONFIGURATIONS OF POINTS AND LINES AND GRAPHS LEVI

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Nowadays in the algebraic geometry there is an increasing number of methods serving to examine the basic objects which come from combinatorial analysis and graph theory that in a surprising manner allow to obtain many significant results as well as to understand better the structures of some spaces which parameterize certain objects. The aim of the paper will be to present a new approach towards the examination of straight line configuration (or curves in the general case) on the projective plane using the tools offered by the graph theory, which has already been mentioned, and commutative algebra. For certain straight line configuration we create a Levi graph which describes incidences between the points and straight lines of the configuration. For such a constructed graph we consider the edge ideal, which codes algebraic information. In this paper we will provide a detailed consideration of the straight lines going thorugh one point, we will calculate the free resolvent of the edge ideal and then we will calculate its Castelnuovo-Mumford regularity, an important invariant used in both commutative algebra and algebraic geometry.

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STRONG RESOLVABILITY IN GRAPHS

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Given a simple and connected graph $G = (V, E)$, the distance $d(x, y)$ between two vertices $x, y \in V(G)$ is the length of a shortest $x - y$ path. A vertex $w \in V(G)$ *strongly resolves* two vertices $u, v \in V(G)$, if $d(w, u) = d(w, v) + d(v, u)$ or $d(w, v) = d(w, u) + d(u, v)$, *i.e.*, there exists some shortest $w - u$ path containing v or some shortest $w - v$ path containing u. A set S of vertices in a connected graph G is a *strong metric generator* for G if every two vertices of G are strongly resolved by some vertex of S. The smallest cardinality of a strong metric generator for G is called *strong metric dimension* and is denoted by $dim_s(G)$ (see [1]).

In concordance with the above metric parameter, the following concept was introduced in [2]. For a vertex x and a set W of G, the distance between x and W is defined as $d(x, W) = \min\{d(x, w) : w \in W\}$. It is said that a set W of vertices of G *strongly resolves* two different vertices $x, y \notin W$, if either $d(x, W) = d(x, y) + d(y, W)$ or $d(y, W) = d(y, x) + d(x, W)$. An ordered vertex partition $\Pi = \{U_1, U_2, ..., U_k\}$ of the vertex set $V(G)$ is a *strong resolving partition* for G if every two different vertices of G belonging to the same set of the partition Π are strongly resolved by some set of Π. The minimum cardinality of any strong resolving partition is the *strong partition dimension* of G, which is denoted by $pd_s(G)$.

In this work, several issues regarding the strong (metric or partition) dimension of graphs are addressed.

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RAINBOW CYCLES IN SPLIT GRAPH

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A subgraph of an edge-coloured graph is *rainbow* if all of its edges have different colours. For graphs G and H the *anti-Ramsey number* $ar(G, H)$ is the maximum number of colours in an edge-colouring of G with no rainbow copy of H. The notion was introduced by Erdős, Simonovits and V. Sós and studied in case $G = K_n$. Afterwards exact values or bounds for anti-Ramsey numbers $ar(K_n, H)$ were established for various H among others by Alon, Jiang & West, Montellano-Ballesteros & Neumann-Lara, Schiermeyer. There are also results concernig bipartite graphs, cubes or product of cycles as G obtained by Axenovich, Li, Montellano-Ballesteros, Schiermeyer and others. In the talk the survey of these results will be given. Also results concerning anti-Ramsey numbers for cycles in complete split graphs will be presented.

CONFIGURATIONS AND ORBITAL MATRICES

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Configurations are linear regular uniform hypergraphs, mainly discussed in a geometrical language, and closely related to bipartite graphs, combinatorial designs and similar structures. A small but already quite interesting example is the Fano configuration with 7 points and 7 lines, corresponding to the Heawood graph. In order to exist the parameters of a configuration have to fulfill certain necessary conditions. In general, it has to be investigated whether these conditions are also sufficient, and if yes, how many non-isomorphic structures there are and what properties they have. The current knowledge concerning existence, enumeration, etc. will be discussed. Also more general structures such as lambda-configurations will be considered. For further information see the corresponding chapter in the Handbook of Combinatorial Designs. Orbital matrices are generalizations of symmetric designs. They are described by their incidence matrices. The main difference is that these matrices not only contain the entries 0 and 1 but also greater integers. Somehow a point lies on a line more than once whatever this may mean geometrically. In matrix and design theory (and in graph theory if you will) the results are comparable to symmetric designs, however there more non-existence results, not only by Bruck-Ryser-Chowla. Altogether this talk is meant to be making configurations and orbital matrices better known to Polish graph theorists, but also to participants from other countries in the Gdask workshop. In particular, there is probably a certain Polish contribution to configurations in history.

CIRCULAR, FRACTIONAL AND J-FOLD COLORINGS OF THE PLANE.

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We consider the circular and the fractional version of the famous Nelson-Hadwiger problem, i.e. the problem of finding the chromatic number of the graph G_1 whose vertices are all points of the plane and edges join all pairs of points at distance equal to 1. It is known that the number is at least 4 and at most 7.

An r-circular coloring of a graph G is an assignment of arcs of length 1 of a circle of perimeter r to vertices of G in such a way that adjacent vertices get disjoint arcs. The circular chromatic number of G is the infimum over all r such that there exists an r-circular coloring of G. We show that the r-circular chromatic number of the graph G_1 does not exceed $4 + \frac{4\sqrt{3}}{3} \approx 6.30$. It is the first result that improves the upper bound of 7 for this number. The lower bound equal to 4 was proved by Devos at al. [1].

A j-fold colouring of a graph is an assignment of j-elemental sets of colors to its vertices in such a way that the sets assigned to any two adjacent vertices are disjoint. We construct some j-fold colorings of the plane for small j in particular we show 2-fold and 3-fold colorings with 12 and 16 colors, respectively. For large values of j a j-fold coloring is closely related to a fractional coloring of the plane (see [3]).

Moreover, we generalize the above results for a graph $G_{[a,b]}$ (introduced by Exoo [2]) whose vertex set is the set of all points of the plane, and the edge set consists of all pairs of points at distance from the interval $[a, b]$.

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A NEW ALGORITHM TO FIND K SHORTEST S-T PATH IN DIGRAPHS

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We give an algorithm to find the k shortest simple paths connecting a certain pair of nodes, s and t, in an acyclic digraph. First the nodes of the graph are labeled according to the topological ordering. Then for node i an ordered list of simple $s-i$ paths is created. The length of the list is at most k and it is created by using tournament trees. We prove the correctness of the algorithm and show that its worst-case complexity is $O(m + kn \log d)$ in which n is the number of nodes and m is the number of arcs and d is the mean degree of the graph. The algorithm has a space complexity of $O(k\Delta)$ in which Δ is the maximum degree of the graph.

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TOTAL DOMINATOR COLORING IN GRAPHS

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Given a graph G, a total dominator coloring of a graph G is a proper coloring of the vertices of G in which each vertex of the graph is adjacent to every vertex of some color class. The total dominator chromatic number $\chi_d^t(G)$ of G is the minimum number of color classes in a total dominator coloring of G. This concept have introduced in [2], and continued in [1, 3, 4]. It is shown that the finding of the total dominator chromatic number of a graph is NP-complete, and for any without isolated vertices graph G of order n, $\gamma_t(G) \leq \chi_d^t(G) \leq n$, where $\gamma_t(G)$ denotes the total domination number of G. Also the exact amount of the total dominator chromatic number of trees, cycles, paths and wheels are given [2]. In this talk, we discuss on the relation between the total dominator chromatic number of the cross and Cartesian product of two graphs in according to the same number of each of the graphs. Showing that the total dominator chromatic number of the Mycieleskian of a graph G is between $\chi_d^t(G) + 1$ and $\chi_d^t(G) + 2$ will be our next work.

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DOMINATION STABILITY IN GRAPHS

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A subset D of the set of vertices of a graph G is a dominating set if any vertex not in D is adjacent to some vertex of D. The domination number $\gamma(G)$ is the minimum cardinality of a dominating set of G. The concept of domination stability was introduced in [1]. The domination stability, or just γ-stability of a graph G is the minimum number of vertices whose removal changes the domination number. We show that the decision problem for domination stability is NP-complete even when restricted to bipartite graphs, and we determine domination stability for several classes of graphs. We present several sharp bounds for the domination stability and we characterize graphs achieving equality of the bounds. In particular, we characterize all trees with domination stability 1 or 2. We also consider this concept for several domination parameters.

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DISMANTLING LONGEST CYCLES IN DIGRAPHS

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Let D be a digraph (symmetric arcs are allowed). An oriented graph is a digraph without symmetric arcs. The circumference of a digraph D, denoted by $c(D)$, is defined as the length of a longest directed cycle in D , if D has a directed cycle. If D is acyclic, then $c(D) = 0$. In this talk, we consider the problem of destroying all longest cycles of a digraph with $c(D) \in \{2, 3\}$. It is proved that this can be done by removing at most $\frac{1}{c(D)}$ of the vertices. The result is not longer valid for $c(D) \geq 4$. We show an infinite family of digraphs of circumference 4 such that we need $\frac{1}{3}$ of the vertices to destroy all directed cycles of length 4. The case of digraphs of circumference greater than 4 is also discussed. Finally, a conjecture is posed for the problem in the case of oriented graphs. This work is part of paper [1], whose main results were obtained in a spring meeting of the authors at Salt Rock, South Africa in 2013.

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ON THE DOMINATION NUMBERS OF ZERO DIVISOR GRAPH OF COMMUTATIVE RINGS

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Let R be a commutative ring with identity. The *zero-divisor graph* $\Gamma(R)$ of a ring R, is an undirected graph whose vertices are all elements of $Z(R) \setminus \{0\}$ such that there is an edge between vertices a and b if and only if $a \neq b$ and $ab = 0$.
In this talk, we investigate the domination, total domination and semi-total domination numbers of a zero-divisor graph of a commutative Noetherian ring. Also, some relations between the domination numbers of $\Gamma(R/I)$ and $\Gamma_I(R)$, and the domination numbers of $\Gamma(R)$ and $\Gamma(R[x, \alpha, \delta])$, where $R[x, \alpha, \delta]$ is the Ore extension of R, are studied.
This is a joint work with Sima Kiani and Reza Nikandish.

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INTERVAL INCIDENCE COLORING OF GRAPHS AND ITS APPLICATIONS

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In the talk we give a survey of our recent results on the *interval incidence coloring* problem [2, 3, 4] and its applications [1]. We compare our model with the model of *incidentor* coloring, which was widely studied by Pyatkin and Vizing (e.g. [5, 6]).

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SECURE DEFENSIVE STRUCTURES IN GRAPHS

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In the talk we give a survey of our recent results on the minimum global defensive structures: alliances [4, 6], edge alliances [5], defensive sets [3, 6] and secure sets [7].

For a given graph G and a subset S of a vertex set of G we define for every subset X of S the predicate $SEC(X) = true$ iff $|N[X] \cap S| \geq |N[X] \setminus S|$ holds, where $N[X]$ is a closed neighbourhood of X in G.

Set S is an *alliance* iff for each vertex $v \in S$ we have $SEC(\{v\}) = true$. If S is also a dominating set of G (i.e. $N[S] = V(G)$), we say that S is a *global alliance*.

Set S is an *edge alliance* iff $G[S]$ has no isolated vertices and for each edge $e = \{v, u\} \in E(G[S])$ we have $SEC(\{v, u\}) = true$. Set S is a *global edge alliance* if it also dominates G.

Set S is a *defensive set* in G iff for each vertex $v \in S$ we have $SEC(\{v\}) = true$ or there exists a neighbour u of v such that $u \in S$ and $SEC(\{v, u\}) = true$. Similarly, if set S is also a dominating set of G, we say that S is a *global defensive set*.

A set S is *secure* if and only if for each subset $X \subset S$ we have $SEC(X) = true$. If set S is also a dominating set of G, we say S is a *global secure set*.

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ON THE SUPER EDGE-MAGIC DEFICIENCY OF GRAPHS

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A graph G of order p and size q is called *super edge-magic* if there exists a bijection $f : V(G) \cup E(G) \to \{1, 2, 3, \cdots, p+q\}$ such that $f(x) + f(xy) + f(y)$ is a constant for every edge $xy \in E(G)$ and $f(V(G)) = \{1, 2, 3, \cdots, p\}$. The notion of a super edge-magic graph was first introduced by Enomoto *et al* [1]. Furthermore, Figueroa-Centeno *et al* [2] introduced the concept of super edge-magic deficiency of a graph as follows. The *super edge-magic deficiency* of a graph G, $\mu_s(G)$, is either the minimum nonnegative integer n such that $G \cup nK_1$ is super edge-magic or $+\infty$ if there exists no such integer n.

In this talk, we study the super edge-magic deficiency of join product graphs. We found a lower bound of the super edge-magic deficiency of join product of two graphs and an upper bound of the super edge-magic deficiency of join product of super edge-magic graphs with isolated vertices. This upper bound is better than the upper bound presented in [3]. We also study the super edge-magic deficiency of other graphs.

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A REMARK OF TOPOLOGICAL INDEX ON GRASSMANN GRAPHS

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In this work, we study some algebraic properties of a vertex-transitive graph G and the end, we compute Wiener index W(G), Harary index H(G) and reciprocal degree distance index RDD(G) for Grassmann graphs. The reciprocal degree distance is a new topological index that is defined by Hua et al. as $RDD(G) = \Sigma_{\{u,v\}\subseteq V(G)}(d(u)+d(v))[d(u,v)]^{-1}$, where the d(u,v) denotes the distance between vertices u and v.

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THE DENSITY TURÁN PROBLEM FOR SOME UNIFORM HYPERGRAPHS

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Let $\mathcal{H} = (V, \mathcal{E})$ be a 3-uniform linear hypergraph. Consider a blow-up hypergraph $\mathcal{B}[\mathcal{H}]$.

We present an efficient algorithm to decide whether a given set of hyperedge densities $\{\gamma_e\}_{e \in \mathcal{E}(\mathcal{H})}$ ensures the existence of a hypergraph $\mathcal{H}$ in the blow-up hypergraph $\mathcal{B}[\mathcal{H}]$ or does not ensure. In this way we extend some results presented in papers [1]-[3].

We show some results for 3-uniform linear hypertrees and for 3-uniform unihypercyclic linear hypergraphs with hypercycle $\mathcal{C}_3$.

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ON 3-COLOR RAMSEY NUMBER OF LOOSE CYCLES

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For given k-uniform hypergraphs $\mathcal{H}_1, \mathcal{H}_2, \ldots, \mathcal{H}_t$, the *t-color Ramsey number* $R(\mathcal{H}_1, \mathcal{H}_2, \ldots, \mathcal{H}_t)$ is the smallest integer N such that in every t-coloring of the hyperedges of the complete k-uniform hypergraph $\mathcal{K}_N^k$ there is a monochromatic copy of $\mathcal{H}_i$ in color i, for some i, $1 \leq i \leq t$. By the k-uniform loose cycle $\mathcal{C}_n^k$ we mean the hypergraph with vertex set $\{v_1, v_2, \ldots, v_n(k-1)\}$ and with the set of n hyperedges $e_i = \{v_1, v_2, \ldots, v_k\} + i(k-1)$, $i = 0, 1, \ldots, n-1$, where we use mod n arithmetic and adding a number t to a set $H = \{v_1, v_2, \ldots, v_k\}$ means a shift, i.e. the set obtained by adding t to subscripts of each element of H. Exact values of the 2-color Ramsey numbers for 3-uniform loose cycles were determined recently. Here we determine the 3-color Ramsey number of 3-uniform loose cycles in some cases.

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ON THE (N, K)-DISTRIBUTIVE GRAPHS

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Let, $n \geq 1$ and $k \geq 1$ be non-negative integers, then we denote each distribution of n identical objects in k distinct boxes, by a nondeacrasing n-bit string $a_1a_2 \cdots a_n$, where $1 \leq a_1 \leq a_2 \cdots \leq a_n \leq k$.Now, construct a graph in which its vertices are coresponding to this n-strings and two vertices are adjacent if their corresponding n-strings differ in one digit.We denote this graph by D_k^n and called a (n, k)- Distributive graph.The (n, k)-distributive graphs have recurrent structures.In this paper, we introduce some structural properties of this graphs.

Keywords:solutions of linear equations,recurrent structure, Tower of Hanoi,labbeling of a graph.

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HAMMING DISTANCE K-LABELING OF GRAPHS

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Let S be a set of q elements and d be a positive integer. The Hamming graph $H(d, q)$ has vertex set S^d, the set of ordered d-tuples of elements of S and two vertices are adjacent if they differ in precisely one coordinate. This concept was motivated by the study of error-correcting codes and association schemes. Inspired from the relevance of the Hamming graph, in this paper, we introduce the notion of the *Hamming distance k-labeling* of graph and its empirical study demonstrates that every graph admits the Hamming distance 2-labeling. In particular, we characterize the graphs which admit the Hamming distance 1-labeling. The methodology is a blending of graph theoretic and linear algebra techniques.

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THE LOCATING CHROMATIC NUMBER OF REGULAR BIPARTITE GRAPHS

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The *locating chromatic number* of a graph G is defined as the cardinality of minimum resolving partition of the vertex set of G such that every partition does not contain two adjacent vertices, and all vertices have different distance coordinate to all partition classes. A bipartite graph $G(n, n)$ is a graph whose vertex set V can be partitioned into two subsets V_1 and V_2 with $|V_1| = |V_2| = n$ such that every edge of $G(n, n)$ joins V_1 and V_2. A graph G is called k-regular graph if every vertex of G is adjacent to k other vertices of G. In this paper, we determine the locating chromatic number of k-regular bipartite graphs $G(n, n)$ where $k = n-1$ or $k = n-2$.

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ON THE JUMP NUMBER OF TWO-DIMENSIONAL POSETS

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The jump number problem for posets is to find a linear extension in which the number of incomparable adjacent pairs is minimized. Computation of the jump number is NP-hard even on posets of height 1 [2]. In this work the class of two-dimensional posets is considered. As observed by Ceroi [1], for two-dimensional posets the jump number can be interpreted as the problem of finding a maximum weight independent set of a family of axis-parallel rectangles corresponding to certain chains of the poset. The purpose of this talk is to discuss algorithmic conclusions from this reduction. In particular, we propose a tabu-search algorithm which extends the semi-strongly greedy algorithm [3].

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GRAPHS WITH EQUAL VERTEX COVER AND TOTAL DOMINATION NUMBER

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A vertex cover of a graph $G = (V, E)$ is a set $X \subseteq V$ such that each edge of G is incident to at least one vertex of X. The vertex cover number $\tau(G)$ is the size of a minimum vertex cover of G. A dominating set $D \subseteq V$ is a total dominating set of G if the subgraph $G[D]$ induced by D, has no isolates. The total domination number $\gamma_t(G)$ of G is the minimum cardinality among all total dominating sets of G. In this talk we study the relationship between these two parameters and characterize the trees having a γ_t-set which is also a τ-set.

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