About IPM and its School of Mathematics

The Institute for Research in Fundamental Sciences (IPM) is an institute affiliated with the Ministry of Science, Research, and Technology. It was founded in 1989 under the name "Institute for Studies in Theoretical Physics and Mathematics" and its initial goal was the advancement of research and innovation in theoretical physics and mathematics. The foundation of the Institute was also accompanied by hopes and expectations that a model would be developed which could serve as a basis for the promotion of the culture of research all across the country.

The Institute started its activities with three research groups in physics and three research groups in mathematics (Combinatorics and Computing, Dynamical Systems, and Mathematical Logic & Theoretical Computer Science). Initially it had few researchers and limited resources, but gradually it managed to expand its manpower in physics and mathematics, and it also attracted scientists from other disciplines. The activities of the Institute thus extended to other fields and in 1997 it acquired its present name. The Institute now consists of nine schools: Analytic Philosophy, Astronomy, Biological Sciences, Cognitive Sciences, Computer Science, Mathematics, Nano-Science, Particles and Accelerator, and Physics. It enjoys an expanding base of infrastructures and facilities (electronic networking, computers, laboratories, a well-equipped and up-to-date library), and has an active presence in the national research activities within the corresponding fields.

The School of Mathematics (formerly called the Section of Mathematics) has been one of the founder schools of IPM. Presently, there are three main research areas at the School: Combinatorics and Computing, Commutative Algebra, and Mathematical Logic. Different research modalities are available at the School of Mathematics: Founding Fellows, Faculty Members, Postdoctoral Research Fellows, Senior Associate Researchers, Junior Associate Researchers, Non-resident Researchers, and Student Researchers in full-time, part-time, and non-resident modes.

About the Conference

The purpose of the IPMCCC is to bring together researchers and individuals interested in all areas of combinatorics and computer sciences, to discuss the latest developments and findings in their areas, take stock of what remains to be done and explore different visions for setting the direction for future work.

Scientific Committee

- **Omran Ahmadi** (IPM, Iran)
- **Salman Beigi** (IPM, Iran)
- **Richard A. Brualdi** (University of Wisconsin-Madison, USA)
- **Hadi Kharaghani** (University of Lethbridge, CANADA)
- **Bojan Mohar** (Simon Fraser University, CANADA)
- **Qing Xiang** (University of Delaware, USA)
- **Behruz Tayfeh-Rezaie** (IPM, Iran)

Organizing Committee

- **Omran Ahmadi** (IPM, Iran)
- **Salman Beigi** (IPM, Iran)
- **Behruz Tayfeh-Rezaie** (IPM, Iran)

Invited Speakers

- **Peyman Afshani**, Aarhus University, Denmark
  Email: peyman@madalgo.au.dk
- **Omid Etesami**, IPM, Iran
  Email: etesami@gmail.com
- **Luis Goddyn**, Simon Fraser University, Canada
  Email: goddyn@math.sfu.ca
- **Hossein Hajiabolhassan**, Shahid Beheshti University & IPM, Iran
  Email: hhaji@sbu.ac.ir
- **Jack Koolen**, University of Science and Technology of China, China
  Email: koolen@ustc.edu.cn
- **Reza Naserasr**, CR1, LRI, Paris-Sud., France
  Email: reza@lri.fr
- **Gholamreza Omidi**, Isfahan University of Technology & IPM, Iran
  Email: romidi@cc.iut.ac.ir
- **Edwin van Dam**, Tilburg University, The Netherlands
  Email: edwin.vandam@tilburguniversity.edu

Contributed Speakers

- **Alireza Abdollahi**, University of Isfahan & IPM, Iran
  Email: alireza_abdollahi@yahoo.com
- **Saeid Alikhani**, Yazd University, Iran
  Email: alikhani@yazd.ac.ir
- **Afshin Behmaram**, University of Tabriz & IPM, Iran
  Email: behmarammath@gmail.com
- **Ameneh Farhadian**, Sharif University of Technology, Iran
  Email: afarhadian@mehr.sharif.ir
- **Florent Foucaud**, Universite Blaise Pascal, France
  Email: florent.foucaud@gmail.com
- **Hamid Reza Golmohammadi**, Tafresh University, Iran
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- **Moharram N. Iradmusa**, Shahid Beheshti University & IPM, Iran
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- **Ghaffar Raeisi**, Shahrekord University & IPM, Iran
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- **Maryam Shahsiah**, IPM, Iran
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- **Hossein Teimoori Faal**, Allameh Tabataba'i University, Iran
  Email: hossein.teimoori@gmail.com
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- **Manouchehr Zaker**, IASBS, Iran
  Email: mzaker@iasbs.ac.ir

Daily Program

IPM Combinatorics and Computing Conference 2015 (IPMCCC 2015)

Wednesday, April 29, 2015

Registration

8:00AM - 8:45AM

Opening Session

8:45AM - 9:00AM

Welcoming Remarks

Morning Session

9:00AM - 12:30PM

9:00AM	*Almost Distance-regular Graphs and Walk-Regularity*
(1)	**Edwin van Dam**, Tilburg University, The Netherlands
10:00AM	Coffee Break
10:30AM	*On a Structure Theory for Graphs with Smallest Eigenvalue* -3
(2)	**Jack Koolen**, University of Science and Technology of China, China
11:30AM	*Groups All of Whose Undirected Cayley Graphs are Determined by Their Spectrum*
(3)	**Alireza Abdollahi**, University of Isfahan, & IPM, Iran
11:50AM	*On Degenerate Degree Sequence of Graphs and its Applications*
(4)	**Manouchehr Zaker**, IASBS, Iran
12:10AM	*Induced Matching and Edge Roman Domination in Regular Graphs*
(5)	**Afshin Behmaram**, University of Tabriz & IPM, Iran

Lunch

12:30PM - 2:00PM

Afternoon Session

2:00pm - 5:50pm

2:00pm *Data Structure Lower Bounds*

(6) **Peyman Afshani**, Aarhus University, Denmark

3:00pm Coffee Break

3:30pm *The Value of Help Bits*

(7) **Omid Etesami**, IPM, Iran

4:30pm *Lyndon Covers and a Multivariate Generalization of the Coin Arrangements Lemma*

(8) **Hossein Teimoori Faal**, Allameh Tabataba'i University, Iran

4:50pm *Finding the Arc- and Non Arc- Disjoint Paths in Networks*

(9) **Mehdi Kadivar**, Iran

5:10pm *Uniform Matroidal Codes*

(10) **Hossein Yekani**, Urmia University, Iran

5:30pm *Optical Computing: One Step Towards Solving the NP Problem in Practice*

(11) **Ameneh Farhadian**, Sharif University of Technology, Iran

Conference Reception

6:00pm - 7:00pm

Daily Program

IPM Combinatorics and Computing Conference 2015 (IPMCCC 2015)

Thursday, April 30, 2015

Morning Session

9:00AM - 12:30PM

9:00AM	*Parity Trackles on Surfaces*
(1)	**Luis Goddyn**, Simon Fraser University, Canada
10:00AM	Coffee Break
10:30AM	*Chromatic Number via Turán Number*
(2)	**Hossein Hajiabolhassan**, Shahid Beheshti University & IPM, Iran
11:30AM	*Location-Domination and Metric Dimension of Interval and Permutation Graphs*
(3)	**Florent Foucaud**, Universite Blaise Pascal, France
11:50AM	*On the k-dominating Graph of Specific Graphs*
(4)	**Saeid Alikhanir**, Yazd University, Iran
12:10AM	*Permutation Representation of graphs*
(5)	**Moharram N. Iradmusa**, Shahid Beheshti University & IPM, Iran

Lunch

12:30PM - 2:00PM

Afternoon Session

2:00PM - 5:50PM

2:00PM	*Homomorphisms of Signed Bipartite Graphs*
(6)	**Reza Naserasr**, CR1, LRI, Paris-Sud., France
3:00PM	Coffee Break
3:30PM	*A Spectral Excess Theorem for Normal Digraphs*
(7)	**Gholamreza Omidi**, Isfahan University of Technology & IPM, Iran
4:30PM	*A New Class of $(k, 6)$-Graphs with Applications in Ramsey Theory*
(8)	**Ghaffar Raeisi**, Shahrekord University & IPM, Iran
4:50PM	*Ramsey Numbers of Loose Cycles in Uniform Hypergraphs*
(9)	**Maryam Shahsiah**, IPM, Iran
5:10PM	*(k, k', k'')-Domination in Graphs*
(10)	**Hamid Reza Golmohammadi**, Tafresh University, Iran

Abstracts

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Groups All of Whose Undirected Cayley Graphs are Determined by Their Spectrum

Alireza Abdollahi
University of Isfahan & IPM, Iran

Let G be a finite group, and S be a subset of $G \setminus \{1\}$ such that $S = S^{-1}$. Suppose that $Cay(G, S)$ is the Cayley graph on G with respect to the set S which is the graph whose vertex set is G and two vertices $a, b \in G$ are adjacent if and only if $ab^{-1} \in S$. The adjacency spectrum $Spec(\Gamma)$ of a graph Γ is the multiset of eigenvalues of its adjacency matrix. A graph Γ is called "determined by its spectrum" (or for short DS) whenever if a graph Γ' has the same spectrum as Γ, then $\Gamma \cong \Gamma'$. We say that the group G is DS (Cay-DS, respectively) whenever if Γ is a Cayley graph over G and $Spec(\Gamma) = Spec(\Gamma')$ for some graph (Cayley graph, respectively) Γ', then $\Gamma \cong \Gamma'$. In this paper, we study finite DS groups and finite Cay-DS groups. In particular we prove that all finite DS groups are solvable and all Sylow p-subgroups of a finite DS group is cyclic for all $p \geq 5$. We also give several infinite families of non Cay-DS solvable groups. In particular we prove that there exist two cospectral non-isomorphic 6-regular Cayley graphs on the dihedral group of order $2p$ for any prime $p \geq 13$.

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Data Structure Lower Bounds

Peyman Afshani
Aarhus University, Denmark

In this talk, we will have a broad look at the landscape of data structure lower bounds. We will begin by introducing some fundamental lower bound models and then move on to demonstrate the key techniques that enable us to prove non-trivial results in each model. These include the pointer machine model, the cell-probe model, the I/O-model, and the semi-group (or group) model. We will also briefly touch the new emerging conditional lower bounds.

Many different open problems will be presented throughout the talk.

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On the k-dominating Graph of Specific Graphs

Saeid Alikhani
Yazd University, Iran

Let $G = (V, E)$ be a graph. A set $S \subseteq V(G)$ is a dominating set, if every vertex in $V(G) \setminus S$ is adjacent to at least one vertex in S. 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. The graph $D_k(G)$ aids in studying the reconfiguration problem for dominating sets. In this paper we consider and study the n-dominating graph of specific graphs.

This talk is based on a joint work with Davood Fatehi.

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Induced Matching and Edge Roman Domination in Regular Graphs

Afshin Behmaram
University of Tabriz & IPM, Iran

An induced matching M of a graph G is a set of edges $M \subseteq E$ such that M is a matching and no two edges of M are joined by an edge of G. we find lower bound for the number of Maximum Induced Matching In regular graph especially in Hypercube and cubic graphs. An edge Roman dominating function of a graph G is a function $f : E(G) \rightarrow \{0, 1, 2\}$ satisfying the condition that every edge e with $f(e) = 0$ is adjacent to some edge e with $f(e) = 2$. we apply our result for induced matching to improve the upper bound of edge roman domination in hypercube and cubic graphs.

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The Value of Help Bits

Omid Etesami
IPM, Iran

Help bits are some extra information about instances of a computational problem that may be helpful in solving those instances. The value of help bits have been studied in worst-case scenarios. We look at the value of help bits in average-case complexity, showing a connection between the information-theoretic entropy of the help bits with the average-case complexity of the computational problem. We also look at the value of help bits in randomized computation settings and relate it to the problem of rate-distortion.

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Optical Computing: One Step Towards Solving the NP Problem in Practice

Ameneh Farhadian
Sharif University of Technology, Iran

Although the Problem of P versus NP is an open problem in theory, but the practical world doesnt wait for theory. It wants a practical solution to solve the problem in application. The optical computing, in spite of being expensive, provides us with solving NP problem in practice for bounded values. The facilities and speed that optics brings us in computing is not comparable with the machines based on electricity. I want to show the ability of optics in computing. In addition, we review some different optical solutions of SAT problem. Finally, a new effective optical method to solve the SAT problem by optics is introduced.

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Location-Domination and Metric Dimension of Interval and Permutation Graphs

Florent Foucaud
Universite Blaise Pascal, France

A locating-dominating set of a graph is a dominating set where every vertex (outside of the dominating set) is dominated by a distinct subset. In other words, it is a set of vertices that distinguishes all pairs of vertices using their neighborhood within the solution set. A resolving set is a set of vertices which distinguishes all pairs of vertices by their respective distances to the vertices of the set. For these two concepts, the goal is to minimize the number of vertices in a solution set. We give bounds that relate the minimum size of a solution set to the order and/or the diameter of interval and permutation graphs. We also discuss the algorithmic complexity of finding an optimal solution given an interval or permutation graph. This is joint work with George B. Mertzios, R. Naserasr, A. Parreau and P. Valicov.

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Parity Trackles on Surfaces

Luis Goddyn
Simon Fraser University, Canada

A drawing of a graph G on a surface X is a *parity thrackle* if every pair of edges properly cross each other an odd number of times. We show that G can be drawn as a parity thrackle on X if and only if it can be drawn on X in such a way that every pair of edges crosses exactly once. A key feature is that G has a 2-cell embedding on another surface whose Euler genus differs from that of X by at most 1, and carrying a particular Z_2-homological intersection form.

This extends work by Cairns and Nikolayevsky (2009) where X is orientable. This also leads to improved upper bounds on the edge density of classical a Conway (1969) thrackle.

This is joint work with Yian Xu.

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(k, k', k'')-Domination in Graphs

Hamid Reza Golmohammadi
Tafresh University, Iran

We introduce and study the concept of (k, k, k) -domination numbers in graphs that contains so many domination parameters in this area. In this way, we conclude and improve many many well-known results in literatures.

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Chromatic Number via Turán Number

Hossein Hajiabolhassan
Shahid Beheshti University & IPM, Iran

For a graph G and a family $\mathcal{F}$ of graphs, the general Kneser graph $\mathrm{KG}(G, \mathcal{F})$ has all subgraphs of G isomorphic to a member of $\mathcal{F}$ as vertex set and two vertices are adjacent if the corresponding subgraphs are edge-disjoint.

In this talk, we introduce a colored version of the generalized Turán number and use that to determine the chromatic number of some families of graphs. In particular, we determine the chromatic number of a large family of matching graphs $\mathrm{KG}(G, M_r)$, where the family M_r consists of a matching of size r. This extends the well-known theorems of Lovász (1978) and Schrijver (1978). Moreover, we show that the chromatic number of the tree dense graph $\mathrm{KG}(G, \mathcal{T}_n)$ is the minimum cut of G, where G is a large dense graph with n vertices and the family $\mathcal{T}_n$ consists of all trees with n vertices. Also, we determine the chromatic number of every Kneser multigraph $\mathrm{KG}(G, \mathcal{F})$ in terms of the generalized Turán Number of G and $\mathcal{F}$, where G is a multigraph such that the multiplicity of each edge is greater than 1 and $\mathcal{F}$ is a family of simple graphs.

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Permutation Representation of Graphs

Moharram N. Iradmusa
Shahid Beheshti University & IPM, Iran

There are many geometric and algebraic representations of graphs. In this talk, we introduce a new representation of graphs by use of permutations and present some results about this representation and related parameters. Let G be a graph. A k-permutation representation of G is a map π of $V(G)$ to symmetric group S_k, such that for any two vertices v and u, $v \sim u$ if and only if there exists $i \in \{1, 2, 3, \cdots, k\}$ such that $\pi(v)(i) = \pi(u)(i)$. We define the permutation number $\pi(G)$ to be the minimum of k such that G has a k-permutation representation.

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Finding the Arc- and Non Arc- Disjoint Paths in Networks

Mehdi Kadivar
—, Iran

Let $G = (N, A)$ be a directed network in which N and A are node and arc sets receptively. We present an algorithm to find the arc- and non arc- disjoint paths in the network. Our method is based on the Minimum Cost Flow (MCF) Problem.

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On a Structure Theory for Graphs with Smallest Eigenvalue -3

Jack Koolen
University of Science and Technology of China, China

In 1976 Cameron et al. showed that a connected graph with smallest eigenvalue at least -2 is either a generalized line graph or the number of vertices is bounded by 36. Hoffman (1977) extended this result to graphs with smallest eigenvalue $> -1-\sqrt{2}$. In this talk I will extend the theory of Hoffman to graphs with smallest eigenvalue at least -3. This talk is based on joint work with Jaeyoung Yang, Qianqian Yang, Aida Abiad.

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Homomorphisms of Signed Bipartite Graphs

Reza Naserasr
CR1, LRI, Paris-Sud., France

I introduce the notion of homomorphisms of signed graphs and show that this notion helps strengthening homomorphism type results for minor closed families such as planar graphs or series parallel graphs. Then I show that the restriction of this notion on the class of signed bipartite graphs still captures the notion of homomorphisms of graphs. I will then present some results and several open questions on this subject.

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A Spectral Excess Theorem for Normal Digraphs

Gholamreza Omidi
Isfahan University of Technology & IPM, Iran

"The spectral excess theorem, a remarkable result due to Fiol and Garriga, states that a connected regular graph with $d+1$ distinct eigenvalues is distance-regular if and only if the average excess (the mean of the numbers of vertices at distance d from every vertex) is equal to the spectral excess (a number that only depends on the spectrum of the graph). In 2012, Lee and Weng gave a generalization of this result in order to make it applicable to nonregular graphs. Up to now, there has been no such characterization for distance-regular digraphs. Motivated by this, we give a variation of the spectral excess theorem for normal digraphs (which is called "SETND" for short), generalizing the above mentioned results for graphs. We show that the average weighted excess (a generalization of the average excess) is, at most, the spectral excess in a connected normal digraph, with equality if and only if the digraph is distance-regular. Distance-regularity of a digraph (also a graph) is in general not determined by its spectrum. As an application of SETND, we show that distance-regularity of a connected normal digraph is determined by the spectrum and the average excess of the digraph. Finally, as another application of SETND, we show that every connected normal digraph G with $d+1$ distinct eigenvalues and diameter D either is a bipartite digraph, is a generalized odd graph or has odd-girth at most $\min\{2d-1, 2D+1\}$. This generalizes a result of Van Dam and Haemers."

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A New Class of $(k, 6)$-Graphs with Applications in Ramsey Theory

Ghaffar Raeisi
Shahrekord University & IPM, Iran

Let $G_1, G_2, \ldots, G_t$ be arbitrary graphs. The Ramsey number $R(G_1, G_2, \ldots, G_t)$ is the smallest positive integer n such that if the edges of the complete graph K_n are partitioned into t disjoint color classes giving t graphs $H_1, H_2, \ldots, H_t$, then at least one H_i has a subgraph isomorphic to G_i. In this paper, a new class of k-regular graphs with girth 6 are presented which provide a lower bound for the Ramsey number of a star versus a quadrangle and in many cases, this lower bound is the exact value for this Ramsey number.

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Ramsey Numbers of Loose Cycles in Uniform Hypergraphs

Maryam Shahsiah
IPM, Iran

A k-uniform loose cycle $\mathcal{C}_n^k$ is a hypergraph with vertex set $\{v_1, v_2, \ldots, v_{n(k-1)}\}$ and with the set of n edges $e_i = \{v_{(i-1)(k-1)+1}, v_{(i-1)(k-1)+2}, \ldots, v_{(i-1)(k-1)+k}\}$, $1 \leq i \leq n$, where we use mod $n(k-1)$ arithmetic. The 2-color Ramsey number $R(\mathcal{C}_n^k, \mathcal{C}_n^k)$ is asymptotically $\frac{1}{2}(2k-1)n$ as has been proved by Gyarfas, Sarkozy and Szemeredi. We investigate to determining the exact value of diagonal Ramsey number of $\mathcal{C}_n^k$ and we show that for $n \geq 2$ and $k \geq 8$

$$R(\mathcal{C}_n^k, \mathcal{C}_n^k) = (k-1)n + \lfloor \frac{n-1}{2} \rfloor.$$

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Lyndon Covers and a Multivariate Generalization of the Coin Arrangements Lemma

Hossein Teimoori Faal
Allameh Tabataba'i University, Iran

In this paper we first give a multiset version of the well-known graph theoretical interpretation of determinant of a matrix as a signed weighted sum over the cycle covers of associated digraph of the matrix. Then, as a direct consequence of this new result, we give a multivariate generalization of the coin arrangements lemma.

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Almost Distance-regular Graphs and Walk-Regularity

Edwin van Dam
Tilburg University, The Netherlands

A t-walk-regular graph is a graph for which the number of walks of given length between two vertices depends only on the distance between these two vertices, as long as this distance is at most t. Such graphs generalize distance-regular graphs and t-arc-transitive graphs. Moreover, 0-walk-regularity is commonly known as walk-regularity, a concept introduced by Godsil and McKay.

Besides mentioning some generalities about t-walk-regular graphs, we will focus on 1- and in particular 2-walk-regular graphs, and study analogues of certain results that are important for distance-regular graphs. We will for example generalize Delsarte's clique bound to 1-walk-regular graphs and Godsil's multiplicity bound to 2-walk-regular graphs.

Uniform Matroidal Codes

Hossein Yekani
Urmia University, Iran

In this talk we construct a new method of structure of uniform codes via uniform matroid representation.this type of codes can lead to study of code decomposition and other applications in obtaining text chiper and enchiper algorithms. therefore,we translate matroid-theoretic result of G. Oxley in representable matroids.

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On Degenerate Degree Sequence of Graphs and its Applications

Manouchehr Zaker
IASBS, Iran

Let G be a graph and v any vertex of G. We define the degenerate degree of v, denoted by $\zeta(v)$ as $\zeta(v) = \max_{H:v\in H} \delta(H)$, where the maximum is taken over all subgraphs of G containing the vertex v. We present a linear time algorithm which determines the degree sequence of any given graph. Given any sequence $\mathcal{D}$ of integers, we obtain a sufficient and necessary condition to determine whether $\mathcal{D}$ is the degenerate degree sequence of some graph. A k-independent set in G is any set S of vertices such that $\Delta(G[S]) \leq k$. The smallest cardinality of any k-independent set is denoted by $\alpha_k(G)$. For $k \in \{1, 2, 3\}$, we obtain a lower bound for $\alpha_{k-1}(G)$ in terms of the degenerate degree sequence of G. The resulting lower bounds improve greatly the famous Caro-Wei bound and also the best known bounds for $\alpha_1(G)$ and $\alpha_2(G)$ for some families of graphs. We also discuss the equality in our bounds. These bounds are achieved by greedy-type algorithms.