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COMMON NEIGHBORHOOD AND NEAR COMMON NEIGHBORHOOD n-SIGRAPHS

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Abstract

In this paper we introduced the new notions eccentric and super eccentric symmetric n-sigraph of a symmetric n-sigraph and its properties are obtained. Also, we obtained the structural characterizations of these notions. Further, we presented some switching equivalent characterizations.

1. Introduction

Unless mentioned or defined otherwise, for all terminology and notion in graph theory the reader is refer to [5]. We consider only finite, simple graphs free from self-loops.

Key Words : *Symmetric n-sigraph, Symmetric n-marked graph, Balance, Switching, Eccentric symmetric n-sigraph, Super eccentric symmetric n-sigraph, Complementation.*

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Let $n \geq 1$ be an integer. An *n-tuple* $(a_1, a_2, ..., a_n)$ is *symmetric*, if $a_k = a_{n-k+1}, 1 \leq k \leq n$. Let $H_n = \{(a_1, a_2, ..., a_n) : a_k \in \{+, -\}, a_k = a_{n-k+1}, 1 \leq k \leq n\}$ be the set of all symmetric n-tuples. Note that H_n is a group under coordinate wise multiplication, and the order of H_n is 2^m, where $m = \lceil \frac{n}{2} \rceil$.

A *symmetric n-sigraph (symmetric n-marked graph)* is an ordered pair $S_n = (G, \sigma)$ ($S_n = (G, \mu)$), where $G = (V, E)$ is a graph called the *underlying graph* of S_n and $\sigma : E \rightarrow H_n$ ($\mu : V \rightarrow H_n$) is a function.

In this paper by an *n-tuple/n-sigraph/n-marked graph* we always mean a symmetric n-tuple/symmetric n-sigraph/symmetric n-marked graph.

An n-tuple $(a_1, a_2, ..., a_n)$ is the *identity n-tuple*, if $a_k = +$, for $1 \leq k \leq n$, otherwise it is a *non-identity n-tuple*. In an n-sigraph $S_n = (G, \sigma)$ an edge labelled with the identity n-tuple is called an *identity edge*, otherwise it is a *non-identity edge*.

Further, in an n-sigraph $S_n = (G, \sigma)$, for any $A \subseteq E(G)$ the *n-tuple* $\sigma(A)$ is the product of the n-tuples on the edges of A.

In [11], the authors defined two notions of balance in n-sigraph $S_n = (G, \sigma)$ as follows (See also R. Rangarajan and P.S.K.Reddy [7]).

Definition. Let $S_n = (G, \sigma)$ be an n-sigraph. Then,

(i) S_n is *identity balanced* (or *i-balanced*), if product of n-tuples on each cycle of S_n is the identity n-tuple, and

(ii) S_n is *balanced*, if every cycle in S_n contains an even number of non-identity edges.

Note: An i-balanced n-sigraph need not be balanced and conversely.

The following characterization of i-balanced n-sigraphs is obtained in [11].

Theorem 1.1 :***(E. Sampathkumar et al. [11])***. An n-sigraph $S_n = (G, \sigma)$ is i-balanced if, and only if, it is possible to assign n-tuples to its vertices such that the n-tuple of each edge uv is equal to the product of the n-tuples of u and v.

In [11], the authors also have defined switching and cycle isomorphism of an n-sigraph $S_n = (G, \sigma)$ as follows: (See also [6], [8-10], [13-23].

Let $S_n = (G, \sigma)$ and $S'_n = (G', \sigma')$, be two n-sigraphs. Then S_n and S'_n are said to be *isomorphic*, if there exists an isomorphism $\phi : G \rightarrow G'$ such that if uv is an edge in S_n with label $(a_1, a_2, ..., a_n)$ then $\phi(u)\phi(v)$ is an edge in S'_n with label $(a_1, a_2, ..., a_n)$.

Given an n-marking μ of an n-sigraph $S_n = (G, \sigma)$, *switching* S_n with respect to μ is the operation of changing the n-tuple of every edge uv of S_n by $\mu(u)\sigma(uv)\mu(v)$. The n-sigraph obtained in this way is denoted by $\mathcal{S}_\mu(S_n)$ and is called the *μ-switched n-sigraph* or just *switched n-sigraph*.

Further, an n-sigraph S_n *switches* to n-sigraph S'_n (or that they are *switching equivalent* to each other), written as $S_n \sim S'_n$, whenever there exists an n-marking of S_n such that $\mathcal{S}_\mu(S_n) \cong S'_n$.

Two n-sigraphs $S_n = (G, \sigma)$ and $S'_n = (G', \sigma')$ are said to be *cycle isomorphic*, if there exists an isomorphism $\phi : G \to G'$ such that the n-tuple $\sigma(C)$ of every cycle C in S_n equals to the n-tuple $\sigma(\phi(C))$ in S'_n. We make use of the following known result (see [11]).

Theorem 1.2 : emph(**E. Sampathkumar et al. [11]**). Given a graph G, any two n-sigraphs with G as underlying graph are switching equivalent if, and only if, they are cycle isomorphic.

Let $S_n = (G, \sigma)$ be an n-sigraph. Consider the n-marking μ on vertices of S defined as follows: each vertex $v \in V$, $\mu(v)$ is the product of the n-tuples on the edges incident at v. *Complement* of S is an n-sigraph $\overline{S_n} = (\overline{G}, \sigma')$, where for any edge $e = uv \in \overline{G}$, $\sigma'(uv) = \mu(u)\mu(v)$. Clearly, $\overline{S_n}$ as defined here is an i-balanced n-sigraph due to Theorem 1.1.

2. Common Neighborhood n-Sigraph of an n-Sigraph

The common neighborhood graph $\mathcal{CN}(G)$ of $G = (V, E)$ is a graph with $V(\mathcal{CN}(G)) = V(G)$ and any two vertices u and v in $\mathcal{CN}(G)$ are joined by an edge if and only if the vertices u and v in G have at least one common neighbor in the graph G. This concept were introduced by A. Alwardi et al. [1].

Motivated by the existing definition of complement of an n-sigraph, we extend the notion of common neighborhood to n-sigraphs as follows:

The *common neighborhood n-sigraph* $\mathcal{CN}(S_n)$ of an n-sigraph $S_n = (G, \sigma)$ is an n-sigraph whose underlying graph is $\mathcal{CN}(G)$ and the n-tuple of any edge uv is $\mathcal{CN}(S_n)$ is $\mu(u)\mu(v)$, where μ is the canonical n-marking of S_n. Further, an n-sigraph $S_n = (G, \sigma)$ is called common neighborhood n-sigraph, if $S_n \cong \mathcal{CN}(S'_n)$ for some n-sigraph S'_n. The following result restricts the class of common neighborhood graphs.

Theorem 2.1 : For any n-sigraph $S_n = (G, \sigma)$, its common neighborhood n-sigraph $\mathcal{CN}(S_n)$ is i-balanced.

Proof : Since the n-tuple of any edge uv in $\mathcal{CN}(S_n)$ is $\mu(u)\mu(v)$, where μ is the canonical n-marking of S_n, by Theorem 1.1, $\mathcal{CN}(S_n)$ is i-balanced. □

For any positive integer k, the k^{th} iterated common neighborhood n-sigraph $\mathcal{CN}(S_n)$ of S_n is defined as follows:

$$(\mathcal{CN})^0(S_n) = S_n,\ (\mathcal{CN})^k(S_n) = \mathcal{CN}((\mathcal{CN})^{k-1}(S_n)).$$

Corollary 2.2 : For any n-sigraph $S_n = (G, \sigma)$ and any positive integer k, $(\mathcal{CN})^k(S_n)$ is i-balanced.

The following result characterize n-sigraphs which are common neighborhood n-sigraphs.

Theorem 2.3 : An n-sigraph $S_n = (G, \sigma)$ is a common neighborhood n-sigraph if, and only if, S_n is i-balanced n-sigraph and its underlying graph G is a common neighborhood graph.

Proof : Suppose that S_n is i-balanced and G is a $\mathcal{CN}(G)$. Then there exists a graph H such that $\mathcal{CN}(H) \cong G$. Since S_n is i-balanced, by Theorem 1.1, there exists an n-marking μ of G such that each edge uv in S_n satisfies $\sigma(uv) = \mu(u)\mu(v)$. Now consider the n-sigraph $S'_n = (H, \sigma')$, where for any edge e in H, $\sigma'(e)$ is the n-marking of the corresponding vertex in G. Then clearly, $\mathcal{CN}(S'_n) \cong S_n$. Hence S_n is a common neighborhood n-sigraph.

Conversely, suppose that $S_n = (G, \sigma)$ is a common neighborhood n-sigraph. Then there exists an n-sigraph $S'_n = (H, \sigma')$ such that $\mathcal{CN}(S'_n) \cong S_n$. Hence G is the $\mathcal{CN}(G)$ of H and by Theorem 2.1, S_n is i-balanced. □

In [2], the authors remarked that $\mathcal{CN}(G) \cong G$ if and only if G is K_n or $\overline{K_n}$ or C_n. We now characterize the signed graphs such that the common neighborhood n-sigraph and its corresponding n-sigraph are switching equivalent.

Theorem 2.4 : For any n-sigraph $S_n = (G, \sigma)$, the common neighborhood n-sigraph $\mathcal{CN}(S_n)$ and S_n are cycle isomorphic if and only if the underlying of S_n is isomorphic to K_n or $\overline{K_n}$ or C_n and S_n is i-balanced.

Proof : Suppose $\mathcal{CN}(S_n) \sim S_n$. This implies, $\mathcal{CN}(G) \cong G$ and hence G is isomorphic to K_n or $\overline{K_n}$ or C_n. Then $\mathcal{CN}(S_n)$ is i-balanced and hence if S_n is i-unbalanced and its common neighborhood n-sigraph $\mathcal{CN}(S_n)$ being i-balanced can not be switching equivalent to S_n in accordance with Theorem 1.2. Therefore, S_n must be i-balanced.

Conversely, suppose that S_n is an i-balanced n-sigraph with the underlying graph G is isomorphic to K_n or $\overline{K_n}$ or C_n. Then, since $\mathcal{CN}(S_n)$ is i-balanced as per Theorem 2.1 and since $\mathcal{CN}(G) \cong G$, the result follows from Theorem 1.2 again. □

In [4], the authors defined the derived graph of a graph as follows: The derived graph $\mathcal{DR}(G)$ of $G = (V, E)$ is a graph with $V(\mathcal{DR}(G)) = V(G)$ and any two vertices u and v in $\mathcal{DR}(G)$ are joined by an edge if and only if $d(u, v) = 2$ in graph G.

We now define the derived n-sigraph of an n-sigraphs as follows: The *derived n-sigraph* $\mathcal{DR}(S_n)$ of an n-sigraph $S_n = (G, \sigma)$ is an n-sigraph whose underlying graph is $\mathcal{DR}(G)$ and the n-tuple of any edge uv is $\mathcal{DR}(S_n)$ is $\zeta(u)\zeta(v)$, where ζ is the canonical marking of S_n. Further, an n-sigraph $S_n = (G, \sigma)$ is called a derived n-sigraph, if $S_n \cong \mathcal{DR}(S'_n)$ for some n-sigraph S'_n. The following result restricts the class of derived graphs.

Theorem 2.5 : For any n-sigraph $S_n = (G, \sigma)$, its derived n-sigraph $\mathcal{D}\nabla(S_n)$ is i-balanced.

Proof : Since the n-tuple of any edge uv in $\mathcal{DR}(S_n)$ is $\mu(u)\mu(v)$, where μ is the canonical n-marking of S_n, by Theorem 1.1, $\mathcal{DR}(S_n)$ is i-balanced. □

For any positive integer k, the k^{th} iterated derived n-sigraph $\mathcal{DR}(S_n)$ of S_n is defined as follows:

$$(\mathcal{DR})^0(S_n) = S_n,\ (\mathcal{DR})^k(S_n) = \mathcal{DR}((\mathcal{DR})^{k-1}(S_n)).$$

Corollary 2.6 : For any n-sigraph $S_n = (G, \sigma)$ and any positive integer k, $(\mathcal{DR})^k(S_n)$ is i-balanced.

The following result characterize n-sigraphs which are derived n-sigraphs.

Theorem 2.7 : An n-sigraph $S_n = (G, \sigma)$ is a derived n-sigraph if, and only if, S_n is i-balanced n-sigraph and its underlying graph G is a derived graph.

Proof : Suppose that S_n is i-balanced and G is a $\mathcal{DR}(G)$. Then there exists a graph H such that $\mathcal{DR}(H) \cong G$. Since S_n is i-balanced, by Theorem 1.1, there exists an n-marking μ of G such that each edge uv in S_n satisfies $\sigma(uv) = \mu(u)\mu(v)$. Now consider the n-sigraph $S'_n = (H, \sigma')$, where for any edge e in H, $\sigma'(e)$ is the n-marking of the corresponding vertex in G. Then clearly, $\mathcal{DR}(S'_n) \cong S_n$. Hence S_n is a derived n-sigraph.

Conversely, suppose that $S_n = (G, \sigma)$ is a derived n-sigraph. Then there exists an n-sigraph $S'_n = (H, \sigma')$ such that $\mathcal{DR}(S'_n) \cong S_n$. Hence G is the $\mathcal{DR}(G)$ of H and by Theorem 2.1, S_n is i-balanced. □

We now characterize the n-sigraphs for which $\overline{S_n}$ and $\mathcal{DR}(S_n)$ are cycle isomorphic.

Theorem 2.8 : For any n-sigraph $S_n = (G, \sigma)$, $\mathcal{DR}(S_n)$ and $\overline{S_n}$ are cycle isomorphic if and only if diameter of G is 2.

Proof : Suppose $\mathcal{DR}(S_n) \sim \overline{S_n}$. This implies, $\mathcal{DR}(G) \cong \overline{G}$. Then any pair of non-adjacent vertices is at distance two and hence diameter of G is 2.

Conversely, suppose that S_n is any n-sigraph with diameter of G is 2. Then, $\mathcal{DR}(G) \cong \overline{G}$, and any pair of non-adjacent vertices is at distance two, and these vertices are adjacent in $\mathcal{DR}(G)$. Since for any n-sigraph S_n, both $\mathcal{DR}(S_n)$ and $\overline{S_n}$ are i-balanced, the result follows by Theorem 1.2. □

In [2], the authors remarked that $\mathcal{CN}(G) \cong \mathcal{DR}(G)$ if and only if G is bipartite. We now characterize the n-sigraphs for which: $\mathcal{CN}(S_n)$ and $\mathcal{DR}(S_n)$ are cycle isomorphic.

Thwoewm 2.9 : For any n-sigraph $S_n = (G, \sigma)$, $\mathcal{CN}(S_n)$ and $\mathcal{DR}(S_n)$ are cycle isomorphic if and only if the underlying graph of S_n is bipartite.

Proof : Suppose $\mathcal{CN}(S_n) \sim \mathcal{DR}(S_n)$. This implies, $\mathcal{CN}(G) \cong \mathcal{DR}(G)$. Then G is bipartite.

Conversely, suppose that S_n is any n-sigraph whose underlying graph G is bipartite. Then, $\mathcal{CN}(G) \cong \mathcal{DR}(G)$. Since for any n-sigraph S_n, both $\mathcal{CN}(S_n)$ and $\mathcal{DR}(S_n)$ are i-balanced, the result follows by Theorem 1.2. □

3. Near Common Neighborhood n-Sigraph of an n-Sigraph

Motivated by the existing definition of complement of an n-sigraph, we extend the notion of near common neighborhood to n-sigraphs as follows:

The *near common neighborhood n-sigraph* $\mathcal{NCN}(S_n)$ of an n-sigraph $S_n = (G, \sigma)$ is an n-sigraph whose underlying graph is $\mathcal{NCN}(G)$ and the n-tuple of any edge uv is $\mathcal{NCN}(S_n)$ is $\mu(u)\mu(v)$, where μ is the canonical n-marking of S_n. Further, an n-sigraph $S_n = (G, \sigma)$ is called near common neighborhood n-sigraph, if $S_n \cong \mathcal{NCN}(S'_n)$ for some n-sigraph S'_n. The following result restricts the class of near common neighborhood graphs.

Theorem 3.1 : For any n-sigraph $S_n = (G, \sigma)$, its near common neighborhood n-sigraph $\mathcal{NCN}(S_n)$ is i-balanced.

Proof : Since the n-tuple of any edge uv in $\mathcal{NCN}(S_n)$ is $\mu(u)\mu(v)$, where μ is the canonical n-marking of S_n, by Theorem 1.1, $\mathcal{NCN}(S_n)$ is i-balanced. □

For any positive integer k, the k^{th} iterated near common neighborhood n-sigraph $\mathcal{NCN}(S_n)$ of S_n is defined as follows:

$$(\mathcal{NCN})^0(S_n) = S_n,\ (\mathcal{NCN})^k(S_n) = \mathcal{NCN}((\mathcal{NCN})^{k-1}(S_n)).$$

Corollary 3.2 : For any n-sigraph $S_n = (G, \sigma)$ and any positive integer k, $(\mathcal{NCN})^k(S_n)$ is i-balanced.

The following result characterize n-sigraphs which are near common neighborhood n-sigraphs.

Theorem 3.3 : An n-sigraph $S_n = (G, \sigma)$ is a near common neighborhood n-sigraph if, and only if, S_n is i-balanced n-sigraph and its underlying graph G is a near common neighborhood graph.

Proof : Suppose that S_n is i-balanced and G is a $\mathcal{NCN}(G)$. Then there exists a graph H such that $\mathcal{NCN}(H) \cong G$. Since S_n is i-balanced, by Theorem 1.1, there exists an n-marking μ of G such that each edge uv in S_n satisfies $\sigma(uv) = \mu(u)\mu(v)$. Now consider the n-sigraph $S'_n = (H, \sigma')$, where for any edge e in H, $\sigma'(e)$ is the n-marking of the corresponding vertex in G. Then clearly, $\mathcal{NCN}(S'_n) \cong S_n$. Hence S_n is a near common neighborhood n-sigraph.

Conversely, suppose that $S_n = (G, \sigma)$ is a near common neighborhood n-sigraph. Then there exists an n-sigraph $S'_n = (H, \sigma')$ such that $\mathcal{NCN}(S'_n) \cong S_n$. Hence G is the $\mathcal{NCN}(G)$ of H and by Theorem 2.1, S_n is i-balanced. □

In [3], the proved that, for any graph G, the near common neighborhood graph $\mathcal{NCN}(G)$ and common neighborhood of $\overline{G}$ are isomorphic. In view of this, we have the following:

Theorem 3.4 : For any n-sigraph $S_n = (G, \sigma)$, $\mathcal{NCN}(S_n)$ and $\mathcal{CN}(\overline{S_n})$ are switching equivalent.

In [3], the authors proved the following result:

Theorem 3.5 : For any graph $G = (V, E)$, $\mathcal{NCN}(G)$ and $\mathcal{CN}(G)$ are isomorphic if and only if $G \cong \overline{G}$.

In view of the above the result, we have the following result:

Theorem 3.6 : For any n-sigraph $S_n = (G, \sigma)$, $\mathcal{CN}(S_n)$ and $\mathcal{NCN}(S_n)$ are switching equivalent if and only if $G \cong \overline{G}$.

Proof : Suppose that $\mathcal{CN}(S_n) \sim \mathcal{NCN}(S_n)$. Then clearly, $\mathcal{CN}(G) \sim \mathcal{NCN}(G)$. Hence, G is a self-complementary.

Conversely, suppose that S_n is an n-sigraph whose underlying graph G is self-complementary. Then, $\mathcal{CN}(G) \cong \mathcal{NCN}(G)$. Since for any n-sigraph S_n, both $\mathcal{CN}(S_n)$ and $\mathcal{NCN}(S_n)$ are i-balanced, the result follows by Theorem 1.2. □

In [3], the authors remarked that: $G \cong \mathcal{NCN}(G)$ if and only if G is the complement of strongly regular graph which is bipartite. In view of this, we have the following result:

Theorem 3.7 : For any n-sigraph $S_n = (G, \sigma)$, S_n and $\mathcal{NCN}(S_n)$ are switching equivalent if and only if S_n is i-balanced and G is the complement of strongly regular graph which is bipartite.

Proof : Suppose $\mathcal{NCN}(S_n) \sim S_n$. This implies, $\mathcal{NCN}(G) \cong G$ and hence G is the complement of strongly regular graph which is bipartite. Now, if S_n is any n-sigraph with underlying graph G is the complement of strongly regular graph which is bipartite. Then $\mathcal{NCN}(S_n)$ is i-balanced and hence if S_n is i-unbalanced and its $\mathcal{NCN}(S_n)$ being i-balanced can not be switching equivalent to S_n in accordance with Theorem 1.2. Therefore, S_n must be i-balanced.

Conversely, suppose that S_n is i-balanced n-sigraph with the underlying graph G is the complement of strongly regular graph which is bipartite. Then, $\mathcal{NCN}(G) \cong G$. Since $\mathcal{NCN}(S_n)$ is i-balanced, the result follows from Theorem 1.2 again. □

References

[1] Alwardi A., Soner H. D., Gutman I., On the commonneighborhood energy of a graph, Bull. Acad. Serbe Sci. Arts (Cl. Sci. Math.), 143 (2011), 49-59.

[2] Alwardi A., Branko Arsic, Ivan Gutman, and Soner N. D., The Common Neighborhood Graph and Its Energy, Iran. J. Math. Sci. Inform., 7(2) (2012), 1-8.

[3] Al-Kenani A. N., Alwardi A. and Omar A. Al-Attas, On the Near-Common Neighborhood Graph of a Graph, International Journal of Computer Applications, 149(6) (2016), 1-4.

[4] Ayyaswamy S. K., Balachandran S. and Ivan Gutman, On second-stage spectrum and energy of a graph, Kragujevac J. Math., 34 (2010), 139-146.

[5] Harary F., Graph Theory, Addison-Wesley Publishing Co., (1969).

[6] Lokesha V., Reddy P. S. K. and Vijay S., The triangular line n-sigraph of a symmetric n-sigraph, Advn. Stud. Contemp. Math., 19(1) (2009), 123-129.

[7] Rangarajan R. and Reddy P. S. K., Notions of balance in symmetric n-sigraphs, Proceedings of the Jangjeon Math. Soc., 11(2) (2008), 145-151.

[8] Rangarajan R., Reddy P. S. K. and Subramanya M.S., Switching Equivalence in Symmetric n-Sigraphs, Adv. Stud. Comtemp. Math., 18(1) (2009), 79-85.

[9] Rangarajan R., Reddy P. S. K. and SonerN. D., Switching equivalence in symmetric n-sigraphs-II, J. Orissa Math. Sco., 28 (1 & 2) (2009), 1-12.

[10] Rangarajan R., Reddy P.S.K. and Soner N. D., m^{th} Power Symmetric n-Sigraphs, Italian Journal of Pure & Applied Mathematics, 29(2012), 87-92.

[11] Sampathkumar E., Reddy P.S.K., and Subramanya M. S., Jump symmetric n-sigraph, Proceedings of the Jangjeon Math. Soc., 11(1) (2008), 89-95.

[12] Sampathkumar E., Reddy P.S.K., and Subramanya M. S., The Line n-sigraph of a symmetric n-sigraph, Southeast Asian Bull. Math., 34(5) (2010), 953-958.

[13] Reddy P.S.K. and Prashanth B., Switching equivalence in symmetric n-sigraphs-I, Advances and Applications in Discrete Mathematics, 4(1) (2009), 25-32.

[14] Reddy P.S.K., Vijay S. and Prashanth B., The edge C_4 n-sigraph of a symmetric n-sigraph, Int. Journal of Math. Sci. & Engg. Appls., 3(2) (2009), 21-27.

[15] Reddy P.S.K., Lokesha V. and Gurunath Rao Vaidya, The Line n-sigraph of a symmetric n-sigraph-II, Proceedings of the Jangjeon Math. Soc., 13(3) (2010), 305-312.

[16] Reddy P.S.K., Lokesha V. and Gurunath Rao Vaidya, The Line n-sigraph of a symmetric n-sigraph-III, Int. J. Open Problems in Computer Science and Mathematics, 3(5) (2010), 172-178.

[17] Reddy P.S.K., Lokesha V. and Gurunath Rao Vaidya, Switching equivalence in symmetric n-sigraphs-III, Int. Journal of Math. Sci. & Engg. Appls., 5(1) (2011), 95-101.

[18] Reddy P.S.K., Prashanth B. and Kavita. S. Permi, A Note on Switching in Symmetric n-Sigraphs, Notes on Number Theory and Discrete Mathematics, 17(3) (2011), 22-25.

[19] Reddy P.S.K., Geetha M. C. and Rajanna K. R., Switching Equivalence in Symmetric n-Sigraphs-IV, Scientia Magna, 7(3) (2011), 34-38.

[20] Reddy P.S.K., Nagaraja K. M. and Geetha M. C., The Line n-sigraph of a symmetric n-sigraph-IV, International J. Math. Combin., 1 (2012), 106-112.

[21] Reddy P.S.K., Geetha M. C. and Rajanna K. R., Switching equivalence in symmetric n-sigraphs-V, International J. Math. Combin., 3 (2012), 58-63.

[22] Reddy P.S.K., Nagaraja K. M. and Geetha M. C., The Line n-sigraph of a symmetric n-sigraph-V, Kyungpook Mathematical Journal, 54(1) (2014), 95-101.

[23] Reddy P.S.K., Rajendra R. and Geetha M. C., Boundary n-Signed Graphs, Int. Journal of Math. Sci. & Engg. Appls., 10(2) (2016), 161-168.