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Generalized λ_c-Open Set

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Abstract. In this paper, we define a new class of sets which we call generalized λ_c-closed sets, and we give some of their properties.

Keyword. λ_c-open sets**,** λ_c-closed sets and generalized λ_c-closed sets**.**

Introduction. In 1970 [1], Levine N, defined generalized closed sets in topology. In 1987, Bhattacharyya P. and Lahiri B. K, define Semi-generalized closed set in topology In 1963, Levine [2], defined semi open sets and semi continuous functions in a space *X*, and discussed many of its properties. Sarhad Faiq Namiq & Alias B. Khalaf [3],[4],[5],[6],[7],[8],[9]. They study a new class of semi open sets, which they call a λ-open set and λ_c-open set in topological spaces and also they define the notions of λ-interior, λ-limit point, λ-derived set. In the second section, we define the notions of λ_c-interior, λ_c-limit point and λ_c-derived set of a set and they show that some of their properties are analogous to the properties in open sets. Moreover, we give some additional properties of λ_c-closure and λ_c-interior of a set. We see Willard S., General Topology [10], to study some concepts in topological space.

3.Preliminaries

In 1970 [1], Levine N, defined generalized closed sets in topology. In 1963, Levine [2] defined semi open sets and semi continuous functions in a space *X*. Sarhad Faiq Namiq and Alias B.Khalaf [3],[4],[5],[6], They introduce new classes of semi open sets called λ-open and λ_c-open sets in topological spaces. They consider λ as a function defined on the family of semi-open sets of *X* into the power set of *X* and $\lambda : SO(X) \to P(X)$ is called an s-operation if $V \subseteq \lambda(V)$ for each *V*.

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The followings depended on[3],[4],[5],[6],[7],[8].

Definition 3.1

Let (X,τ) be a topological space and $\lambda : SO(X) \rightarrow P(X)$ be an s-operation. Then a subset *A* of *X* is called a λ-open set if for each $x \in A$ there exists a semi open set *U* such that $x \in U$ and $\lambda(U) \subseteq A$. The complement of a λ-open set is said to be λ-closed. The family of all λ-open (resp. λ-closed) subsets of a topological space (X,τ) is denoted by $SO_{\lambda}(X,\tau)$ or $SO_{\lambda}(X)$ (resp. $SC_{\lambda}(X,\tau)$ or $SC_{\lambda}(X)$).

Definition 3.2

A λ-open subset *A* of a topological space (X,τ) is called λ_c-open if for each $x \in A$ there exists a closed set *F* such that $x \in F \subseteq A$. The complement of a λ_c-open set is said to be λ_c-closed. The family of all λ_c-open (resp. λ_c-closed) subsets of a topological space (X,τ) is denoted by $SO_{\lambda c}(X,\tau)$ or $SO_{\lambda c}(X)$ (resp. $SC_{\lambda c}(X,\tau)$ or $SC_{\lambda c}(X)$).

Remark 3.3

From the definition of s-operation, it is clear that $\lambda(X) = X$ for any s-operation λ. Through out this thesis we assume that $\lambda(\phi) = \phi$, for any s-operation λ.

Definition 3.4

A subset of topological space (X,τ) is said to be λ_c-clopen if it is both λ_c-open and λ_c-closed set. The family of λ_c-clopen sets of *X*, denoted by $CO_{\lambda c}(X)$.

Definition 3.5

Let (X,τ) be a topological space and let *A* be a subset of *X*. Then:

(1) The λ-closure of *A* ($\lambda Cl(A)$) is the intersection of all λ-closed sets containing *A*.

(2) The λ-interior of *A* ($\lambda Int(A)$) is the union of all λ_c-open sets of *X* contained in *A*.

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(3) A point $x \in X$ is said to be a λ-limit point of A if every λ-open set containing x contains a point of A different from x, and the set of all λ-limit points of A is called the λ-derived set of A denoted by $\lambda d(A)$.

Proposition 3.6

Let (X,τ) be a topological space and $A \subseteq X$. For each point $x \in X$, $x \in \lambda Cl(A)$ if and only if $V \cap A \neq \phi$ for every $V \in SO_\lambda(X)$ such that $x \in V$.

Definition 3.7

A subset A of a topological space (X,τ) is called:

(1) A generalized closed set (g-closed) [1], if $A \subseteq U$ and $U \in \tau$ implies that $Cl(A) \subseteq U$,

(2) A semi-generalized closed set (sg-closed) [11], if $A \subseteq U$ and U is semi open implies that $sCl(A) \subseteq U$,

(3) a generalized semi-closed set (gs-closed) [12], if $A \subseteq U$ and $U \in \tau$ implies that $sCl(A) \subseteq U$.

Example 3.8

Let $X = \{a,b,c\}$, and $\tau = \{\phi, \{a,c\}, X\}$. We define an s-operation $\lambda : SO(X) \to P(X)$ as:

$$\lambda(A) = \begin{cases} A & \text{if} \quad A = \{a,c\} \text{ or } \phi \\ X & \text{Otherwise} \end{cases}.$$

Then:

$SO(X) = \{\phi, \{a,c\}, X\}$; $SO_\lambda(X) = \{\phi, \{a,c\}, X\}$; and $SO_{\lambda c}(X) = \{\phi, X\}$;

Here, it is clear that $SO_{\lambda c}(X)$ is indiscrete, but $SO_\lambda(X)$ and $SO(X)$ are not indiscrete.

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Example 3.9

Let $X = \{a,b,c\}$, and $\tau = P(X)$. We define an s-operation $\lambda : SO(X) \to P(X)$ as:

$$\lambda(A) = \begin{cases} A & \text{if } A = \{b\} \text{ or } \{a,b\} \text{ or } \{a,c\} \text{ or } \phi \\ X & \text{Otherwise} \end{cases}.$$

Then we can easily find the following families of sets:

$SO(X) = P(X) = \{\phi, \{a\}, \{b\}, \{c\}, \{a,b\}, \{a,c\}, \{b,c\}, X\}$;

$SO_\lambda(X) = \{\phi, \{b\}, \{a,b\}, \{a,c\}, X\}$;

$SO_{\lambda c}(X) = \{\phi, \{b\}, \{a,b\}, \{a,c\}, X\}$;

Here, it is clear that $SO(X)$ is discrete, but $SO_\lambda(X)$ and $SO_{\lambda c}(X)$ are not discrete.

Proposition 3.10

For subsets A, B of a topological space (X,τ), the following statements are true.

(1) $\lambda_c Cl(A) \cup \lambda_c Cl(B) \subseteq \lambda_c Cl(A \cup B)$.

(2) $\lambda_c Cl(A \cap B) \subseteq \lambda_c Cl(A) \cap \lambda_c Cl(B)$.

Proposition 3.11

For each point $x \in X$, $x \in \lambda_c Cl(A)$ if and only if $V \cap A \neq \phi$, for every $V \in SO_{\lambda c}(X)$ such that $x \in V$.

Proposition 3.12

For any subset A of a topological space (X,τ), The following statements are true.

(1) $X \setminus \lambda_c Int(A) = \lambda_c Cl(X \setminus A)$.

(2) $\lambda_c Cl(A) = X \setminus \lambda_c Int(X \setminus A)$.

(3) $X \setminus \lambda_c Cl(A) = \lambda_c Int(X \setminus A)$.

(4) $\lambda_c Int(A) = X \setminus \lambda_c Cl(X \setminus A)$.

Theorem 3.13

Let A, B be subsets of X. If $\lambda : SO(X) \rightarrow P(X)$ is a λ-regular s-operation Then:

(1) $\lambda_c d(A \cup B) = \lambda_c d(A) \cup \lambda_c d(B)$.

(2) $\lambda_c Cl(A \cup B) = \lambda_c Cl(A) \cup \lambda_c Cl(B)$.

$\lambda_c Int(A \cap B) = \lambda_c Int(A) \cap \lambda_c Int(B)$.

4.Generalized λ_c-Open Set

Definition 4.1

A subset A of a topological space (X, τ) is said to be generalized λ_c-closed (briefly. g-λ_c- closed) if $\lambda_c Cl(A) \subseteq U$, whenever $A \subseteq U$ and U is a λ_c-open set in (X, τ).

We say that a subset B of X is generalized λ_c-open (briefly. g-λ_c-open) if its complement $X \setminus B$ is generalized λ_c-closed in (X, τ).

Remark 4.2

The generalized λ_c-closed set and generalized closed set (resp. semi generalized closed set, generalized semi closed set) are independent, in Example 3.8, we have $\{a,c\}$ is not generalized closed set, semi generalized closed set and generalized semi closed set, but it is generalized λ_c-closed set, and also in Example 3.9, we have $\{a,b\}$ is generalized closed set, semi generalized closed set and generalized semi closed set, but it is not generalized λ_c-closed set.

In the following proposition we show that every λ_c-closed subset of X is g- λ_c-closed.

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Proposition 4.3

Every λ_c-closed set is g-λ_c-closed.

Proof. A set $A \subseteq X$ is λ_c-closed if and only if $\lambda_c Cl(A) = A$. Thus $\lambda_c Cl(A)$ $\subseteq U$ for every $U \in SO_{\lambda c}(X)$ containing A.

The converse of Proposition 4.3 is not true in general and now give an example of a g-λ_c-closed set which is not λ_c-closed.

Example 4.4

Let $X = \{a,b,c\}$, and $\tau = P(X)$. We define an s-operation $\lambda : SO(X)$ $\to P(X)$ as:

$$\lambda(A) = \begin{cases} A & \text{if} \quad A = \{a\} \text{ or } \phi \\ X & \text{Otherwise} \end{cases}.$$

Then, if we let $A = \{a,b\}$, and since the only λ_c-open supersets of A is X, so A is g-λ_c-closed but it is not λ_c-closed.

Proposition 4.5

The intersection of a g-λ_c-closed set and a λ_c-closed set is always g-λ_c-closed.

Proof. Let A be g-λ_c-closed and F be λ_c-closed. Assume that U is λ_c-open set such that $A \cap F \subseteq U$, set $G = X \setminus F$. Then $A \subseteq U \cup G$, since G is λ_c-open, then $U \cup G$ is λ_c-open and since A is g-λ_c-closed, then $\lambda_c Cl(A) \subseteq U \cup G$. Now by Proposition 3.10, $\lambda_c Cl(A \cap F) \subseteq \lambda_c Cl(A) \cap$ $\lambda_c Cl(F) = \lambda_c Cl(A) \cap F \subseteq (U \cup G) \cap F = (U \cap F) \cup (G \cap F) = (U \cap F)$ $\cup\ \phi \subseteq U$.

Note 4.6

The union of two g-λ_c-closed sets need not be g-λ_c-closed, as shown in the following example:

Example 4.7

Let $X=\{a,b,c\}$, and $\tau=P(X)$. We define an s-operation $\lambda : SO(X) \to P(X)$ as:

$$\lambda(A)=\begin{cases} A & \text{if } A=\{a,b\} \text{ or } \{a,c\} \text{ or } \{b,c\} \text{ or } \phi \\ X & \text{Otherwise} \end{cases}.$$

Then, if $A=\{a\}$ and $B=\{b\}$. So, A and B are g-λ_c-closed, but $A\cup B=\{a,b\}$ is not g-λ_c-closed, since $\{a,b\}$ is λ_c-open and $\lambda_c Cl(\{a,b\})=X$.

Theorem 4.8

If $\lambda : SO(X) \to P(X)$ is a λ-regular s-operation. Then the finite union of g-λ_c-closed sets is always a g-λ_c-closed set.

Proof. Let A and B be two g-λ_c-closed sets, and let $A\cup B\subseteq U$, where U is λ_c-open. Since A and B are g-λ_c-closed sets, therefore $\lambda_c Cl(A)\subseteq U$ and $\lambda_c Cl(B)\subseteq U$ implies $\lambda_c Cl(A)\cup\lambda_c Cl(B)\subseteq U$. But by Theorem 3.13, we have $\lambda_c Cl(A)\cup\lambda_c Cl(B)=\lambda_c Cl(A\cup B)$. Therefore $\lambda_c Cl(A\cup B)\subseteq U$. Hence we get $A\cup B$ is g-λ_c-closed set.

Note 4.9

The intersection of two g-λ_c-closed sets need not be g-λ_c-closed, as it is shown in the following example:

Example 4.10

Let $X=\{a,b,c\}$, and $\tau=P(X)$. We define an s-operation $\lambda : SO(X) \to P(X)$ as:

$$\lambda(A)=\begin{cases} A & \text{if } A=\{a\} \text{ or } \phi \\ X & \text{Otherwise} \end{cases}.$$

Then the sets $A=\{a,b\}$ and $B=\{a,c\}$ are g-λ_c-closed sets, since X is their only λ_c-open superset. But $C=\{a\}=A\cap B$ is not g-λ_c-closed, since $C \subseteq \{a\} \in SO_{\lambda c}(X)$ and $\lambda_c Cl(C)=X \not\subset \{a\}$.

Theorem 4.11

If a subset A of a topological space (X,τ) is g-λ_c-closed and $A\subseteq B \subseteq \lambda_c Cl(A)$, then B is a g-λ_c-closed set in X.

Proof. Let U be a λ_c-open set of X such that $B\subseteq U$. Since A is g-λ_c-closed, we have $\lambda_c Cl(A) \subseteq U$. Now $\lambda_c Cl(B) \subseteq \lambda_c Cl(\lambda_c Cl(A)) = \lambda_c Cl(A) \subseteq U$. That is $\lambda_c Cl(B) \subseteq U$, where U is λ_c-open. Therefore B is a g-λ_c-closed set in X.

The converse of the Theorem 4.11 need not be true as seen from the following example.

Example 4.12

Let $X=\{a,b,c\}$, with $\tau=\{\phi,\{a\},\{c\},\{a,c\},\{b,c\},X\}$. And let $\lambda: SO(X) \rightarrow P(X)$ be a λ-identity s-operation. If $A=\{a\}$ and $B=\{a,b\}$. Then A and B are g-λ_c-closed sets in (X,τ). But $A\subseteq B$Ú $\lambda_c Cl(A)$.

Theorem 4.13

Let $\lambda: SO(X) \rightarrow P(X)$ be an s-operation. Then for each $x\in X$, $\{x\}$ is λ_c-closed or $X\setminus\{x\}$ is g-λ_c-closed in (X,τ).

Proof. Suppose that $\{x\}$ is not λ_c-closed, then $X\setminus\{x\}$ is not λ_c-open. Let U be any λ_c-open set such that $X\setminus\{x\}\subseteq U$, then $U=X$. Therefore $\lambda_c Cl(X\setminus\{x\}) \subseteq U$. Hence $X\setminus\{x\}$ is g-λ_c-closed.

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Proposition 4.14

A subset A of a topological space (X,τ) is g-λ_c-closed if and only if $\lambda_c Cl(\{x\}) \cap A \neq \phi$, holds for every $x \in \lambda_c Cl(A)$.

Proof. Let U be a λ_c-open set such that $A \subseteq U$ and let $x \in \lambda_c Cl(A)$. By assumption, there exists a $z \in \lambda_c Cl(\{x\})$ and $z \in A \subseteq U$. It follows from Theorem 3.11, that $U \cap \{x\} \neq \phi$, hence $x \in U$, implies $\lambda_c Cl(A) \subseteq U$. Therefore A is *g*-λ_c-closed.

Conversely, suppose that $x \in \lambda_c Cl(A)$ such that $\lambda_c Cl(\{x\}) \cap A = \phi$. Since, $\lambda_c Cl(\{x\})$ is λ_c-closed. Therefore by Definition 3.2, $X \setminus \lambda_c Cl(\{x\})$ is λ_c-open set in X. Since $A \subseteq X \setminus \lambda_c Cl(\{x\})$ and A is *g*-λ_c-closed implies that $\lambda_c Cl(A) \subseteq X \setminus \lambda_c Cl(\{x\})$ holds, and hence $x \notin \lambda_c Cl(A)$, a contradiction. Therefore $\lambda_c Cl(\{x\}) \cap A \neq \phi$.

Theorem 4.15

If a subset A of a topological space (X,τ) is a *g*-λ_c-closed set in X, then $\lambda_c Cl(A) \setminus A$ does not contain any non empty λ_c-closed set in X.

Proof. We prove the result by contradiction. Let F be a λ_c-closed set such that $F \subseteq \lambda_c Cl(A) \setminus A$ and $F \neq \phi$. Then $F \subseteq X \setminus A$ which implies $A \subseteq X \setminus F$. Since A is *g*-λ_c-closed and $X \setminus F$ is λ_c-open set, therefore $\lambda_c Cl(A) \subseteq X \setminus F$, that is $F \subseteq X \setminus \lambda_c Cl(A)$. Hence $F \subseteq \lambda_c Cl(A) \cap X \setminus \lambda_c Cl(A) = \phi$. This shows that, $F = \phi$ which is a contradiction. Hence $\lambda_c Cl(A) \setminus A$ does not contains any non empty λ_c-closed set in X.

Lemma 4.16

Let A be a subset of a topological space (X,τ). If $\lambda_c d(A) \subseteq U$ for λ_c-open set U, then $\lambda_c d(\lambda_c d(A)) \subseteq U$.

Proof. Suppose $x \in \lambda_c d(\lambda_c d(A))$ but $x \notin U$. Then $x \notin \lambda_c d(A)$ and so, for some λ_c-open set V, $x \in V$ and $A \cap V \subseteq \{x\}$, but $x \in \lambda_c d(\lambda_c d(A))$ implies

$y \in \lambda_c d(A) \cap V \setminus \{x\}$ for some y. Now, $y \in U \cap V$ and $y \in \lambda_c d(A)$ and so $\phi \neq A \cap U \cap V \cap X \setminus \{y\} \subseteq A \cap V \subseteq \{x\}$. It follows that $x \in U$, a contradiction.

Theorem 4.17

If λ is λ-regular s-operation. Then the λ_c-derived set is g-λ_c-closed.

Proof. If A is any subset of a topological space (X, τ) with $\lambda_c d(A) \subseteq U$ for U is λ_c-open. Then by Lemma 4.16, $\lambda_c Cl(\lambda_c d(A)) = \lambda_c d(\lambda_c d(A)) \cup \lambda_c d(A) \subseteq U$.

Theorem 4.18

A subset A of a topological space (X, τ) is g-λ_c-open if and only if $F \subseteq \lambda_c Int(A)$ whenever $F \subseteq A$ and F is λ_c-closed in (X, τ).

Proof. Let A be g-λ_c-open and $F \subseteq A$ where F is λ_c-closed. Since $X \setminus A$ is g-λ_c-closed and $X \setminus F$ is a λ_c-open set containing $X \setminus A$ implies $\lambda_c Cl(X \setminus A) \subseteq X \setminus F$. By Proposition 3.12, $X \setminus \lambda_c Int(A) \subseteq X \setminus F$. That is $F \subseteq \lambda_c Int(A)$.

Conversely, suppose that F is λ_c-closed and $F \subseteq A$, implies that $F \subseteq \lambda_c Int(A)$. Let $X \setminus A \subseteq U$, where U is λ_c-open. Then $X \setminus U \subseteq A$, where $X \setminus U$ is λ_c-closed. By hypothesis $X \setminus U \subseteq \lambda_c Int(A)$. That is $X \setminus \lambda_c Int(A) \subseteq U$ and then by Proposition 3.12, $\lambda_c Cl(X \setminus A) \subseteq U$. This implies $(X \setminus A)$ is g-λ_c-closed and A is g-λ_c-open.

Note 4.19

The union of two g-λ_c-open sets need not be g-λ_c-open. As it is shown in the following example:

Example 4.20

Let $X=\{a,b,c\}$, and $\tau=P(X)$. We define an s-operation $\lambda:SO(X) \to P(X)$ as:

$$\lambda(A)=\begin{cases} A & \text{if} \quad A=\{b\} \text{ or } \phi \\ X & \text{if} \quad A\neq\{b\} \end{cases}.$$

If $A=\{a\}$ and $B=\{c\}$, then A and B are g-λ_c-open sets in X, but $A\cup B=\{a,c\}$ is not a g-λ_c-open set in X.

Theorem 4.21

Let $\lambda:SO(X)\to P(X)$ be a λ-regular s-operation, and let A and B be two g-λ_c-open sets in a space X. Then $A\cap B$ is also g-λ_c-open.

Proof. If A and B are g-λ_c-open sets in a space X. Then $X\setminus A$ and $X\setminus B$ are g-λ_c-closed sets in a space X. By Theorem 4.8, $(X\setminus A)\cup(X\setminus B)$ is also g-λ_c-closed set in X. That is $(X\setminus A)\cup(X\setminus B)=X\setminus(A\cap B)$ is a g-λ_c-closed set in X. Therefore $A\cap B$ is a g-λ_c-open set in X.

Theorem 4.22

A set A is g-λ_c-open if and only if $\lambda_c Int(A)\cup X\setminus A\subseteq G$ and G is λ_c-open implies $G=X$.

Proof. Suppose that A is g-λ_c-open in X. Let G be λ_c-open and $\lambda_c Int(A)\cup(X\setminus A)\subseteq G$. Then $X\setminus G\subseteq X\setminus(\lambda_c Int(A)\cup(X\setminus A))=(X\setminus\lambda_c Int(A))\cap A$. That is $X\setminus G\subseteq(X\setminus\lambda_c Int(A))\setminus(X\setminus A)$. Thus $X\setminus G\subseteq\lambda_c Cl(X\setminus A)\setminus(X\setminus A)$,

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since $X \setminus \lambda_c Int(A) = \lambda_c Cl(X \setminus A)$. Now, $X \setminus G$ is λ_c-closed and $X \setminus A$ is g -λ_c-closed, by Theorem 4.15, it follows that $X \setminus G = \phi$. Hence G = X.

Conversely, let $\lambda_c Int(A) \cup X \setminus A \subseteq G$ and G is λ_c-open, this implies that G = X. Let U be a λ_c-open set such that $X \setminus A \subseteq U$. Now $\lambda_c Int(A) \cup (X \setminus A) \subseteq \lambda_c Int(A) \cup U$ which is clearly, λ_c-open and so by the given condition $\lambda_c Int(A) \cup U = X$, then $(X \setminus \lambda_c Int(A)) \cap (X \setminus U) = \phi$, so $(X \setminus \lambda_c Int(A)) \subseteq U$ which implies that $\lambda_c Cl(X \setminus A) \subseteq U$ by Proposition 3.12. Hence $X \setminus A$ is g-λ_c-closed, therefore A is g-λ_c-open.

Theorem 4.23

Every singleton set in a space X is either g-λ_c-open or λ_c-closed.

Proof. Suppose that $\{x\}$ is not g-λ_c-open, then by definition $X \setminus \{x\}$ is not g-λ_c-closed. This implies that by Theorem 4.13, the set $\{x\}$ is λ_c-closed.

Theorem 4.24 2.3.24

If $\lambda_c Int(A) \subseteq B \subseteq A$ and A is g-λ_c-open, then B is g-λ_c-open.

Proof. Let $\lambda_c Int(A) \subseteq B \subseteq A$ implies that $X \setminus A \subseteq X \setminus B \subseteq X \setminus \lambda_c Int(A)$. That is, $X \setminus A \subseteq X \setminus B \subseteq \lambda_c Cl(X \setminus A)$ by Proposition 3.12. Since $X \setminus A$ is g-λ_c-closed, by Theorem 4.11, $X \setminus B$ is g-λ_c-closed and B is λ_c-open.

References

1. Levine, N., *Generalized closed sets in topology.* Rendiconti del Circolo Matematico di Palermo, 1970. **19**(1): p. 89-96.

2. Levine, N., *Semi-open sets and semi-continuity in topological spaces.* The American Mathematical Monthly, 1963. **70**(1): p. 36-41.

3. Namiq, S.F., *NEW TYPES OF CONTINUITY AND SEPARATION AXIOMS BASED ON OPERATIONS IN TOPOLOGICAL SPACES*. 2011, University of Sulaimani.

4. Khalaf, A.B. and S.F. Namiq, *[[lambda]. sub. c]-open sets and [[lambda]. sub. c]-separation axioms in topological spaces.* Journal of Advanced Studies in Topology, 2013. **4**(1): p. 150-159.

5. Namiq, S.F., *lambda–Connected Spaces Via lambda-Open Sets.* Garmian University, 2015. **1**: p. 165-178.

6. Namiq, S.F., *ON Minimal λ*-Open Sets.*

7. Namiq, A.B.K.a.S.F., *ON Minimal λc-Open Sets Via λc-Open Sets.* Asian Journal of Fuzzy and Applied Mathematics 2014. **02**(06).

8. Khalaf, A.B. and S.F. Namiq, *Generalized λ-Closed Sets and-Continuous Functions.* International Journal of Scientific & Engineering Research, 2012. **03**(12).

9. Namiq, S.F., *lammda sub c-Separation Axioms Via lammda sub c-open sets* International Journal of Scientific & Engineering Research, 2017. **8**(5).

10. Willard, S., *General topology*. 1970: Courier Corporation.

11. Bhattacharyya, P. and B. Lahiri, *Semi-generalized closed sets in topology.* Indian J. Math, 1987. **29**(3): p. 375-382.

12. Arya, S. and T. Nour, *Characterizations of s-normal spaces.* INDIAN JOURNAL OF PURE & APPLIED MATHEMATICS, 1990. **21**(8): p. 717-719.