

δg^* -Continuous Functions in Topological Spaces

R.Sudha

Assistant Professor
SNS College of Technology
Coimbatore-43

K.Sivakamasundari

Associate Professor
Avinashilingam University for Women
Coimbatore-43

ABSTRACT

The Aim of this paper is to introduce the new class of function called δg^* -continuous function by using δg^* -closed set and study their basic properties in topological spaces. We also investigate its relationship with other types of functions.

Keywords and phrases

Generalized closed sets, δ -closure, δg -closed sets and g -open sets.

Mathematics Subject classification: 54C08, 54C10.

1. INTRODUCTION

Different types of generalizations of continuous maps were introduced and studied by various authors in the recent development of topology. In 2011, Lellis Thivagar et. al., [10] introduced the notion of $\delta \hat{g}$ -continuity in topological spaces. A new weaker form of the closed sets called δg^* -closed sets is introduced and investigated by Sudha et. al., [17]. In this paper, we study δg^* -continuous maps as a new generalization of δg -continuous and obtain their characterizations, properties and discuss the relationships with some other functions.

2. PRELIMINARIES

Throughout this paper (X, τ) (or simple X) represents topological space on which no separation axioms are assumed unless otherwise mentioned. For a subset A of X , $cl(A)$, $int(A)$ and A^c denote the closure of A , the interior of A and the complement of A respectively. Let us recall the following definitions, which are useful in the sequel.

2.1 Definition

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

- (i) semi-open set [11] if $A \subseteq cl(int(A))$.
- (ii) α -open set [16] if $A \subseteq int(cl(int(A)))$.
- (iii) regular open set [17] if $A = int(cl(A))$.

The complement of a semi open (resp. α -open, regular open) set is called semi-closed (resp. α -closed, regular closed). The semi-closure [5] (resp. α -closure [16]) of a subset A of (X, τ) , denoted by $scl(A)$ (resp. $\alpha cl(A)$) is defined to be the intersection of all semi-closed (resp. α -closed) sets containing A . It is known that $scl(A)$ (resp. $\alpha cl(A)$) is a semi-closed (resp. α -closed) set.

2.2 Definition [19]

The δ -interior of a subset A of X is the union of all regular open sets of X contained in A and is denoted by $int_{\delta}(A)$. The subset A is called δ -open if $A = int_{\delta}(A)$. i.e., a set is δ -open if it is the union of regular open set. The complement

of a δ -open set is called δ -closed. Alternatively, a set $A \subseteq X$ is called δ -closed if $A = cl_{\delta}(A)$, where $cl_{\delta}(A) = \{x \in X; int(cl(U)) \cap A \neq \emptyset, U \in \tau \text{ and } x \in U\}$.

2.3 Definition

A subset A of (X, τ) is called

- 1) generalized closed (briefly g -closed) [12] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in (X, τ) .
- 2) δ -generalized closed (briefly δg -closed) [7] if $cl_{\delta}(A) \subseteq U$ whenever $A \subseteq U$ and U is open in (X, τ) .
- 3) δg^* -closed [18] if $cl_{\delta}(A) \subseteq U$ whenever $A \subseteq U$ and U is a g -open set in (X, τ) .
- 4) $\delta \bar{g}$ -closed [8] if $cl_{\delta}(A) \subseteq U$ whenever $A \subseteq U$ and U is \bar{g} -open in (X, τ) .
- 5) α -generalized closed (briefly αg -closed) [14] if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in (X, τ) .
- 6) generalized α closed (briefly $g\alpha$ -closed) [13] if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is α -open in (X, τ) .
- 7) generalized closed (briefly g -closed) [12] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in (X, τ) .
- 8) semi-generalized closed (briefly sg -closed) [4] if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is semi-open in (X, τ) .
- 9) generalized semi-closed (briefly gs -closed) [2] if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in (X, τ) .
- 10) $\alpha \bar{g}$ -closed [1] if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is \bar{g} -open in (X, τ) .

The complements of the above mentioned sets are called their respective open sets.

2.4 Definition

A map $f: (X, \tau) \rightarrow (Y, \sigma)$ is called

- 1) $\delta \bar{g}$ -continuous [8] if $f^{-1}(V)$ is $\delta \bar{g}$ -closed in (X, τ) for every closed set V of (Y, σ) .
- 2) $\alpha \bar{g}$ -continuous [9] if $f^{-1}(V)$ is $\alpha \bar{g}$ -closed in (X, τ) for every closed set V of (Y, σ) .
- 3) sg -continuous [12] if $f^{-1}(V)$ is sg -closed in (X, τ) for every closed set V of (Y, σ) .
- 4) gs -continuous [3] if $f^{-1}(V)$ is gs -closed in (X, τ) for every closed set V of (Y, σ) .
- 5) αg -continuous [6] if $f^{-1}(V)$ is αg -closed in (X, τ) for every closed set V of (Y, σ) .

- 6) $g\alpha$ -continuous [6] if $f^{-1}(V)$ is $g\alpha$ -closed in (X, τ) for every closed set V of (Y, σ) .
- 7) α -continuous [15] if $f^{-1}(V)$ is α -closed in (X, τ) for every closed set V of (Y, σ) .
- 8) g -continuous [12] if $f^{-1}(V)$ is g -closed in (X, τ) for every closed set V of (Y, σ) .

2.5 Definition [18]

A space X is called

- 1) $\delta g^* T_{\delta}$ -space if every δg^* -closed set in it is δ -closed.
- 2) $\alpha g T_{\delta g^*}$ -space if every αg -closed set in it is δg^* -closed.

3. δg^* -CONTINUOUS FUNCTIONS

In this section we introduce δg^* -continuous map in topological spaces and study some of their properties. We prove that the composition of two δg^* -continuous maps need not be δg^* -continuous.

3.1 Definition

A map $f : (X, \tau) \longrightarrow (Y, \sigma)$ is said to be δg^* -continuous if the inverse image of every closed set in (Y, σ) is δg^* -closed in (X, τ) .

3.2 Theorem

A map $f : (X, \tau) \longrightarrow (Y, \sigma)$ is δg^* -continuous if and only if the inverse image of every open set in (Y, σ) is δg^* -open in (X, τ) .

Proof: (Necessity) Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be δg^* -continuous and U be an open set in (Y, σ) . Then $Y - U$ is closed in (Y, σ) . Since f is δg^* -continuous, $f^{-1}(Y - U) = X - f^{-1}(U)$ is δg^* -closed in (X, τ) and hence $f^{-1}(U)$ is δg^* -open in (X, τ) .

(Sufficiency) Assume that $f^{-1}(V)$ is δg^* -open in (X, τ) for each open set V in (Y, σ) . Let V be a closed set in (Y, σ) . Then $Y - V$ is open in (Y, σ) . By assumption, $f^{-1}(Y - V) = X - f^{-1}(V)$ is δg^* -open in (X, τ) , which implies that $f^{-1}(V)$ is δg^* -closed in (X, τ) . Hence f is δg^* -continuous.

3.3 Proposition

Every δ -continuous map is δg^* -continuous

Proof: Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δ -continuous map. Let V be any closed set in (Y, σ) . Since f is a δ -continuous map, $f^{-1}(V)$ is δ -closed in (X, τ) . By Proposition 3.2.[18], every δ -closed set is δg^* -closed, $f^{-1}(V)$ is δg^* -closed in (X, τ) . Therefore f is δg^* -continuous.

The converse of the above Proposition need not be true as seen from the following example.

3.4 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{a, b, c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be the identity map. Then

f is δg^* -continuous but not δ -continuous, since for the closed set $\{c\}$ in (Y, σ) , $f^{-1}(\{c\}) = \{c\}$ is δg^* -closed but not δ -closed in (X, τ) .

3.5 Proposition

Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δg^* -continuous map and (X, τ) be a $\delta g^* T_{\delta}$ -space. The f is δ -continuous.

Proof: Let V be a closed set in (Y, σ) . Since f is δg^* -continuous, $f^{-1}(V)$ is δg^* -closed in (X, τ) . Since (X, τ) is a $\delta g^* T_{\delta}$ -space, $f^{-1}(V)$ is δ -closed in (X, τ) . Hence f is δ -continuous.

3.6 Corollary

Every δg^* -continuous map is δg -continuous.

Proof: Follows from the fact that every δg^* -closed set is δg -closed.

The converse of the above Proposition need not be true as seen from the following example.

3.7 Example

Let $X = Y = \{a, b, c, d\}$ with $\tau = \{X, \phi, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{a, b, c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be the identity map. Then f is δg -continuous but not δg^* -continuous, since for the closed set $\{d\}$ in (Y, σ) , $f^{-1}(\{d\}) = \{d\}$ is δg^* -closed in (X, τ) .

3.8 Proposition

Every δg^* -continuous map is $\delta \hat{g}$ -continuous

Proof: Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δg^* -continuous map. Let V be any closed set in (Y, σ) . Since f is a δg^* -continuous map, $f^{-1}(V)$ is δg^* -closed in (X, τ) . By Proposition 3.20. [18], every δg^* -closed set is $\delta \hat{g}$ -closed, $f^{-1}(V)$ is $\delta \hat{g}$ -closed in (X, τ) . Therefore f is $\delta \hat{g}$ -continuous.

The converse of the above Proposition need not be true as seen from the following example.

3.9 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}\}$ and $\sigma = \{Y, \phi, \{a\}, \{a, b\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be the identity map, then f is $\delta \hat{g}$ -continuous but not δg^* -continuous, since for the closed set $\{b, c\}$ in (Y, σ) , $f^{-1}(\{b, c\}) = \{b, c\}$ is $\delta \hat{g}$ -closed but not δg^* -closed in (X, τ) .

3.10 Proposition

Every δg^* -continuous map is αg -continuous

Proof: Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δg^* -continuous map. Let V be any closed set in (Y, σ) . Since f is a δg^* -continuous map, $f^{-1}(V)$ is αg -closed in (X, τ) , as every δg^* -closed set is αg -closed [Proposition 3.14, [18]]. Therefore f is αg -continuous.

The converse of the above Proposition need not be true as seen from the following example.

3.11 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{b, c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = b$, $f(b) = a$, $f(c) = c$. Then f is αg -continuous but not δg^* -

continuous, since for the closed set $\{a\}$ in (Y, σ) , $f^{-1}(\{a\}) = \{b\}$ is αg -closed but not δg^* -closed in (X, τ) .

3.12 Proposition

Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a αg -continuous map and (X, τ) be a $\alpha g T_{\delta g^*}$ -space. Then f is δg^* -continuous.

Proof: Let V be a closed set in (Y, σ) . Since $f : (X, \tau) \longrightarrow (Y, \sigma)$ is αg -continuous, $f^{-1}(V)$ is αg -closed in (X, τ) . Since (X, τ) is $\alpha g T_{\delta g^*}$ -space, $f^{-1}(V)$ is δg^* -closed in (X, τ) . Hence f is δg^* -continuous.

3.13 Proposition

Every δg^* -continuous map is $g s$ -continuous.

Proof: The proof follows from the fact that every δg^* -closed set is $g s$ -closed.

The converse of the above Proposition need not be true as seen from the following example.

3.14 Example

Let $X = Y = \{a, b, c, d\}$ with $\tau = \{X, \phi, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{c, d\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = a, f(b) = c, f(c) = d, f(d) = b$. Then f is $g s$ -continuous but not δg^* -continuous, since for the closed set $\{a, b\}$ in (Y, σ) , $f^{-1}(\{a, b\}) = \{a, d\}$ is $g s$ -closed but not δg^* -closed in (X, τ) .

3.15 Proposition

Every δg^* -continuous map is $\alpha \hat{g}$ -continuous.

Proof: The proof follows from the fact that every δg^* -closed set is $\alpha \hat{g}$ -closed

The converse of the above Proposition need not be true as seen from the following example.

3.16 Example

Let $X = Y = \{a, b, c, d\}$ with $\tau = \{X, \phi, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{b\}, \{b, a\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = a, f(b) = d, f(c) = b, f(d) = c$. Then f is $\alpha \hat{g}$ -continuous but not δg^* -continuous, since for the closed set $\{c, d\}$ in (Y, σ) , $f^{-1}(\{c, d\}) = \{b, d\}$ is $\alpha \hat{g}$ -closed but not δg^* -closed in (X, τ) .

3.17 Remark

The following examples show that the notions of δg^* -continuity and $g \alpha$ -continuity are independent.

3.18 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}\}$ and $\sigma = \{Y, \phi, \{b, c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = b, f(b) = a, f(c) = c$. Then f is $g \alpha$ -continuous but not δg^* -continuous, since for the closed set $\{a\}$ in (Y, σ) , $f^{-1}(\{a\}) = \{b\}$ is $g \alpha$ -closed but not δg^* -closed in (X, τ) .

3.19 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = b, f(b) = c, f(c) = a$. Then f is δg^* -continuous but not

$g \alpha$ -continuous, since for the closed set $\{a, b\}$ in (Y, σ) , $f^{-1}(\{a, b\}) = \{a, c\}$ is δg^* -closed but not $g \alpha$ -closed in (X, τ) .

3.20 Remark

The following examples show that the notions of δg^* -continuity and $g s$ -continuity are independent.

3.21 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{b\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{a\}, \{a, b\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be the identity map. Then f is $g s$ -continuous but not δg^* -continuous, since for the closed set $\{b\}$ in (Y, σ) , $f^{-1}(\{b\}) = \{b\}$ is $g s$ -closed but not δg^* -closed in (X, τ) .

3.22 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = b, f(b) = c, f(c) = a$. Then f is δg^* -continuous but not $g s$ -continuous, since for the closed set $\{a, b\}$ in (Y, σ) , $f^{-1}(\{a, b\}) = \{a, c\}$ is δg^* -closed but not $g s$ -closed in (X, τ) .

3.23 Remark

The following examples show that the notions of δg^* -continuity and α -continuity are independent.

3.24 Example

Let $X = Y = \{a, b, c, d\}$ with $\tau = \{X, \phi, \{a\}\}$ and $\sigma = \{Y, \phi, \{a, b, d\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = d, f(b) = c, f(c) = b, f(d) = a$. Then f is α -continuous but not δg^* -continuous, since for the closed set $\{c\}$ in (Y, σ) , $f^{-1}(\{c\}) = \{b\}$ is α -closed but not δg^* -closed in (X, τ) .

3.25 Example

Let $X = Y = \{a, b, c, d\}$ with $\tau = \{X, \phi, \{a, b\}\}$ and $\sigma = \{Y, \phi, \{c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = c, f(b) = d, f(c) = a, f(d) = b$. Then f is δg^* -continuous but not α -continuous, since for the closed set $\{a, b, d\}$ in (Y, σ) , $f^{-1}(\{a, b, d\}) = \{b, c, d\}$ is δg^* -closed but not α -closed in (X, τ) .

3.26 Remark

The composition of two δg^* -continuous maps need not be δg^* -continuous as seen from the following example.

3.27 Example

Let $X = Y = \{a, b, c\}$ with $\tau = \{X, \phi, \{a\}, \{b, c\}\}$, $\sigma = \{Y, \phi, \{a, b\}\}$ and $\eta = \{Z, \phi, \{c\}\}$. Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be defined by $f(a) = c, f(b) = b, f(c) = a$ and $g : (Y, \sigma) \longrightarrow (Z, \eta)$ be defined by $g(a) = a, g(b) = c, g(c) = b$. Then the maps f and g are δg^* -continuous but their composition $g \circ f : (X, \tau) \longrightarrow (Z, \eta)$ is not δg^* -continuous, since for the closed set $\{a, b\}$ in (Z, η) , $(g \circ f)^{-1}(\{a, b\}) = \{a, c\}$ is not δg^* -closed in (X, τ) .

3.28 Proposition

Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be any topological space and (Y, σ) be a $\delta g^* T_\delta$ -space. If $f : (X, \tau) \longrightarrow (Y, \sigma)$ and $g : (Y, \sigma) \longrightarrow (Z, \eta)$ are δg^* -continuous maps, then their composition $g \circ f : (X, \tau) \longrightarrow (Z, \eta)$ is a δg^* -continuous maps.

Proof: Let V be a closed set in (Z, η) . Since $g : (Y, \sigma) \longrightarrow (Z, \eta)$ is δg^* -continuous, $g^{-1}(V)$ is δg^* -closed in (Y, σ) . Since (Y, σ) is a $\delta g^* T_\delta$ -space, $g^{-1}(V)$ is δ -closed in (Y, σ) .

Now $g^{-1}(V)$ is closed in (Y, σ) . Since $f : (X, \tau) \longrightarrow (Y, \sigma)$ is δg^* -continuous, $f^{-1}(g^{-1}(V)) = (g \circ f)^{-1}(V)$ is δg^* -closed in (X, τ) . Hence $g \circ f : (X, \tau) \longrightarrow (Z, \eta)$ is δg^* -continuous.

3.29 Proposition

Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δg^* -continuous map. Then for every subset A of (X, τ) $f(\delta g^* cl(A)) \subseteq \delta cl(f(A))$.

Proof: Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a δg^* -continuous map and A be any subset of (X, τ) . Then $\delta cl(f(A))$ is a closed set in (Y, σ) . Since f is δg^* -continuous, we have $f^{-1}(\delta cl(f(A)))$ is δg^* -closed in (X, τ) . Hence $\delta g^* cl(f^{-1}(\delta cl(f(A)))) = f^{-1}(\delta cl(f(A)))$ by Proposition 3.3.. Since $f(A) \subseteq cl(f(A))$, $A \subseteq f^{-1}(f(A)) \subseteq f^{-1}(\delta cl(f(A)))$. Hence $f^{-1}(\delta cl(f(A)))$ is δg^* -closed set containing A . By definition of δg^* -closure, we have $\delta g^* cl(A) \subseteq f^{-1}(\delta cl(f(A)))$ which implies that $f(\delta g^* cl(A)) \subseteq \delta cl(f(A))$.

3.30 Proposition

Let $f : (X, \tau) \longrightarrow (Y, \sigma)$ be a map. If for each point $x \in X$ and each open set V in (Y, σ) containing $f(x)$, there exists a δg^* open set U in (X, τ) containing x such that $f(U) \subseteq V$, then for every subset A of (X, τ) , $f(\delta g^* cl(A)) \subseteq cl(f(A))$.

Proof: Let $y \in f(\delta g^* cl(A))$. Therefore $y = f(x)$ for some $x \in \delta g^* cl(A) \subseteq X$. Let V be any open set in (Y, σ) containing $f(x)$. Then by hypothesis, there exists a δg^* open set U in (X, τ) containing x such that $f(U) \subseteq V$. This implies that $U \cap A \neq \emptyset$. Then $f(U \cap A) \neq \emptyset$ which implies that $V \cap f(A) \neq \emptyset$. Hence $y \in cl(f(A))$.

4. CONCLUSION

We have introduced and studied the concept of δg^* -continuous functions using δg^* -closed sets. The same can be extended to Bitopological spaces, Fuzzy topological spaces in the Future.

5. REFERENCES

[1] Abd El-Monsef, M.E., Rose Mary, S. and Lellis Thivagar, M., On $\alpha \bar{g}$ -closed sets in topological spaces, Assiut University Journal of Mathematics and Computer Science, 36 (2007), 43 – 51.

[2] Arya, S.P. and Nour, T., Characterizations of S-normal spaces, Indian J. Pure. Appl. Math., 21(8) (1990), 717 – 719.

[3] Balachandran, K., Sundaram, P. and Maki, H., On generalized continuous maps in topological spaces, Mem. Fac. Sci. Kochi Univ. Math., 12 (1991), 5 – 13.

[4] Bhattacharya, P. and Lahiri, B.K., Semi-generalized closed sets in topology, Indian J. Math., 29(1987), 375 – 382.

[5] Crossley, S.G. and Hildebrand, S.K., Semi-closure, Texas J. Sci., 22 (1971), 99-112.

[6] Devi, R., Balachandran, K., and Maki, H., On generalized α -continuous maps and α -generalized continuous maps, Far East J. Math., Sci., Special Volume (1997), 1 – 15.

[7] Dontchev, J. and Ganster, M., On δ -generalized closed set s a n d $T_{3/4}$ – spaces, Mem. Fac. Sci. Kochi Univ. Ser. A, Math., 17 (1996), 15-31.

[8] Lellis Thivagar, M., Meera Devi, B., Some new class of functions via $\delta \bar{g}$ - sets, International Journal of mathematical archive, 1 (2011), 169 – 173.

[9] Lellis Thivagar, M., Rose Mary, M., Remarks on contra $\alpha \bar{g}$ - continuous functions, International Journal of Mathematics Game theory and Algebra.

[10] Lellis Thivagar, M., Meera Devi, B. and Hatir, B., $\delta \bar{g}$ - closed sets in topological spaces, Gen. Math. Notes, 1 (2010), 17 – 25.

[11] Levine, N., Semi-open sets a n d semi-continuity in t o p o l o g i c a l s p a c e s, Amer. Math. Monthly, 70 (1963), 36 – 41.

[12] Levine, N., Generalized c l o s e d sets in topology, Rend. Circ. Mat. Palermo, 19 (1970), 89 – 96.

[13] Maki, K., Devi, R. and Balachandran, K., Generalized α -closed sets in topology, Bull. Fukuoka Uni. Ed part III, 42(1993), 13 – 21.

[14] Maki, K., Devi, R. and Balachandran, K., Associated topologies of generalized α -closed sets and α -generalized closed sets, Mem. Fac. Sci. Kochi Univ. Ser.A. Math., 15(1994), 57 – 63.

[15] Mashhour, A.S., Hasanein, I.A., and EL-Deep, S.N., α -continuous and α -open mappings. Acta Math. Hung. 41 (1983), 213 – 218.

[16] Njastad, O., On s o m e c l a s s e s o f nearly open sets, Pacific J Math. 15 (1965), 961 – 970.

[17] Stone, M., Application of the theory of Boolean rings to general topology, Trans. Amer. Math. Soc. 41(1937), 374 – 481.

[18] Sudha, R., Sivakamasundari, K., On δg^* -closed sets in topological spaces, International Journal of mathematical archive, 3 (2012), 1122 – 1230.

[19] Velicko, N.V., H-closed topological spaces. Amer. Math. Soc. Transl., 78 (1968), 103 – 118.