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On Generalized α b- Continuous Maps, On Generalized α b - open maps and On Generalized α b - closed maps

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Abstract

In this paper we study new class is called of generalized α b – Continuous mappings (denoted by g α b-Continuous) and study some of their properties. Also we study On Generalized- αb open maps and On Generalized-αb closed maps.

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1. Introduction

Balachandran et al in[16] introduced the concept of generalized continuous maps and gc-irresolute maps of a topological space. In this chapter we introduce and study the concept of a new class of maps called generalized α b-Continous maps which includes the includes generalized b – continuous maps, Moreover we introduce and study the concept of generalized αb- closed maps, generalized αb- open maps and [1]Ahmad Al-Omari and [2]Mohd. Salmi Md. Noorani are introduced on Generalized b-closed sets, and they introduced ap-b-continuous,ap-b-closed and contra-b-continuous maps.

2. Preliminaries

In this section let us recall some definitions and results which are used in this section

Definition 2.1: A subset A of a topological space (X,τ) is called α - open[16] if A$\subseteq$ int (cl(int(A))

Definition 2.2:A subset A of a topological space (X, τ) is called semi- open [1]if A$\subseteq$ cl(int (A))

Definition 2.3:A subset A of a topological space (X, τ) is called pre-open[6] if A $\subseteq$ int (cl(A))

Definition 2.4: A subset A of a topological space (X, τ) is called semi-pre open [1] if A $\subseteq$ cl (int (cl(A)))

Definition 2.5:A subset A of a topological space (X, τ) is called b-open [4]if A $\subseteq$ cl (int (A)) $\bigcup$ int (cl(A)).

Definition 2.6:A is said to be generalized closed set (g-closed) [12] if
cl(A) $\subseteq$ U whenever A$\subseteq$U and U is open

Definition 2.7:A is said to be α -generalized closed set (α g-closed) [16] if α cl(A)$\subseteq$U whenever A $\subseteq$U and U is open.

Definition 2.8:A is said to be generalized pre-closed set (gp-closed) [12]if A* $\subseteq$ U whenever A $\subseteq$U and U is open.

Definition 2.9:A is said to be generalized semi-preclosed(gsp-closed) set[6] if spcl(A)$\subseteq$U whenever A$\subseteq$U and U is open.

Definition2.10:A is said to be generalized semi-closed set(gs-closed) set[3] if scl(A)$\subseteq$U whenever A$\subseteq$U and U is open.

Definition 2.11:A is said to be semi generalized closed set (sg-closed) [3] if scl(A)$\subseteq$U whenever A$\subseteq$U and U is semi open.

Definition 2.12:A is said to be generalized b-closed set(gb-closed) [18] if bcl(A)$\subseteq$U whenever A$\subseteq$U and U is open.

Definition 2.13: A subset A of a topological space X s called generalized α b-closed (gα b-closed)[19]bcl (A)$\subseteq$U whenever A$\subseteq$U and U is α -open.

Remark 2.14: The complement of the above open sets are known as their respective closed sets and vice-versa

3. On Generalized α b-Continuous Functions

Definition 3.1: Let X and Y be topological space. A map f : (X,τ)→(Y,σ) is said to be Generalized-α b-Continuous if the inverse image of every open set in Y is gα b-open in X.

Theorem 3.2: If a map f : (X,τ)→(Y,σ) from a topological space X into a topological space Y is continuous then it is gα b-Continuous but not conversely.

Proof: Let V be an open set in Y since f is continuous then $f^{-1}(V)$ is open in X. As open set is gα b-open in X.Therefore f is gα b-Continuous.

Remark 3.3: The converse of the above theorem need not be true as seen from the following example.

Example 3.4: Let X=Y={a,b,c} with τ={X,Φ,{b},{b,c}} and σ = {Y, Φ, {a},{b},{a,b},{a,c}}.Let f : (X,τ)→(Y,σ) be defined by f(a) = a, f(b) = c, f(c) = a, then f is gαb-Continuous but not continuously as the inverse image of an open set {a,b} in Y is {a,c} is not gαb-open in X.

Theorem 3.3: If a map f : (X,τ)→(Y,σ) is gαb-Continuous if and only if the inverse image of every closed set in Y is gαb-Closed set in X.

Proof: Let E be closed in Y.Then E^c is open in Y, since f is gαb-Continuous $f^{-1}(E)$ is gαb-Closed in X.Conversely assume that the inverse image of every closed set in Y is gαb-Closed in X. Let V be an open set in Y then V^c is closed in Y, therefore $f^{-1}(V^c)$= X-$f^{-1}(V)$ is gαb-Closed in X, and so $f^{-1}(V)$ is gαb-open in X.Therefore gαb-Continuous.

Theorem 3.4: Let X and Y be topological space.If a map f : (X,τ)→(Y,σ) is sg-continous then it is gαb-Continuous but not conversely.

Proof: Assume that a map f : (X,τ)→(Y,σ) is sg-continuous.Let V be an open set in Y, since f is sg-continous then $f^{-1}(V)$ is sg-open and hence every sg-open is gαb- open in X.Therefore f is gαb-Continuous.

Remark 3.5: The converse of the theorem need not be true.

Example 3.6: Let X=Y={a,b,c} with τ={X,Φ,{a},{a,b}} and σ = {Y, Φ, {b},{a,b},{b,c}} and f be the identy map therefore f(b) = b, f(c) = c. Thus f is gαb-Continuous but not sg-continous as the inverse image of the open set {b,c} in Y is {b,c} in X is not sg-open.

Theorem 3.5: Let X and Y be topological space. If a map f : (X,τ)→(Y,σ) is gαb-Continuous then it is gs-continous but not conversely.

Proof: Assume that a map f : (X,τ)→(Y,σ) is gαb-Continuous let V be an open set in Y, since f is gαb-Continuous $f^{-1}(V)$ is gαb-open and hence every gαb-open is gs-open in X therefore f is gs-continuous.

Remark 3.6: The converse of the theorem is need not be true.

Example 3.7: Let X=Y={a,b,c} with τ={X,Φ,{c}} and σ = {Y, Φ,{a},{a,b}} and f : (X,τ)→(Y,σ) be continous and then f(a)=a=f(b), the f is gs-continous but not gαb-Continuous as the inverse image of the open set {a} in Y is {a,b} is not gαb-open in X.

Theorem 3.8: Let X and Y be topological space. If a map f : $(X,\tau)\rightarrow(Y,\sigma)$ is gαb-Continuous then it is αg-Continuous but not conversely.

Proof: Assume that a map f : $(X,\tau)\rightarrow(Y,\sigma)$ is gαb-Continous.Let E be an open set in Y since f is gαb-Continuous $f^{-1}(E)$ is gαb-open is αg-open in X therefore f is αg-continuous.

Remark 3.9: The converse of the theorem need not be true.

Example 3.10: Let X=Y={a,b,c} with τ={X,Φ,{a}} and σ = {Y,Φ,{c},{b,c}} and f : $(X,\tau)\rightarrow(Y,\sigma)$ be continuous and then f(c)=c=f(b), and f(a)=a then the function f is αg-continuous but not gαb-Continuous and the pre-image of c is {b,c} open in Y is not gαb-open in X.

Theorem 3.11: Let X and Y be topological space If a map f : $(X,\tau)\rightarrow(Y,\sigma)$ is αg-continuous then it is gαb-Continuous.

Proof: Assume that a f : $(X,\tau)\rightarrow(Y,\sigma)$ is αg-continous.Let E be an α-open set in Y since f is αg-continuous and then $f^{-1}(E)$ is αg-open then every αg-open is gαb-open in X therefore f is gαb-continuous.

Remark 3.12: The converse of the theorem is need not be true.

Example 3.13: Let X=Y={a,b,c} with τ={X,Φ,{b},{b,c}} and σ = {Y,Φ,{a},{c},{a,c}} and f : $(X,\tau)\rightarrow(Y,\sigma)$ be continuous and then f(a)=c and f(c)=a, and f(b)=b then the inverse image open set {a,c} in Y is {a,c} is not gαb-open in X.

Remark 3.14: From the above examples αg-continuous $\underset{\nleftarrow}{\nrightarrow}$ gαb-continuous.

Theorem 3.15: Let X and Y be topological space. If a map f : $(X,\tau)\rightarrow(Y,\sigma)$ is swg-continuous then it is gαb-Continuous but not conversely.

Proof: Assume that a f : $(X,\tau)\rightarrow(Y,\sigma)$ is swg-continous.Let V be an open set in Y since f is swg-continuous and then $f^{-1}(V)$ is swg-open and hence gαb-open in X.Therefore f is gαb-continuous.

Remark 3.16: The converse of the theorem need not be true.

Example 3.17: Let X=Y={a,b,c} with τ={X,Φ,{b},{a,b}} and σ = {Y, Φ, {a},{c},{a,c}} and f be the identity map.Then f is gαb-continuous but not swg-continuous then f(b)=b and f(a)=b, and f(a)=b then the inverse image open set {a,b} in Y is {a,b} is not swg-open in X.

Theorem 3.18: Let X and Y be topological space. If a map f : (X,τ)→(Y,σ) is gαb-continuous then it is gb-continous but not conversely.

Proof: Assume that a f : (X,τ)→(Y,σ) is gαb-Continuous. Let V be an open set in Y since f is gαb-Continuous and then f^{-1}(V) is gαb-open set is gb-open set in X.Therefore f is gb-continuous.

Remark 3.19: The converse of the theorem need not be true.

Example 3.20: Let X=Y={a,b,c} with τ={X,Φ,{a},{a,c}} and σ = {Y, Φ, {a},{a,c}} and f be the identity map. Then f is gb-continous but not gαb-continuous then f(a)=b and f(c)=c then the inverse image of open set {a,c} in Y is {b,c} is not gαb-open in X.

Theorem 3.21: Let X and Y be topological space. If a map f : (X,τ)→(Y,σ) is gαb-Continuous then it is gpr-continuous but not conversely.

Proof: Assume that a f : (X,τ)→(Y,σ) is gαb-Continuous..Let E be an open set in Y since f is gαb-Continuous and then f^{-1}(E) is gαb-open set in X.Therefore every gαb-open is gpr-open set in X.Therefore f is gpr-continuous.

Remark 3.22: The converse of the theorem need not be true.

Example 3.23: Let X=Y={a,b,c} with τ={X,Φ,{b},{b,c}} and σ = {Y, Φ, {a},{a,b}} and f be the identity map. Then f is gpr-continuous but not gαb-continuous then f(a)=a= f(c)and f(b)=b then the inverse image of open set {a} in Y is {a,c} is not gαb-open in X.

Theorem 3.24: Let X and Y be topological space. If a map f : (X,τ)→(Y,σ) is gαb-Continuous then it is gp-continuous but not conversely.

Proof: Assume that a f : (X,τ)→(Y,σ) is gαb-Continuous. Let V be an open set in Y since f is gαb-Continuous and then f^{-1}(V) is gαb-open in X.Therefore every gαb-open is gp-open in X.Therefore f is gp-continuous.

Remark 3.25: The converse of the theorem need not be true.

Example 3.26: Let X=Y={a,b,c} with τ={X,Φ,{a},{a,c}} and σ = {Y, Φ, {b},{c},{b,c}} and f be the identity map.Then f is gp-continuous but not gαb-continuous then f(b)=b and f(c)=c then the inverse image of open set {b,c} in Y is {b,c} is not gαb-open in X.

Theorem 3.27: Let X and Y be topological space. If a map f : (X,τ)→(Y,σ) is gαb-Continuous then it is g-continuous but not conversely.

Proof: Assume that f : (X,τ)→(Y,σ) is gαb-Continuous. Let E be an open set in Y since f is g-Continuous and then $f^{-1}(V)$ is g-open in X.Therefore every g-open set is gαb- open sets in X.Therefore f is gαb -continuous.

Remark 3.28: The following examples shows that gαb –continuous and g-continuous are need not be same.

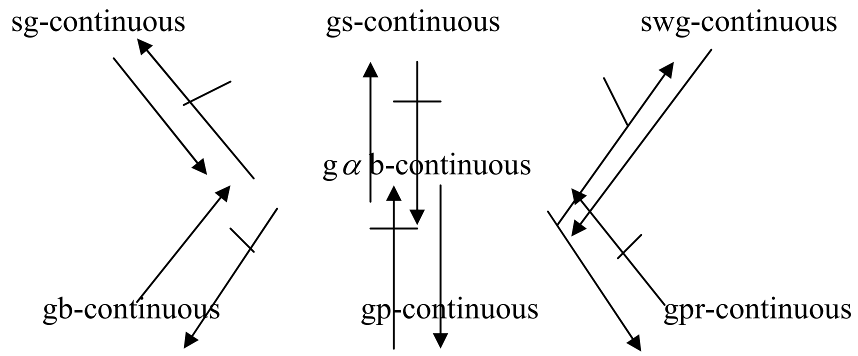
Example 3.29: Let X=Y={a,b,c}with τ ={X,Φ,{a}}and σ = {Y, Φ, {b},{c},{a,c},{b,c}} and f be the identity map. Then f is g-continuous but not gαb-continuous then f(a)=b and f(c)=c then the inverse image of open set {a,c} in Y is {b,c} is not gαb-open in X.

Example3.30: LetX=Y={a,b,c}with τ={X,Φ,{a},{c},{a,c}}and σ ={Y,Φ, {a},{b},{a,b}} and f be the identity map. Then f is gαb-continuous but not g-continuous then f(a)=b and f(b)=a and f(c)=c then the inverse image of open set {a,b} in Y is {a,b} is not g-open in X.

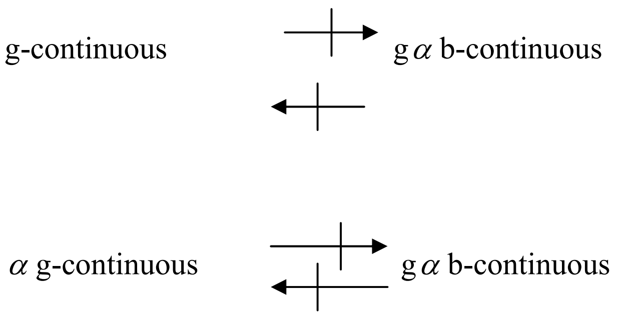
Remark3.31:The following examples shows that

gαb –continuous $\nrightarrow$ $\nleftarrow$ g-continuous are need not be same.

1.From the above results we form the following diagram:



2.



4.Generalized- αb open maps and Generalized-αbclosed maps.

In this section we introduce generalized-αb open(gαb-open) maps and generalized-αb closed(gαb-closed) maps.

Definition 4.1: Let X and Y be two topological space. A map f:(X,τ)→(Y,σ) is called generalized-αb- open(gαb-open) map if the image of every open set in X is gab-open in Y.

Theorem 4.2: Every open map is gαb-open but not conversely.

Proof: Let f:(X,τ)→(Y,σ) is an open map and V be an open set in X then f(V) is open in Y and hence gαb-open inY.Thus f is gαb- open the converse of the above theorem need not be true as seen from the following example.

Example4.3: Consider X=Y ={a,b,c}, τ ={X,Φ, {b},{a,b},{b,c}} and σ ={Y, Φ,{b}}.Let a map f:(X,τ)→(Y,σ) be defined by f(a)=a=f(c),f(b)=b then this function is gαb-open but not open as the image of the open set {a,b}in X is{a,b} not open in Y.

Definition4.4 : Let X and Y be topological space. A map f:(X,τ)→(Y,σ) is called gαb-closed map if the image of every closed set in X is gαb-closed set in Y.

Theorem4.5: Every closed map is gαb-closed but not conversely.

Proof:Let f:(X,τ)→(Y,σ) be closed map and V be a closed set in X.Then f(v) is closed and hence gαb-closed in Y.Thus f is gαb-closed.
The converse of the above theorem need not be true as seen from the following example.

Example4.6: Consider X=Y={a,b,c} ,τ= {X,Φ, {b}} and σ ={Y, Φ, {b},{a,b}} and a map f:(X,τ)→(Y,σ) be defined by f(a)=a,f(b)=b,f(c)=c. This function f is gαb-closed but not closed as f({a,b})={a,b} is not closed in Y.

Theorem4.7:A map f:(X,τ)→(Y,σ) is gαb-closed if and only if for each subset S of Y and for each α -open set U containg $f^{-1}(S)$ there is a gαb-open set V of Y such that $S\subseteq V$and $f^{-1}(V)\subseteq U$.

Proof: Suppose f is gαb-closed.Let S be a subset of Y and U be an α–open set of X such that $f^{-1}(S)\subseteq U$,V=Y -f(X-U) is gαb-open set containing S such that $f^{-1}(V)\subseteq U$.
Converse, suppose that F is a closed set of X.Then f^{-1} (Y-f(F)) $\subseteq$ X-F and X-F is open. By hypothesis there is a gαb-open set V of Y such that X-f(F)$\subseteq$ V and f^{-1} (V)$\subseteq$ X-F.Therefore F$\subseteq$ X- f^{-1} (V),hence Y-V$\subseteq$ f(F)$\subseteq$ f(X- f^{-1} (V))$\subseteq$Y-V which implies f(F)=Y-V, since Y-V is gαb-closed, f(F) is gαb-closed and hence f is gαb-closed map.

Theorem4.8: If a map f:(X,τ)→(Y,σ) is continuous and gαb-closed A is gαb-closed set of X then f(A) is gαb-closed in Y.

Proof: Let f(A)⊆ U where U is α-open set inY,since f is continuous f^{-1} (U) is an open set containing A hence bcl(A) ⊆ f^{-1} (U) as A is gαb-closed since f is gαb-closed f(bcl(A))⊆ U is gαb-closed U is an α–open set which implies bcl(f(bcl(A)) ⊆ U and hence bcl(f(A)) ⊆ U so f(A) is gαb-closed set in Y.

Corollary 4.9: If map f:(X,τ)→(Y,σ) is continuous and closed and A is gαb-closed then f(A) is gαb-closed in Y.

Corollary 4.10: If a map f:(X,τ)→(Y,σ) is gαb-closed and A is closed set of X the f_A:A→Y is gαb-closed.

Corollary 4.11: If a map f:(X,τ)→(Y,σ) is gαb-closed and continuous and A is gαb-closed set of X then f_A:A→Y is continuous and gαb-closed.

Proof: Let F be a closed set of A then F is gαb-closed set of X by the theorem f(A) is gαb-closed hence f_A(F)=f(F) is gαb-closed set of Y.Here f_A is gαb-closed and also continuous.

Definition 4.12:A space X is said to be α–normal if for every two disjoint closed subsets A and B of X there exist two disjoint α -open sets U and V such that A ⊂ U and B ⊂ M.

Theorem 4.13: If a map f:(X,τ)→(Y,σ) is continuous gαb-closed map from a α–normal space X into a space then is α– normal.

Proof: Let A,B be disjoint closed sets of Y,then f is continuous A and B are closed sets implies f^{-1}(A),f^{-1}(B) are disjoint closed sets of X,since X is α –normal there are two disjoint open sets U,V in X such that f^{-1}(A) ⊆ U and f^{-1}(B) ⊆ V since f is g α b-closed by the theorem 4.2, there are gαb-open sets G,H in Y such that A ⊆ G,B⊆ H and f^{-1}(G)⊆ U and f^{-1}(H)⊆ V since U,V are disjoint α-open sets bint(G) and bint(H) are disjoint open sets since G is α –open, A is closed and A⊆ G,A⊆ bint(G) and H is α–open set is closed and B⊆ H then B⊆ bint (H) hence Y is α–normal.

Definition 4.14:A space X is said to be α -regular if for each closed set F of X and each x∈ X-F there exit disjoint α -open sets U and V such that x ∈ U and F⊂V.

Theorem 4.15: If a map f:(X,τ)→(Y,σ) is α –open, continuous, gαb-closed and surjection where X is α–regular then Y is α-regular.

Proof: Let U be an α–open set containing a part x of X such that f(x)=p since X is α–regular and f is continuous there is an α-open set V such that $x\in V\subseteq f^{-1}(U)$ hence $p\in f(V)\subseteq f(bcl(V))\subseteq U$ since f is gαb-closed f(bcl(V)) is gαb-closed then $f(bcl(V))\subseteq U$,U is and α –open set it follows that $cl(int(f(bcl(V))\subseteq U$ and hence $p\in f(V)\subseteq bcl(f(V))\subseteq U$ and f(U) is α -open, since f is α–open hence y is α–regular.

Remark: The following example show that the α -regular closed maps and gαb-closed maps are independent.

Example4.16:Let X=Y={a,b,c} and a map f:(X,τ)→(Y,σ) be identity map with τ = {X,Φ, {a},{b},{a,b}} and σ={y, Φ, {a},{a,b}}.then f is gαb-closed but not α-regular closed as the image of the α-regular closed set {a,c} in X is {a,c} in Y is not gαb-closed.

Definiton 4.17: (approximately- αb-continuous)

A map f:(X,τ)→(Y,σ) is said to be approximately gαb-continuous if $bcl(F)\subseteq f^{-1}(U)$ whenever U is α-open subset of subset of Y and F is gαb-closed subset of X such that $F\subseteq f^{-1}(U)$.

Definition4.18:(approximately-αb-closed)

A map f:(X,τ)→(Y,σ) is said to be approximately αb-closed if $f(F)\subseteq bint(V)$,whenever V is gαb-open subset of Y. F is an α-closed subset of X and $f(F)\subseteq V$

Definition 4.19: (approximatly-αb-continuous map)

A map f:(X,τ)→(Y,σ) is said to be approximately b-open if $bcl(F)\subseteq f(V)$ whenever V is an α-open subset of X. F is gαb-closed subset of Y and $F\subseteq f(V)$.

Theorem 4.20: If a map f:(X,τ)→(Y,σ) is ap-αb-continuous and b-closed then the image of each gαb-closed set in X is gαb-closed in Y.

Proof: Let F be a gαb-closed subset of X.Let $f(F)\subseteq V$ where Vis α-open set of Y. Then $F\subseteq f^{-1}(V)$ since f is ap-αb-continuous we have $bcl(F)\subseteq f^{-1}(V)$ then $f(bcl(F))\subseteq V$ therefore we have $bclf(F)\subseteq bcl(f(bcl(F))=f(bcl(F))\subseteq V$ hence f(F) is gαb-closed in Y.

Theorem 4.21: If f:(X,τ)→(Y,σ) is ap-αb-closed and b-closed function then f(A) is gαb-closed in Y for every gαb-closed set A of X.

Proof: Let A be gαb-closed in X. Let f(A) ⊆ V where V be any α-open set in Y since f is continuous $f^{-1}(V)$ is α-open in X and A⊆ $f^{-1}(V)$.Then we have bcl(A)⊆ $f^{-1}(V)$ and so f(bcl(A)) ⊆V since f is closed,f(bcl(A)) is gαb-closed in Y and hence bcl(f(A)) ⊆ bcl(f(bcl(A)))=f(bcl(A)) ⊆ V.This shows that bcl(f(A))⊆ V therefore f(A) is gαb-closed in Y.

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