On Generalized d-Closed Sets

H. Jude Immaculate
Research Scholar
Nirmala College for Women
Coimbatore.

I. Arockiarani
Department of Mathematics
Nirmala College for Women
Coimbatore.

ABSTRACT
In this paper we present a new class of sets and functions namely gd-closed sets, gd-irresolute functions in the light of d-open sets in topological spaces. Further some of their characterizations are investigated with counter examples.

Keywords
gd-closed sets, gd-continuous functions, gd-irresolute functions.

1. INTRODUCTION
Many different forms of continuous functions have been introduced over years. Most of them involve the concept of g-closed sets, β-open sets, semiopen sets, sg-open sets, etc. In 1987, Bhattacharya and Lahiri [5] introduced the class of semi-generalized closed sets. In 1990, Arya and Nour[3]defined generalized semiclosed sets. The concept of generalized closed sets was first initiated by Levine in 1970[12]. The notion of b-open sets was defined by D. Andrijevic in 1996[2].In this paper a new class of sets called gd-closed sets has been introduced using the concept of d-closed sets by I.Arockiarani et al[10]. Further we study the basic properties of gd-closed sets. Using this new concept of sets we have introduced new class of functions called gd-continuous and gd-irresolute functions. Some of its basic properties and composition of functions is also discussed here.

Preliminaries: We present here relevant preliminaries required for the progress of this paper

Definition 1.1: A subset A of a topological space (X, τ) is called

1. Preclosed set[15] if cl(int(A)) $\subseteq$ A, preopen set if A $\subseteq$ int(cl(A))
2. α -open set [17] if A $\subseteq$ int(cl(int(A))), α -closed set if cl(int(cl(A))) $\subseteq$ A.
3. Regular open set[19] if A=int(cl(A)), regular closed set if A=cl(int(A)))
4. Semiopen set [11] if A $\subseteq$ cl(int(A)), semiclosed set if int(cl(A) $\subseteq$ A.
5. Semi-pre-open set[1] if A $\subseteq$ cl(int(cl(A))), semi-pre-closed set if int(cl(int(A))) $\subseteq$ A.
6. d-open set[10] if A $\subseteq$ scl(int(A)) $\cup$ sint(cl(A))

Definition 1.2: A subset A of a topological space (X, τ) is called

1. A generalized closed set[12] (briefly g-closed) set if cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open.
2. A generalized semiclosed set[3] (briefly gs-closed if $s$cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open.
3. A α-generalized closed set [13](briefly α g-closed) if α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open.
4. A generalized preclosed set [14](briefly gp-closed) if pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open.
5. A generalized pre regular closed set[9] (briefly gpr-closed) if pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open
6. A α-regular generalized closed set[12] (briefly α gr –closed) if α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open
7. A regular generalized closed set [18](briefly rg-closed) if cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular-open.

2. GENERALIZED D-CLOSED SETS
Definition 2.1: A subset A of a space X is called Generalized d-closed set if dcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open. The class of all generalized d-closed sets is denoted by GDC(X).

Definition 2.2:

i. The gd-closure of a subset A of X is denoted by gdcl(A) is the smallest gd-closed set containing A.
ii. The gd-interior of a subset A of X is denoted by gdint(A) is the largest gd-open set contained in A.

Proposition 2.3[9]: The intersection of a open set and d-open set is d-open set.

Proposition 2.4:

i. Every closed set is gd-closed set.
ii. Every d-closed set is gd-closed set.

Proof:

i. Let A be closed set such that A $\subseteq$ U where U is open in (X, τ). Since A is closed cl(A)=A $\subseteq$ U. But every closed set is d-closed. Hence A is gd-closed.

ii. Let A be d-closed set such that A $\subseteq$ U where U is open in (X, τ). Since A is d-closed dcl(A)=A $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.5: Let X= {a, b, c}, τ = {X, φ, {a}, {a, b}}. A= {a, c} is gd-closed but not d-closed or closed.

Proposition 2.6: Every α -closed set is gd-closed set.

Proof: Let A be α -closed set such that A $\subseteq$ U where U is open in (X, τ). Since A is α -closed α cl(A)=A $\subseteq$ U. But every α-closed set is d-closed. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.7: Let X= {a, b, c}, τ = {X, φ, {a}, {b, c}}. A= {b} is gd-closed but not α -closed.

Proposition 2.8: Every preclosed set is gd-closed set.

Proof: Let A be preclosed set such that A $\subseteq$ U where U is open in (X, τ). Since A is preclosed set pcl(A)=A $\subseteq$ U. But every preclosed set is d-closed set. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.9: Let X= {a, b, c}, τ = {X, φ, {a}, {a, b}}. A= {a, c} is gd-closed set but not preclosed set.

Proposition 2.10: Every semiclosed set is gd-closed set.

Proof: Let A be a semiclosed set such that A $\subseteq$ U where U is open in (X, τ). Since A is semiclosed set scl(A)=A $\subseteq$ U. But every semiclosed set is d-closed set. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.11: Let X= {a, b, c}, τ = {X, φ, {a}, {b, c }}. A= {b} is gd-closed set but not semiclosed set.

Proposition 2.12: Every g-closed set is gd-closed set.

Proof: Let A be a g-closed set then cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in (X, τ). Since every closed set is d-closed set we have dcl(A) $\subseteq$ cl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.13: Let X= {a, b, c}, τ = {X, φ, {a}, {a, b}}. A= {b} is gd-closed set but not g-closed set.

Proposition 2.14: Every α g-closed set is gd-closed set.

Proof: Let A be a αg-closed set then α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in (X, τ). Since every α -closed set is d-closed set we have dcl(A) $\subseteq$ α cl(A) $\subseteq$ U. Hence A is d-closed. The converse of the above result need not be true may seen by the following example.

Example 2.15: Let X= {a, b, c}, τ = {X, φ, {b, c}}. A= {b} is gd-closed set but not α g-closed set.

Proposition 2.16: Every gp-closed set is gd-closed set.

Proof: Let A be a gp-closed set then pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in (X, τ). Since every pre closed set is d-closed set we have dcl(A) $\subseteq$ pcl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example2.17: Let X= {a, b, c}, τ = {X, φ, {a}, {b}, {a, b}}. A= {a} is gd-closed set but not gp-closed set.

Proposition2.18: Every gpr-closed set is gd-closed set.

Proof: Let A be a gpr-closed set then pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open in (X, τ). Every regular open is open hence A $\subseteq$ U and U is open. Since every pre closed set is d-closed set we have dcl(A) $\subseteq$ pcl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.19: Let X= {a, b, c}, τ = {X, φ, {a}, {b}, {a, b}}. A= {a} is gd-closed set but not gpr-closed set.

Proposition 2.20: Every α gr-closed set is gd-closed set.

Proof: Let A be a α gr-closed set then α cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open in (X, τ). Every regular open is open hence A $\subseteq$ U and U is open. Since every α -closed set is d-closed set we have dcl(A) $\subseteq$ αcl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example2.21: Let X= {a, b, c}, τ = {X, φ, {a}, {b}, {a, b}}. A= {a} is gd-closed set but not α gr-closed set.

Proposition 2.22: Every rg-closed set is gd-closed set.

Proof: Let A be a rg-closed set then cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open in (X, τ). Every regular open is open hence A $\subseteq$ U and U is open. Since every closed set is d-closed set we have dcl(A) $\subseteq$ cl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.23: Let X= {a, b, c}, τ = {X, φ, {a}, {b}, {a, b}}. A= {a} is gd-closed set but not rg-closed set.

Proposition 2.24: Every gs-closed set is gd-closed set.

Proof: Let A be a gs-closed set then scl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in (X, τ). Since every semiclosed set is d-closed set we have dcl(A) $\subseteq$ scl(A) $\subseteq$ U. Hence A is gd-closed. The converse of the above result need not be true may seen by the following example.

Example 2.25: Let X= {a, b, c}, τ = {X, φ, {b, c}}. A= {b} is gd-closed set but not gs-closed set.

From the above examples we have the following diagram

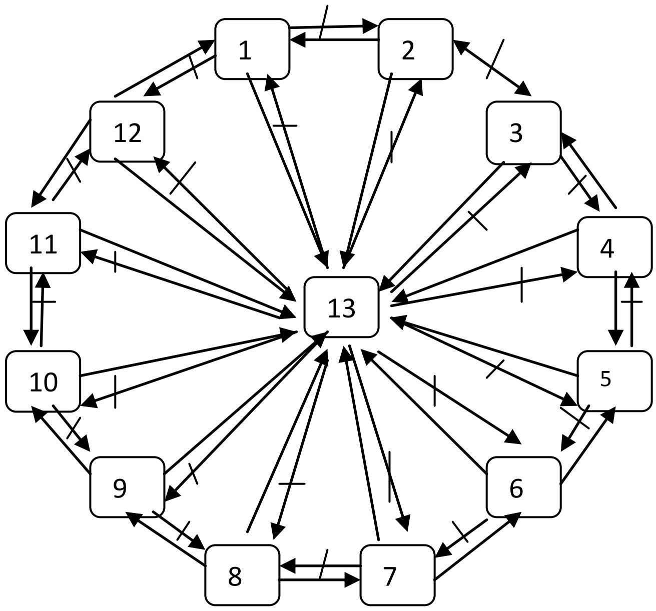

Figure. 1 Relation between generalized d-closed set and other existing closed sets

1.gs closed set 2.g closed set 3. α gr closed set 4. rg closed set 5. gpr closed set 6. gp closed set

7. α g-closed set 8. α -closed set 9.semiclosed set 10.d-closed set 11.preclosed set 12.closed set

13.gd-closed set.

Lemma 2.26: For a subset A of a space X the following hold

a. dcl(A)=A $\cup$ (sint(cl(A) $\cap$ scl(int(A))
b. dint(A)=A $\cap$ (scl(int(A) $\cup$ sint(cl(A))
c. dcl(X-A)=X-dint(A)

Theorem2.27: A set A is gd-open if and only if F $\subseteq$ dint(A) whenever F is closed and F $\subseteq$ A.

Proof: Let A be gd-open and suppose that F $\subseteq$ A and F is closed. Then X-A is gd-closed set. Thus gdcl(X-A) $\subseteq$ X-F . But dcl(X-A)=X-dint(A). Thus X-dint(A) $\subseteq$ X-F. Hence F $\subseteq$ dint(A).Conversely, let F be closed set with F $\subseteq$ dint(A) whenever F $\subseteq$ A. F $\subseteq$ A $\Rightarrow$(X-A) $\subseteq$ (X-F). Also F $\subseteq$ dint(A). Thus (X-dint(A))=dcl(X-A) $\subseteq$ X-F where (X-F) is open. Thus A is gd-open.

Theorem 2.28: Let A be closed subset of (X, τ). Then dcl(A)-A does not contain any non empty closed set.

Proof: Let A be generalized d-closed and F be a non empty closed set such that F $\subseteq$ dcl(A)-A**.** Then F $\subseteq$ dcl(A) $\cap$ F $\subseteq$ dcl(A) and F $\subseteq A^c$. F $\subseteq A^c \Rightarrow F^c$ is open. Then dcl(A) $\subseteq F^c \Rightarrow$F $\subseteq (dcl(A))^c$ .F $\subseteq$ dcl(A) $\cap$ $(dcl(A))^c \Rightarrow$F $\subseteq \varphi$ which is a contradiction. Hence dcl(A)-A contains no non empty closed set.

Theorem 2.29: Let A be a gd-closed subset of (X, τ) and A $\subseteq$ B $\subseteq$ dcl(A), then B is gd-closed.

Proof: Let A $\subseteq$ B $\subseteq$ dcl(A) then dcl(A)=dcl(B).Since A is gd-closed, dcl(A) $\subseteq$ G where A $\subseteq$ G; G is open in X. Let B $\subseteq$ G and G is open in X, since A is gd-closed and since dcl(A)=dcl(B), dcl(B) $\subseteq$ G. Thus B is gd-closed.

Theorem 2.30: A gd-closed set A is d-closed if and only if dcl(A)-A is closed

Proof: Let A be gd-closed. If A is d-closed then dcl(A)-A= φ is a closed set. Thus dcl(A)-A is closed. Conversely, let dcl(A)-A be closed. .dcl(A)-A is closed subset of itself hence dcl(A)-A contain any non empty closed subset thus dcl(A)-A = φ (i.e) A=dcl(A).Hence A is d-closed.

Definition 2.31: Let B $\subseteq$ A $\subseteq$ X, then we say B is gd-closed relative to A if $dcl_A(B)$ $\subseteq$ U when B $\subseteq$ U and U is open in A

Theorem 2.32: Let B $\subseteq$ A $\subseteq$ X where A is gd-closed and open. Then B is gd-closed relative to A if and only if B is gd-closed.

Proof: Let B $\subseteq$ A $\subseteq$ X, where A is gd-closed and open and let B is gd-closed relative to A. Since B $\subseteq$ A and A is gd-closed and open dcl(A) $\subseteq$ A. Thus dcl(B) $\subseteq$ dcl(A) $\subseteq$ A. $dcl_A(B)$ =A $\cap$ dcl(B) so dcl(B)= $dcl_A(B)$ $\subseteq$ A. If B is gd-closed relative to A and U is a open subset of X such that B $\subseteq$ U then B=B $\cap$ A $\subseteq$ U $\cap$ A where U $\cap$ A is open in A. Thus B is gd-closed relative to A. dcl(B)= $dcl_A(B)$ $\subseteq$ U $\cap$ A $\subseteq$ U. Thus B is gd-closed in X. Conversely, Let B is gd-closed in X and U is open subset of A such that B $\subseteq$ U. Let U=V $\cap$ A for some open subset V of X.As B $\subseteq$ V & B is gd-closed in X ,dcl(B) $\subseteq$ V. Thus $dcl_A(B)$ =dcl(B) $\cap$ A $\subseteq$ V $\cap$ A=U. Hence B is gd-closed relative to A.

Corollary 2.33: Let A be a gd-closed set which is also open then A $\cap$ F is gd-closed whenever F is d-closed.

Proof: Let A be a gd-closed and open then dcl(A) $\subseteq$ A. But A $\subseteq$ dcl(A) thus A=dcl(A).Hence A $\cap$ F is d-closed. Every d-closed is gd-closed. A $\cap$ F is gd-closed.

Remark 2.34: Intersection of two gd-closed sets need not be gd-closed.

Example 2.35: Let X={a, b, c}**,** τ ={X, φ,{a}}**.** A= {a, b} which is gd-closed set. B= {a, c} which is gd-closed set. But A $\cap$ B= {a} is not gd-closed.

Remark 2.36: Union of two gd-closed sets need not be gd-closed.

Example 2.37: Let X={a, b, c}**,** τ ={X, φ,{a}, {c}, {a, c}}**,** A={a} which is gd-closed set. B={c} which is gd-closed set. But A $\cup$ B = {a, c} is not gd-closed.

3. gd-Continuous and gd-Irresolute Functions

Definition 3.1: A function f :(X, τ) $\rightarrow$ (Y, σ) is called gd-continuous if the pre image of every closed set of Y is gd-closed in X.

Definition 3.2: A function f: (X, τ) $\rightarrow$ (Y, σ) is called gd-irresolute if the pre image of every gd-closed set of Y is gd-closed in X.

Definition 3.3: A function f: (X, τ) $\rightarrow$ (Y, σ) be d-irresolute if the pre image of every d-open set in Y is d-open in X.

Definition 3.4: A function f: (X, τ) $\rightarrow$ (Y, σ) is called d -continuous if the inverse image of every closed set in Y is d-closed in X

Theorem 3.5: Let f:(X, τ) $\rightarrow$ (Y, σ) be d-continuous, then f is gd-continuous but not conversely.

Proof: Let V be a open set in Y. Since f is d-continuous then $f^{-1}(V)$ is d-open in X. But every d-open set is gd-open in X hence $f^{-1}(V)$ is gd-open in X for V$\in$Y. Thus f is gd-continuous.

Example 3.6: Let X= {a, b, c}, τ = {X, φ, {a}, {a, b}}**.** Y= {a, b, c}, σ = {{X, φ, {a}, {b}, {a, b}}**.** Let f:(X, τ)$\rightarrow$ (Y, σ) be identity map. f is gd-continuous but not d-continuous because f^{-1}(b)={b} $\notin$ DO(X).

Theorem 3.7: Let f: (X, τ) $\rightarrow$ (Y, σ) be a continuous function. If f is gd-continuous then for each point x $\in$ X and for each open set V in Y containing f(x), there exists a gd-open set U containing x such that f(U) $\subseteq$ V

The proof follows immediately.

Theorem 3.8: If the bijective map f :(X, τ)$\rightarrow$ (Y, σ) is d-irresolute and open, then f is gd-irresolute.

Proof: Let V be gd-closed in Y and let $f^{-1}(V)$ $\subseteq$ U where U is open in X. Hence V $\subseteq$ f(U) holds. Since f(U) is open and V is sgd-closed in Y dcl(A) $\subseteq$ f(U).Therefore f^{-1}(dcl(V) $\subseteq$ U and since f is d-irresolute and dcl(V) is d-closed in Y, f^{-1}(dcl(V) is d-closed set in X. Thus dcl($f^{-1}(V)$) $\subseteq$ dcl(f^{-1}(dcl(V))) = f^{-1}(dcl(V) $\subseteq$ U. Hence $f^{-1}(V)$ is gd-closed and thus f is gd irresolute.

Remark 3.9: The concept of d-irresoluteness and gd-irresoluteness are independent.

Example 3.10: Let X= {a, b, c}, τ = {X, φ, {a}, {a, b}}. Y= {a, b, c}, σ = {{X, φ, {a}}. Let f:(X, τ) $\rightarrow$ (Y, σ) be identity map. Here f is d-irresolute but not gd-irresolute since V={c} $\in$ GDO(Y) but f^{-1}(c)={c} $\notin$ GDO(X).

Example 3.11: Let X= {a, b, c}, τ = {X, φ, {a}}. Let f:(X, τ)$\rightarrow$ (Y, σ) be defined by f(a)=f(c)=b, f(b)=c. Here f is gd-irresolute but not d-irresolute, since V={b} $\in$ DC(X) but $f^{-1}(b)$={a, c}$\notin$D $\in$ C(X).

Theorem 3.12: Let f:(X, τ) $\rightarrow$ (Y, σ) be a map from a topological space (X, τ) into a topological space (Y, σ), then the following are equivalent.

a) f is gd-continuous.

b) The inverse image of each open set in Y is gd-open in X.

The proof follows immediately from the definition.

Theorem 3.13: Let f:(X, τ)$\rightarrow$ (Y, σ) and g: (Y, σ)$\rightarrow$(Z, μ) be any two functions then

1. gof: (X, τ)$\rightarrow$(Z, μ) is gd-continuous if g is continuous and f is gd-continuous.
2. gof: (X, τ) $\rightarrow$ (Z, μ) is gd-irresolute if g is gd-irresolute and f is gd- irresolute.
3. gof: (X, τ) $\rightarrow$ (Z, μ) is gd-continuous if g is gd-continuous and f is gd-irresolute.

Proof:

1. Let V closed set in (Z, μ). $g^{-1}(V)$ is closed in (Y, σ), since g is continuous. Thus $f^{-1}(g^{-1}(V))$ is gd-closed in (X,τ) since f is gd-continuous. Thus gof is gd-continuous.
2. Let V be gd-closed set in (Z, μ), since $g^{-1}(V)$ is gd-closed in (Y, σ).Since f is gd-irresolute, is gd-closed in (X, τ). Thus gof is gd-irresolute.
3. Let V be closed set in (Z,μ). Thus $g^{-1}(V)$ is gd-closed in (Y, σ).Since f is gd-irresolute $f^{-1}(g^{-1}(V))$ is gd-closed in (X, τ). Thus gof is gd-continuous.

Definition 3.14: A topological space X is called a d-$T_{\frac{1}{2}}$ space if every gd-closed set is closed.

Definition 3.15 [13]: A topological space X is called a $T_{\frac{1}{2}}$ space if every g-closed sets is closed.

Definition 3.16 [7]: A topological space is called a $_{\alpha}T_b$ space if every α g-closed set is closed.

Proposition **3.18:**

1. Every d-$T_{\frac{1}{2}}$ space is a $T_{\frac{1}{2}}$ space
2. Every d-$T_{\frac{1}{2}}$ space is a $_{\alpha}T_b$ space.

Example 3.18: Let X={a, b, c}, τ = {X, φ, {a} {b},{a, b}}.Then the collection is $T_{\frac{1}{2}}$ and $_{\alpha}T_b$ but not d-$T_{\frac{1}{2}}$ since A={b} is gd-closed but not closed.

Theorem 3.19: Let f:(X, τ)$\rightarrow$ (Y, σ) be gd-irresolute function then f is d-irresolute function if X is d-$T_{\frac{1}{2}}$ space.

Proof: Let V be d-closed set in Y. Since V is gd-closed in Y and f is gd-irresolute, $f^{-1}(V)$ is gd-closed in x. But X is d-$T_{\frac{1}{2}}$ so $f^{-1}(V)$ is closed in X. Every closed is d-closed hence f is d-irresolute.

Theorem 3.20: Let X and Z be any topological spaces and Y be a d-$T_{\frac{1}{2}}$ space then the composition

1. gof: (X, τ) $\rightarrow$ (Z, μ) is gd-continuous if g is gd-continuous and f is gd-continuous.
2. gof: (X, τ) $\rightarrow$ (Z, μ) is d-continuous if g is gd-continuous and f is d-continuous.
3. gof: (X, τ) $\rightarrow$ (Z, μ) is gd-continuous if g is gd-irresolute and f is gd-continuous.
4. gof: (X, τ) $\rightarrow$ (Z, μ) is d-continuous if g is gd-irresolute and f is d-continuous.

Proof:

1. Let U be closed set in Z, then $g^{-1}(U)$ is gd-closed in Y. But Y is a d-$T_{\frac{1}{2}}$ space thus $g^{-1}(U)$ is closed in Y. Since f is gd-continuous $f^{-1}(g^{-1}(V))$ is gd-closed in X. Thus gof is gd-continuous.
2. Let U be closed set in Z, then $g^{-1}(U)$ is gd closed in Y. But Y is a d-$T_{\frac{1}{2}}$ space thus $g^{-1}(U)$ is closed in Y. Since f is d-continuous $f^{-1}(g^{-1}(V))$ is d-closed in X. Thus gof is d-continuous.
3. Let U be gd-closed set in Z, then $g^{-1}(U)$ is gd-closed in Y. But Y is a d-$T_{\frac{1}{2}}$ space thus $g^{-1}(U)$ is closed in Y.Since f is gd-continuous $f^{-1}(g^{-1}(V))$ is gd-closed in X. Thus gof is gd-continuous.
4. Let U be gd-closed in Z, then $g^{-1}(U)$ is gd-closed in Y. But Y is a d-$T_{\frac{1}{2}}$ space thus $g^{-1}(U)$ is closed in Y. Since f is d-continuous $f^{-1}(g^{-1}(V))$ is d-closed in X. Thus gof is d-continuous in X.

3. CONCLUSION

In general toplogy g-closed sets has a major role. Since its inception several weak forms of g-closed sets have been introduced in general toplogy. The present paper investigated in new weak form of g closed sets namely gd-closed sets and functions namely gd-irresolute functions in the light of d-open sets in topological spaces. Some of its basic properties and composition of functions is also discussed. Many examples had been given to justify the results.

4. REFERENCES

[1] D.Andrijevic, “Semi-preopen sets”, Mat. Vesnik,38(1) (1986) 24-32.

[2] D.Andrijevic, “On b-open sets”, Mat Vesnik 48(1996), no 1-2, 59-64.

[3] S.P. Arya and T.M. Nour, “Characterizations of S-normal spaces”, Indian J. Pure. Appl. Math.21(1990).no.8, 717-719.

[4] M.E.Abd.El-Monsef, S.N El-Deeb and R.A Mohmoud,’β-open sets and β-continuous mapping”, Bull. Fac.Sci.Assuit Univ.12(1983),77-90.

[5] P.Bhattacharyya and B.K.Lahiri,”Semigeneralized closed sets in topology”, Indian [4].J.Math. 29(1987)no.3, 375-382(1988)

[6] M.C.Cueva, “On g-closed sets and g-continuous mappings:,Kyungpook Math.J.vol3,2(1993), 205-209.

[7] R.Devi, K.Balachandran and I.Maki, Generalized α-closed maps and α-generalized closed maps. Indian J.Pure.Appl.Math.,29(1)(1998),37-49.

[8] J.Dontchev, “On generalizing semi-preopen sets”, Mem. Fac. Sci. Kochi. Univ. Ser. A. Math. 16(1995), 35-48.

[9] Gnanambal. Y[1997] On generalized pre-regular closed sets in topological spaces. India.J.pure Appl. Math.28(3):351-360.

[10] Jude Immaculate. H and I.Arockiarani,” A note on d-locally closed sets”, International Journal of Mathematical Archive (2014)(Feb)(Accepted).

[11] N. Levine, “Semi-open sets and semi-continuity in topological spaces”, Amer. Math. Monthly 70(1963), 36-41

[12] N. Levine, ”Generalized closed set in topology”, Rend. Circ. Math. Palermo, 19(2), (1970), 489-96.

[13] H.Maki, R. Devi and K. Balachandran,, ”Associated topologies of generalized α-closed sets and α-generalized closed set”,Mem. Fac. Sci. Kochi. Univ. Ser. A. Math 15(1994), 51-63.

[14] H.Maki, J. Umerhara and T. Noiri, “Every topological space is pre$T_{1/2}$”,Mem.Fac. Sci. Kochi.Univ. Ser. A. Math 17(1996)33-42.

[15] A.S. Mashhour, Abd El-Monsef, M.E. and S.N.El-Deeb, ”On precontinuous and weak precontinuous functions”, Proc. Math. Phys. Soc. Egypt 51(1982), 47-53.

[16] T.Noiri, A.Al-Omari and M.S. M. Noorani, “Weakly b-open functions”, Mathematica Belkanica 23(2009),Fasc(1-2)1-14

[17] O.Njastad,” On some classes of nearly open sets”, Pacific J.Math 15(1965)961-970.

[18] Palaniappan.N and K.C.Rao(1993) Regular generalized closed sets. Kyungpook Math. J 33:211- 219.

[19] S.Willard,”General topology spaces”, Addison Wesley,1970.