Chapter 1

Preliminaries

Basic definitions and results in topological spaces, bitopological spaces and fuzzy topological spaces that are used to accomplish the present study are given in this chapter.

1.1 Topological Spaces

Definition 1.1.1 : Throughout the thesis (X, τ) , (Y, σ) and (Z, η) denote topological spaces on which no separation axioms are mentioned unless or otherwise stated.

If A is a non empty subset of (X, τ) then the union of all open sets contained in A is called **interior of A** and it is denoted by **int(A).** The intersection of all closed sets containing A is called **closure of A** and it is denoted by **cl(A).**

Definition 1.1.2 A subset A of (X, τ) is called a

- **Regular open set** (Stone 1937) if A = int(cl(A))
- **Semi open set** (Norman Levine, 1963) if $A \subseteq cl(int(A))$.
- **α-open set** (Njastad, 1965) if $A \subseteq int(cl(int(A)))$.
- **π-open set** (Zaitsav, 1968) if it is the finite union of regular open sets.

Definition 1.1.3 : A subset A of (X, τ) is called a **δ-open set** (Velicko, 1968) if $A = \delta int(A)$ where $\delta int(A)$ is the union of all regular open sets of X contained in A.

That is, a set is δ-open if it is the union of regular open sets.

The complement of δ-open is called δ-closed. That is, a set A is called a **δ-closed set** if $A = \delta cl(A)$ where $\delta cl(A)$ is the intersection of all regular closed sets of (X, τ) containing A.

Definition 1.1.4 A subset A of (X, τ) is called a

- **Pre-open set** (Mashhour et.al., 1982) if $A \subseteq int[cl(A)]$.

- **Semi pre open set** (Andrijevic, 1986) if $A \subseteq cl[int\{cl(A)\}]$

- **b-open set** (Andrijevic, 1996) if $A \subseteq int[cl(A)] \cup cl[int(A)]$.

The complements of the above mentioned sets are called regular closed, semi-closed, α-closed, π-closed, pre-closed, semi pre closed set and b-closed sets respectively.

The intersection of all regular closed, semi-closed (resp., α-closed, π-closed, pre-closed, semi pre closed and b-closed) sets of (X, τ) containing A is called the regular closure, semi-closure (resp., α-closure, π-closure, pre- closure, semi pre closure and b-closure) of A and are denoted by rcl(A), scl(A) (resp. αcl(A), pcl(A), πcl(A), spcl(A) and bcl(A)).

- A subset A of (X, τ) is called **clopen** if is both open and closed in (X, τ).

Definition 1.1.5 A subset A of a topological space (X, τ) is called

1. **generalized closed** (briefly **g-closed**) (Norman Levine, 1970) if $cl(A) \subseteq U$ whenever $A \subseteq U$ where U is open in (X, τ).

2. **generalised semi closed** (briefly, **gs-closed**) (Arya, et.al., 1990) if $scl(A) \subseteq U$ whenever $A \subseteq U$ where U is open in (X, τ).

3. **regular generalized closed** (briefly **rg-closed**) (Palaniappan, et.al.,1993) if $cl(A) \subseteq U$ whenever $A \subseteq U$ where U is regular open in (X, τ).

4. **α-generalized closed** (briefly **αg-closed**) (Maki, et.al., 1994) if αcl(A) ⊆ U whenever A ⊆ U where U is open in (X, τ).

5. **generalized pre-closed** (briefly **gp-closed**) (Maki, et.al., 1996) if pcl(A) ⊆ U whenever A ⊆ U where U is open in (X, τ).

6. **δ-generalized closed** (briefly **δg-closed**) (Julian Dontchev, 1996) if δcl(A) ⊆ U whenever A ⊆ U where U is open in (X, τ).

7. **generalized pre regular closed (**briefly **gpr-closed**) (Gnanambal, 1997) if pcl(A) ⊆ U whenever A ⊆ U where U is regular open in (X, τ).

8. **π-generalised closed** (briefly, **πg-closed**) (Julian Dontchev et.al., 2000) if cl(A) ⊆ U whenever A ⊆ U where U is π-open in (X, τ).

9. **g^*-closed** (Veerakumar, 2002) if cl(A) ⊆ U whenever A ⊆ U where U is g-open in (X, τ).

10. **g^*p -closed** (Veerakumar, 2002) if pcl(A) ⊆ U whenever A ⊆ U where U is g-open in (X, τ).

11. **$\hat{g}$-closed** (Veerakumar, 2003) if cl(A) ⊆ U whenever A ⊆ U where U is semi open in (X, τ).

12. **$g^{\#}$s-closed** (Veerakumar, 2003) if scl(A) ⊆ U whenever A ⊆ U where U is αg-open in (X, τ).

13. **generalized δ-closed** (briefly **gδ-closed**) (Julian Dontchev, 2000) if $cl(A) \subseteq U$ whenever $A \subseteq U$ where U is δ-open in (X, τ).

14. **$\delta g^{\ddagger}$-closed** set(Julian Dontchev, 2000) if $\delta cl(A) \subseteq U$ whenever $A \subseteq U$ where U is δ-open in (X, τ).

15. **π-generalised pre- closed** (briefly, **πgp-closed**) (Park, 2004) if $pcl(A) \subseteq U$ whenever $A \subseteq U$ where U is π-open in (X, τ).

16. **Mildly generalised closed (Mildly g-closed)** (Park, 2004) if $cl(Int(A)) \subseteq U$ whenever $A \subseteq U$ where U is g-open in (X, τ).

17. **$\# gs$ -closed** (Veerakumar 2005) if $scl(A) \subseteq U$ whenever $A \subseteq U$ where U is *g-open in (X, τ).

18. **πgs-closed** (Aslim et.al., 2006) if $scl(A) \subseteq U$ whenever $A \subseteq U$ where U is π-open in (X, τ).

19. **$\alpha\hat{g}$-closed** (Abd El-Monsef et al., 2007) if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ where U is $\hat{g}$-open in (X, τ).

20. **$*g$-closed** (Jafari et.al., 2008) if $pcl(A) \subseteq U$ whenever $A \subseteq U$ where U is $\hat{g}$-open in (X, τ).

21. **regular weakly generalised closed (**briefly**, rwg-closed)** (Vadivel et.al., 2009) if cl(int(A)) $\subseteq$ U whenever A $\subseteq$ U where U is regular open in (X, τ).

22. **πgα-closed** (Janaki, 2009) if αcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is π-open in (X, τ).

23. **$\delta\hat{g}$-closed** (Lellis Thivagar et.al., 2010) if δcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is $\hat{g}$-open in (X, τ).

24. **generalised semi pre regular closed** (briefly, **gspr-closed**) (Sarsak et.al., 2010) if spcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is regular open in (X, τ).

25. **π-generalised semi pre-closed** (briefly, **πgsp-closed**) (Sarsak, 2010) if spcl(A) $\subseteq$ U whenever A $\subseteq$ U, U is π-open in (X, τ).

26. **g*s-closed** (Pushpalatha et.al., 2011) if scl(A) $\subseteq$ U whenever A $\subseteq$ U where U is gs -open in (X, τ).

27. **πgb-closed** (Sreeja et.al., 2011) if bcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is π-open in (X, τ).

28. **δ-generalised star closed** (briefly, **δg^*-closed**) (Sudha, 2012) if δcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is g-open in (X, τ).

29. **$w\delta g^*$-closed** (Sudha, 2012) if δcl(A) $\subseteq$ U whenever A $\subseteq$ U where U is g^*-open in (X, τ).

30. **(gs)*-closed** (Elvina Mary, 2014) if cl(A) □ U whenever A □ U where U is gs-open in (X, τ).

Definition 1.1.6 A subset A of a topological space (X, τ) is called

1. **Locally closed** (briefly, lc) (Ganster, et.al., 1989) if A = U ∩ F where U is open and F is closed in (X, τ).

2. **Generalized locally closed** (briefly, glc) (Balachandran, et.al., 1996) if A = U ∩ F where U is g-open and F is g-closed in (X, τ).

3. **Generalised locally semi closed** (briefly, glsc) (Gnanambal, 1998) if A = U ∩ F where U is g-open and F is semi closed in (X, τ).

Definition 1.1.7 A topological space (X, τ) is said to be a

1. **$T_{1/2}$-space** (Norman Levine, 1970) if every g-closed set is closed in (X, τ).

2. **T_b-space** (Devi, et.al., 1993) if every gs-closed set is closed in (X, τ).

3. **T_d-space** (Devi et.al., 1993) if every gs-closed set is g-closed in (X, τ).

4. **Door space** (Julian Dontchev, 1995) if every subset of (X, τ) is either open or closed in (X, τ).

5. **Submaximal space** (Julian Dontchev, 1995) if every dense subset of (X, τ) is open in (X, τ).

6. **$T_{3/4}$-space** (Julian Dontchev, 1996) if every δg-closed set is δ-closed in (X, τ).

7. **αT_b-space** (Devi et.al., 1998) if every αg-closed set is closed in (X, τ).

8. **T_c-space** (Veerakumar, 2000) if every gs-closed set is g^*-closed in (X, τ).

9. **αT_c -space** (Veerakumar, 2000) if every αg-closed set is g^*-closed in (X, τ).

10. **$^*T_{1/2}$ -space** (Veerakumar, 2000) if every g-closed set is g^*-closed in (X, τ).

11. **T_δ-space** (Julian Dontchev, 2000) if every gδ-closed set is δ-closed in (X, τ).

12. **πg-submaximal space** (Julian Dontchev, 2000) if every πg-dense set is πg-open in (X, τ).

13. **$_{g\delta}T_{\delta g^*}$ -space** (Sudha, 2014) if every gδ -closed set is δg^*-closed in (X, τ).

Results 1.1.8 Let f : X → Y be a map. If A_1 and A_2 are subsets of X and Y respectively then the following results are true.

1. If A_1 □ A_2 then $f(A_1)$ □ $f(A_2)$.

2. If A_1 □ A_2 then $f^{-1}(A_1)$ □ $f^{-1}(A_2)$.

3. In general, A □ $f^{-1}[f(A)]$. If f is injective then A = $f^{-1}[f(A)]$.

4. In general, $f[f^{-1}(A)]$ □ A. If f is injective then A = $f[f^{-1}(A)]$.

5. If f is surjective then $[f(A)]^c$ □ $f(A^c)$.

6. If f is bijective then $[f(A)]^c = f(A^c)$.

Definition 1.1.9 A function f : (X, τ) → (Y, σ) is called

1. C**ontinuous** (Norman Levine, 1970) if $f^{-1}(V)$ is a closed set in (X, τ) for every closed set V in (Y, σ).

2. **δ-continuous** (Noiri, 1980) if $f^{-1}(V)$ is a δ-closed set in (X, τ)) for every closed set V in (Y, σ).
3. **g-continuous** (Balachandran, et.al., 1991) if $f^{-1}(V)$ is a g-closed set in (X, τ) for every closed set V in (Y, σ).
4. **rg-continuous** (Palaniappan, et.al., 1993) if $f^{-1}(V)$ is a rg-closed set in (X, τ) for every closed set V in (Y, σ).
5. **δg-continuous** (Julian Dontchev, 1996) if $f^{-1}(V)$ is a δg-closed set in (X, τ) for every closed set V in (Y, σ).
6. **αg-continuous** (Devi, et.al., 1997) if $f^{-1}(V)$ is a αg-closed set in (X, τ) for every closed set V in (Y, σ).
7. **gpr-continuous** (Gnanambal**,** 1997) if $f^{-1}(V)$ is a gpr-closed set in (X, τ) for every closed set V in (Y, σ).
8. **gspr-continuous** (Gnanambal**,** 1997) if $f^{-1}(V)$ is a gspr-closed set in (X, τ) for every closed set V in (Y, σ).
9. **gp-continuous** (Arokiarani, 1999) if $f^{-1}(V)$ is a gp-closed set in (X, τ) for every closed set V in (Y, σ).
10. **πgp-continuous** (Park, 2004) if $f^{-1}(V)$ is a πgp-closed set in (X, τ) for every closed set V in (Y, σ).
11. **πgb-continuous** (Park, 2004) if $f^{-1}(V)$ is a πgb-closed set in (X, τ) for every closed set V in (Y, σ).
12. **πg-continuous** (Ekici et.al., 2007) if $f^{-1}(V)$ is a πg-closed set in (X, τ) for every closed set V in (Y, σ).
13. **πgs-continuous** (Aslim, 2006) if $f^{-1}(V)$ is a πgs-closed set in (X, τ) for every closed set V in (Y, σ).

14. **πgα-continuous** (Ekici et.al., 2007) if f^{-1}(V) is a πgα-closed set in (X, τ) for every closed set V in (Y, σ).

15. **πgsp-continuous** (Ekici et.al., 2007) if f^{-1}(V) is a πgsp-closed set in (X, τ) for every closed set V in (Y, σ).

16. **gδ–continuous** (Julian Dontchev 2000) if f^{-1}(V) is a gδ-closed set in (X, τ) for every closed set V in (Y, σ).

17. **g*s-continuous** (Pushpalatha et.al., 2011) if f^{-1}(V) is a g^*s-closed set in (X, τ) for every closed set V in (Y, σ).

18. **δg*-continuous** (Sudha 2013) if f^{-1}(V) is a δg^*-closed set in (X, τ) for every closed set V in (Y, σ).

Definition 1.1.10 A function f : (X, τ) → (Y, σ) is called

1. **Strongly continuous** (Norman Levine, 1960) if the inverse image of every subset of (Y, σ) is clopen in (X, τ).

2. **Perfectly continuous** (Noiri, 1976) if the inverse image of every closed set of (Y, σ) is clopen in (X, τ).

3. **Totally continuous** (Jain, 1980) if the inverse image of every open set of (Y,σ) is clopen in (X, τ).

4. **Locally continuous** (briefly, LC-continuous) (Ganster, M. et.al., 1989) if the inverse image of every open set of (Y,σ) is a locally closed set (briefly, lc set) in (X, τ).

5. **Generalized Locally continuous** (briefly, GLC continuous) (Balachandran, et.al., 1996) if the inverse image of every open set of (Y,σ) is a generalized locally closed set (briefly, glc set) in (X, τ).

6. **Contra continuous** (Julian Dontchev, J. 1996) if if the inverse image of every open set of (Y,σ) is a closed set of (X, τ).

Definition 1.1.11 A map f : (X, τ)→(Y, σ) is called

1. **irresolute** (Crossley 1972) if f^{-1}(V) is a semi open set of (X, τ) for every semi open set V of (Y, σ).
2. **α–irresolute** (Maheswari et.al., 1980) if f^{-1}(V) is a α–open set of (X, τ) for every α-open set V of (Y, σ).
3. **δg–irresolute** (Julian Dontchev, 1996) if f^{-1}(V) is a δg–open set of (X, τ) for every δg-open set V of (Y, σ).
4. **αg–irresolute** (Devi et.al., 1997) if f^{-1}(V) is a αg–open set of (X, τ) for every αg-open set V of (Y, σ).
5. **δg^*–irresolute** (Sudha 2014) if f^{-1}(V) is a δg^*–open set of (X, τ) for every δg^*-open set V of (Y, σ).

Definition 1.1.12 A map f : (X, τ)→(Y, σ) is called a

1. **Semi closed map** (Noiri, 1973) if f(V) is semi closed in (Y, σ) for every closed set V of (X, τ).
2. **δ-closed map** (Noiri, 1978) if f(V) is δ-closed in (Y, σ) for every closed set V of (X, τ).
3. **g-closed map** (Malghen, 1982) if f(V) is g-closed in (Y, σ) for every closed set V of (X, τ).
4. **δg–closed map** (Julian Dontchev, 1996) if f(V) is δg-closed in (Y, σ) for every closed set V of (X, τ).
5. **αg–closed map** (Devi et.al., 1998) if f(V) is αg-closed in (Y, σ) for every closed set V of (X, τ).

6. **πg-closed map** (Julian Dontchev et.al., 2000) if f(V) is πg-closed in (Y, σ) for every closed set V of (X, τ).
7. **πgb-closed map** (Julian Dontchev et.al., 2000) if f(V) is πg-closed in (Y, σ) for every closed set V of (X, τ).
8. **πgp-closed map** (Park 2004) if f(V) is πg-closed in (Y, σ) for every closed set V of (X, τ).
9. **πgs-closed map** (Aslim et.al., 2006) if f(V) is πg-closed in (Y, σ) for every closed set V of (X, τ).
10. **$\alpha\hat{g}$-closed map** (Abd.El.Monsef et.al., 2007) if f(V) is $\alpha\hat{g}$-closed in (Y, σ) for every closed set V of (X, τ).
11. **$\delta\hat{g}$ –closed map** (Lellis Thivagar et.al., 2011) if f(V) is δg-closed in (Y, σ) for every closed set V of (X, τ).
12. **πgα-closed map** (Janaki et.al., 2009) if f(V) is πg-closed in (Y, σ) for every closed set V of (X, τ).
13. **δg*-closed map** (Sudha 2014) if f(V) is δg^*-**c**losed in (Y, σ) for every closed set V of (X, τ).

Definition 1.1.13 A bijection map f : (X, τ)→(Y, σ) is called

1. **g-homeomorphism** (Maki et.al.,1991) if f is bijection, g-open and g-continuous.
2. **gc-homeomorphism** (Maki et.al., 1991) if both f and f^{-1} are g-irresolute.
3. **rg-homeomorphism** (Palaniappan et.al., 1993) if f is if f is bijection, rg-open and rg-continuous.
4. **gδ-homeomorphism** (Julian Dontchev, 1996) if f is bijection, gδ-open and gδ-continuous.

5. **rwg-homeomorphism** (Nagaveni, 1999) if f is if f is bijection, rwg-open and rwg-continuous.
6. **πg-homeomorphism** (Julian Dontchev et.al., 2000) if f is if f is bijection, πg-open and πg-continuous.
7. **πgb-homeomorphism** (Julian Dontchev et.al., 2000) if f is if f is bijection, πgb-open and πgb-continuous.
8. **πgs-homeomorphism** (Aslim et.al., 2006) if f is if f is bijection, πgs-open and πgs-continuous.
9. **πgp-homeomorphism** (Aslim et.al., 2006) if f is bijection, πgp-open and πgp-continuous.
10. **$\alpha\hat{g}$ –homeomorphism** (Abd El Monset et.al., 2007) if f is bijection, $\alpha\hat{g}$ - open and $\alpha\hat{g}$ -continuous.
11. **πgα-homeomorphism** (Janaki, 2009) if f is if f is bijection, πgα-open and πgα-continuous.
12. **$\delta\hat{g}$ –homeomorphism** (Lellis Thivagar, 2011) if f is bijection, $\delta\hat{g}$ - open and $\delta\hat{g}$ -continuous.

1.2 Bitopological Spaces

Definition 1.2.1 Let τ_i and τ_j with $i \neq j$ be topologies defined on a non empty set X. Then the triplet (X, τ_i, τ_j) is called a **bitopological space**.

Let A be a subset of (X, τ_i, τ_j). Then the union of all τ_i-open sets contained in A is called **τ_i-interior of A** and it is denoted by $\tau_i$int(A). The intersection of all

τ_j-closed sets containing A is called **τ_j closure of A** and it is denoted by $\tau_j cl(A)$. (Kelley, 1963).

Definition 1.2.2 For i, j ≠ 1, 2 and i ≠ j, a subset A of a bitopological space (X, τ_i, τ_j) is called

- **(i, j) semi-open** (Maheswari, et.al., 1977) if $A \square \tau_j cl[\tau_i int(A)]$.
- **(i, j) regular open** (Bose, 1981) if $A = \tau_i int[\tau_j cl(A)]$.
- **(i, j) α-open** (Jelic, 1990) if $A \square \tau_i int[\tau_j cl\{\tau_i int(A)\}]$.

The complement of the above mentioned sets are called (i, j) semi-closed, (i, j) regular closed and (i, j) α-closed sets respectively.

Definition 1.2.3 For i, j = 1, 2 and i ≠ j, a subset A of a bitopological space (X, τ_i, τ_j) is called

1. (i, j) g-closed (Fukutake, 1986) if $\tau_j \delta cl(A) \subseteq U$, whenever $A \subseteq U$ where U is τ_i-open.
2. (i, j) πgs-closed (Arya et.al., 1990) if $\tau_j scl(A) \subseteq U$, whenever $A \subseteq U$ where U is τ_i–π-open.

3. (i, j) πg-closed (Julian Dontchev, 2000) if τ_j cl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i–π-open.

4. (i, j) gpr-closed (Fukutake et.al., 2002) if τ_j pcl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i-regular open.

5. (i, j) πgp-closed (Park, 2004) if τ_j pcl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i–π-open.

6. (i, j) mildly g-closed (Park, 2004) if τ_j cl[τ_i int(A)] $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i–g-open.

7. (i, j) αg-closed (Tantawy et.al., 2005) if τ_jαcl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i open.

8. (i, j) gp-closed (Tantawy et.al., 2005) if $\tau_j$pcl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i open.

9. (i, j) πgα-closed (Arokiarani, et.al.,2010) if τ_j αcl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i–π-open.

10. (i, j) rg-closed (Abu-Donia, 2013) if $\tau_j$cl(A) $\subseteq$ U, whenever A $\subseteq$ U where U is τ_i-regular open.

11. (i, j) δg^*-closed (Sudha, 2014) if $\tau_j\ \delta cl(A) \subseteq U$, whenever $A \subseteq U$ where U is τ_i g- open.

12. (i, j) πgb-closed (Janaki, et.al.,2014) if $\tau_j\ bcl(A) \subseteq U$, whenever $A \subseteq U$ where U is τ_i –π-open.

Definition 1.2.4 For i, j, k = 1, 2 and i $\neq$ j, a mapping $f : (X, \tau_i, \tau_j) \longrightarrow (Y, \sigma_i, \sigma_j)$ is called

1. $\tau_j\ \sigma_k$-continuous (Maki et.al., 1991) if $f^{-1}(V) \in \tau_j$ for every $V \in \sigma_k$.
2. (i, j) $\pi gs-\sigma_k$-continuous (Arya et.al., 1990) if $f^{-1}(V)$ is (i, j) πgs -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.
3. (i, j) $g-\sigma_k$-continuous (Maki et.al., 1991) if $f^{-1}(V)$ is (i, j) g -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.
4. (i, j) $\pi g-\sigma_k$-continuous (Julian Dontchev, 2000) if $f^{-1}(V)$ is (i, j) πg –closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.
5. (i, j) $gpr-\sigma_k$-continuous (Fukutake et.al., 2002) if $f^{-1}(V)$ is (i, j) gpr -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.

6. (i, j) $\pi gp - \sigma_k$-continuous (Park, 2004) if $f^{-1}(V)$ is (i, j) πgp -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.

7. (i, j) $gp - \sigma_k$-continuous (Tantawy et.al., 2005) if $f^{-1}(V)$ is (i, j) gp -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2

8. (i, j) $\alpha g - \sigma_k$-continuous (El Tantawy et.al., 2005) if $f^{-1}(V)$ is (i, j) αg -closed for each σ_k-closed set V in (Y, σ_i, σ_j), $i \neq j$ and i, j = 1, 2.

List of Symbols

$G\mathcal{C}(X, \tau)$	-	The class of all g-closed sets of (X, τ).
$GS\mathcal{C}(X, \tau)$	-	The class of all gs-closed sets of (X, τ).
$RG\mathcal{C}(X, \tau)$	-	The class of all rg-closed sets of (X, τ).
$\alpha G\mathcal{C}(X, \tau)$	-	The class of all αg-closed sets of (X, τ).
$GP\mathcal{C}(X, \tau)$	-	The class of all gp-closed sets of (X, τ).
$\delta\mathcal{C}(X, \tau)$	-	The class of all δ-closed sets of (X, τ).
$\delta G\mathcal{C}(X, \tau)$	-	The class of all δg-closed sets of (X, τ).
$GPR\mathcal{C}(X, \tau)$	-	The class of all gpr-closed sets of (X, τ).
$\pi G\mathcal{C}(X, \tau)$	-	The class of all πg-closed sets of (X, τ).
$G^{*}\mathcal{C}(X, \tau)$	-	The class of all g^{*}-closed sets of (X, τ).
$G^{*}P\mathcal{C}(X, \tau)$	-	The class of all $g^{*}p$-closed sets of (X, τ).
$\hat{G}\,\mathcal{C}(X, \tau)$	-	The class of all $\hat{g}$ -closed sets of (X, τ).
$G^{\#}S\mathcal{C}(X, \tau)$	-	The class of all $g^{\#}s$-closed sets of (X, τ).
$G\delta\mathcal{C}(X, \tau)$	-	The class of all gδ-closed sets of (X, τ).
$\delta G^{\ddagger}\mathcal{C}(X, \tau)$	-	The class of all $\delta g^{\ddagger}$-closed sets of (X, τ).
$\pi GP\mathcal{C}(X, \tau)$	-	The class of all πgp-closed sets of (X, τ).
$MG\mathcal{C}(X, \tau)$	-	The class of all mildly-g-closed sets of (X, τ).
$\#GS\mathcal{C}(X, \tau)$	-	The class of all #gs-closed sets of (X, τ).
$\pi GS\mathcal{C}(X, \tau)$	-	The class of all πgs-closed sets of (X, τ).
$\alpha\hat{G}\,\mathcal{C}(X, \tau)$	-	The class of all $\alpha\hat{g}$ -closed sets of (X, τ).
$^{*}G\mathcal{C}(X, \tau)$	-	The class of all $^{*}g$-closed sets of (X, τ).
$RWG\mathcal{C}(X, \tau)$	-	The class of all rwg-closed sets of (X, τ).

$\pi G\alpha\mathcal{C}(X, \tau)$	-	The class of all πgα-closed sets of (X, τ).
$\delta\hat{G}\mathcal{C}(X, \tau)$	-	The class of all $\delta\hat{g}$-closed sets of (X, τ).
$GSPR\mathcal{C}(X, \tau)$	-	The class of all gspr-closed sets of (X, τ).
$\pi GSP\mathcal{C}(X, \tau)$	-	The class of all πgsp-closed sets of (X, τ).
$G^*S\mathcal{C}(X, \tau)$	-	The class of all g^*s-closed sets of (X, τ).
$\pi GB\mathcal{C}(X, \tau)$	-	The class of all πgb-closed sets of (X, τ).
$\delta G^*\mathcal{C}(X, \tau)$	-	The class of all δg^*-closed sets of (X, τ).
$W\delta G^*\mathcal{C}(X, \tau)$	-	The class of all $w\delta g^*$-closed sets of (X, τ).
$(GS)^*\mathcal{C}(X, \tau)$	-	The class of all $(gs)^*$-closed sets of (X, τ).
$L\mathcal{C}(X, \tau)$	-	The class of all locally closed sets of (X, τ).
$GL\mathcal{C}(X, \tau)$	-	The class of all generalized locally closed sets of (X, τ).
$GLS\mathcal{C}(X, \tau)$	-	The class of all generalized locally semi closed sets of (X, τ).