Research Journal of Applied Sciences, Engineering and Technology 4(10): 1386-1390, 2012
ISSN: 2040-7467

Submitted: January 19, 2012 Accepted: February 09, 2012 Published: May 15, 2012

Properties of T_S-spaces and pairwise T_S-spaces

D. Narasimhan
Department of Mathematics, Srinivasa Ramanujan Centre, SASTRA University,
Kumbakonam-612001, India

Abstract: The separation axioms play an important role in the application of topological spaces. The concepts of T_S-spaces and pairwise T_S-spaces are introduced and studied by Chandrasekhara Rao and Narasimhan (2006). The aim of this study is to continue the study of some characterizations of T_S-spaces and pairwise T_S-spaces in topological and bitopological spaces.

Key words: T_S-space, Pairwise T_S-space, pairwise ${}_g\hat{T}_{\delta g}$ -space, pairwise T_{ags}-space, pairwise ${}^{\Omega}T_{\frac{1}{2}}$ -space, T_{ags}-space, $T^*_{\frac{1}{2}}$-space, ${}_g\hat{T}_{\delta g}$ -space

INTRODUCTION

Levine (1963, 1970) introduced semi open sets and g-closed sets. Njastad (1965) introduced α-open sets. Maki *et al*. (1993a,b) introduced α g-closed sets. Bhattacharyya and Lahiri (1987), Arya and Nour (1988), Dontchev (1995), Dontchev and Ganster (1996), Gnanambal (1997) and Chandrasekhara Rao and Joseph (2000) investigated sg-closed sets, g s-closed sets, g s p-closed sets, δ-g closed sets, g p r-closed sets and s*g-closed sets, respectively.

Dunham (1977), Bhattacharya and Lahiri (1987), Dontchev (1995) and Gnanambal (1997) were familiar with $T_{\frac{1}{2}}$, semi- $T_{\frac{1}{2}}$, semi pre- $T_{\frac{1}{2}}$ and pre regular $T_{\frac{1}{2}}$ spaces, respectively. Maki *et al*. (1993) introduced T_b, T_d and ${}_\alpha T_b$, ${}_\alpha T_d$-spaces respectively. Chandrasekhara Rao and Thangavelu (2003) studied complemented spaces. Veera Kumar (2000, 2002, 2006a,b) introduced T_p^*, ${}^*T_p$, $T^*_{\frac{1}{2}}$, ${}^*T_{\frac{1}{2}}$ -spaces. Chandrasekhara Rao and Narasimhan (2007, 2009) introduced T_S-spaces.

Meanwhile, Kelly (1963) introduced the concept of bitopological spaces by using quasi metric space as a natural structure. Further work in this area were done by Fletcher (1965), Lane (1967), who introduced pairwise complete regularity independently. The concept of pairwise $T_{1\frac{1}{2}}$ (pairwise semi Hausdorff) was introduced by Kim (1968).

The concept of pairwise $T_{\frac{1}{2}}$ -space was initiated by Sunder Lal and Gupta (1999) and they classified some of pairwise T_i -axioms by affixing strong, weak, minimally and almost. The (i, j)-g*-closed sets, (i,j)− $T^*_{\frac{1}{2}}$ and (i, j)−* $T_{\frac{1}{2}}$ spaces were introduced by Sheik and Sundaram (2004). Rajamani and Vishwanathan (2005) introduced α gs -closed sets and defined new spaces known as τ_i τ_j-$T_{\alpha g s}$ spaces and investigated some of their properties.

The concept of pairwise complemented spaces (2006) and T_S-spaces are introduced and studied by Chandrasekhara Rao and Narasimhan (2008). The aim of this paper is to continue the study of some characterizations of T_S-spaces and pairwise T_S-spaces in topological and bitopological spaces.

PRELIMINARIES

Let (X, τ) or simply X denote a topological space. For any subset A ⊆ X, the closure [resp. δ-closure, α-closure] of a subset A of a space (X, τ) is the intersection of all closed [resp. δ-closed, α-closed] sets that contain A and is denoted by cl(A) [resp. cl_δ (A), α cl(A)]. We shall require the following known definitions.

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

- Semi open if there exists an open set U such that U ⊆ A ⊆ cl (U)
- Semi closed if X-A is semi open
  equivalently, a set A of a topological space (X, τ) is called semi closed if there exists a closed set F such that int (F) ⊆ A ⊆ F
- Generalized closed (g-closed) if cl (A) ⊆ U whenever A ⊆ U and U is open in X

- Generalized semi open (gs-open) if $F \subseteq sint(A)$ whenever $F \subseteq A$ and F is closed in X
- Generalized semi closed (gs-closed) if X-A is gs-open,
- Semi star generalized closed (s^*g-closed) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is semi open in X
- α-open if $A \subseteq int\{cl[int(A)]\}$
- α-closed if $cl\{int[cl(A)]\} \subseteq A$
- α g-closed if $\alpha\, cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X
- α gs-closed if $\alpha\, cl(A) \subseteq U$ whenever $A \subseteq U$ and U is semi open in X
- g*-closed if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is g-open in X
- δ-g closed if $cl_\delta(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X
- δ-$\hat{g}$ closed} if $cl_\delta(A) \subseteq U$ whenever $A \subseteq U$ and U is semi open in X
- Ω-closed if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is g-open in X
- $g^{\#}s$-closed if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is α g-open
- $^{\#}g$-closed if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is $^*g$-open,
- $^{\#}g$ s-closed if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is $^*g$-open

Definition: A topological space (X, τ) is called

- $T_{\frac{1}{2}}$-space if every g-closed set is closed
- $T^*_{\frac{1}{2}}$-space if every g*-closed set is closed
- T_c-space if every g s-closed set is g*-closed
- $_\alpha T_b$-space if every α g-closed set is closed
- $_g\hat{T}_{\delta g}$-space if every g-closed set is $\delta\hat{g}$-closed
- $_\alpha T_c$-space if every α g-closed set is g*-closed
- complemented space if every open set is closed
- $^\Omega T_{\frac{1}{2}}$-space if every g-closed set is Ω-closed
- $T^\Omega_{\frac{1}{2}}$-space if every Ω-closed set is closed
- $^{\#}T_b$-space if every gs-closed set is $g^{\#}s$-closed
- $T_b^{\#}$-space if every $g^{\#}s$-closed set is closed
- $^{\#}T_c$-space if every gs-closed set is $^{\#}g$-closed
- $_{gs}T_c^{\#}$-space if every gs-closed set is $^{\#}gs$-closed
- $_{gs}T_{\frac{1}{2}}^{\#}$-space if every $^{\#}gs$-closed set is closed
- $^{\#}T_{\frac{1}{2}}$-space if every g-closed set is $^{\#}g$-closed
- $T_{\frac{1}{2}}^{\#}$-space if every $^{\#}g$-closed set is closed
- T_d-space if gs-closed set is g-closed

PROPERTIES OF T_S-SPACES

A topological space (X, τ) is called T_S-space if every s^*g-closed set is closed in X . Let X={a, b, c}, $\tau = \{\phi, X, \{a\}\}$. Then s^*g -closed sets in X are ϕ, X, {b, c}, which are closed in X. Hence (X, τ) is T_S-space.

Theorem: If (X, τ) is a T_d-space and $T_{\frac{1}{2}}$-space then X is a T_S-space.

Proof: Let A be s^*g-closed in X. Then A is g s-closed. Since X is T_d-space, A is g-closed in X. Since X is a $T_{\frac{1}{2}}$-space, we have A is closed in X. Hence X is a T_S-space.

Theorem: If (X, τ) is both $^\Omega T_{\frac{1}{2}}$-space and $T^\Omega_{\frac{1}{2}}$-space then X is a T_S-space.

Proof: Let A be s^*g-closed in X. Then A is g-closed. Since X is $^\Omega T_{\frac{1}{2}}$-space, A is Ω-closed in X. Since X is a $T^\Omega_{\frac{1}{2}}$-space, we have A is closed in X. Hence X is a T_S-space.

Theorem: If (X, τ) is both T_c-space and $T^\Omega_{\frac{1}{2}}$-space then X is a T_S-space.

Proof: Let A be s^*g-closed in X. Then A is gs-closed. Since X is T_c-space, A is Ω-closed in X. Since X is a $T^\Omega_{\frac{1}{2}}$-space, we have A is closed in X. Hence X is a T_S-space.

Theorem: Suppose X is a $^{\#}T_b$-space and $T_b^{\#}$-space then X is a T_S-space.

Proof: Let A be a s^*g-closed set. Then A is g s-closed. Since X is a $^{\#}T_b$-space, we have, A is $g^{\#}s$-closed. Since X is a $T_b^{\#}$-space, we have A is closed. Hence, X is a T_S-space.

Theorem: Suppose X is a $^{\#}T_c$-space and $T_{\frac{1}{2}}^{\#}$-space then X is a T_S-space.

Proof: Let A be a s^*g-closed set. Then A is g s-closed. Since X is a $^{\#}T_c$-space, We have, A is $^{\#}g$-closed. Since X is a $T_{\frac{1}{2}}^{\#}$-space, we have A is closed. Hence, X is a T_S-space.

Theorem: Suppose X is a $_{gs}T_c^{\#}$-space and $_{gs}T_{\frac{1}{2}}^{\#}$-space then X is a T_S-space.

Proof: Let A be a s^*g-closed set. Then A is g s-closed. Since X is a $_{gs}T_c^{\#}$-space, we have, A is $^{\#}gs$-closed. Since X is a $_{gs}T_{\frac{1}{2}}^{\#}$-space, we have A is closed. Hence, X is a T_S-space.

Theorem: Suppose X is a $^{\#}$ $T_{\frac{1}{2}}$ -space and $T_{\frac{1}{2}}$ $^{\#}$-space then X is a T_S-space.

Proof: Let A be a s^*g-closed set. Then A is g-closed. Since X is a $^{\#}T_{1/2}$ -space, we have, A is $^{\#}$g-closed. Since X is $T_{\frac{1}{2}}$ $^{\#}$-space, we have A is closed. Hence, X is a T_S-space.

Theorem: Suppose X is a complimented space. If a subset A of X is δ g-closed, then A is δ $\hat{g}$ -closed.

Proof: Suppose X is a complimented space. Let A be a δ g-closed set. Let A⊆U, U is semiopen in X. since X is a complimented space, U is open in X. Since A is δ g-closed, cl_δ (A)⊆U. Hence A is δ $\hat{g}$ -closed.

PROPERTIES OF PAIRWISE T_S-SPACES

First we recall some known definitions.

Definition:
A set A of a bitopological space (X, τ_1,τ_2) is called:

- $\tau_1\tau_2$-generalized closed (τ_1 τ_2-g closed) if τ_2-cl (A)⊆U whenever A⊆U and U is τ_1-open in X
- τ_1 τ_2-semi generalized closed (τ_1 τ_2-sg closed) if τ_2-scl (A)⊆U whenever A⊆U and U is τ_1-semi open in X
- τ_1 τ_2-generalized semi closed (τ_1 τ_2-g s closed) if τ_2-scl (A)⊆U whenever A⊆U and U is τ_1-open in X
- τ_1 τ_2-α open if A⊆ τ_1-int { τ_2-cl [τ_1-int (A)] }
- τ_1 τ_2-α closed if τ_2-cl {τ_1-int [τ_2-cl (A)]}⊆A
- τ_1 τ_2-α g closed if τ_2-α cl (A)⊆U whenever A⊆U and U is τ_1-open
- τ_1 τ_2-α gs closed if τ_2-α cl (A)⊆U whenever A⊆U and U is τ_1-semi open in X
- τ_1 τ_2-g^* closed if τ_2-cl (A)⊆U whenever A⊆U and U is τ_1-g open
- τ_1 τ_2-δg closed if τ_2-cl_δ (A)⊆U whenever A⊆U and U is τ_1-open in X
- τ_1 τ_2- δ $\hat{g}$ closed if τ_2-cl_δ (A)⊆U whenever A⊆U and U is τ_1-semi open in X
- τ_1 τ_2-Ω closed if τ_2-cl(A)⊆U whenever A⊆U and U is τ_1-g open
- τ_1 τ_2-$g^{\#}$s closed if τ_2-scl (A)⊆U whenever A⊆U and U is τ_1-α g open
- τ_1 τ_2-$^{\#}$g closed if τ_2-cl (A)⊆U whenever A⊆U and U is τ_1-*g open
- τ_1 τ_2-$^{\#}$g s closed if τ_2-scl (A)⊆U whenever A⊆U and U is τ_1-*g open

Definition: A bitopological space (X, τ_1, τ_2) is called

- Pairwise $T_{\frac{1}{2}}$ -space if every τ_1 τ_2-g closed set is τ_2-closed and every τ_2 τ_1-g closed set is τ_1-closed
- Pairwise $T_{\frac{1}{2}}$ *-space if every τ_1 τ_2-g^* closed set is τ_2-closed and every τ_2 τ_1-g^* closed set is τ_1-closed
- Pairwise T_b-space if every τ_1 τ_2-gs closed set is τ_2-closed and every τ_2 τ_1-gs closed set is τ_1-closed
- Pairwise T_d-space if τ_1 τ_2-gs closed set is τ_1 τ_2-g closed and τ_2 τ_1-gs closed set is τ_2 τ_1-g closed
- Pairwise $_\alpha T_b$-space if every τ_1 τ_2-α g closed set is τ_2-closed and every τ_2 τ_1-α g closed set is τ_1-closed
- Pairwise $^*T_p$-space if τ_1 τ_2-g p closed set is τ_1 τ_2-g^*p closed and τ_2 τ_1-g p closed set is τ_2 τ_1-g^*p closed

Definition: A bitopological space (X, τ_1, τ_2) is called

- Pairwise T_p *-space if every τ_1 τ_2-g^*p-closed set is τ_2-closed and τ_2 τ_1-g^*p-closed set is τ_1-closed
- Pairwise T_c-space if every τ_1 τ_2-g s closed set is τ_2-g^* closed and τ_2 τ_1-g s closed set is τ_1-g^* closed
- Pairwise $_\alpha T_c$-space if every τ_1 τ_2-α g closed set is τ_2-g^* closed and τ_2 τ_1-α g closed set is τ_1-g^* closed
- Pairwise $_g\hat{T}_{\delta g}$ -space if every τ_1 τ_2-g closed set is τ_1 τ_2-δ $\hat{g}$ closed and τ_1 τ_2-g closed set is τ_1 τ_2-δ $\hat{g}$ -closed
- Pairwise $T_{\alpha gs}$-space if every τ_1 τ_2-αgs closed set is τ_2-closed and every τ_2 τ_1-αgs closed set is τ_1-closed
- Pairwise $^{\Omega}T_{\frac{1}{2}}$ -space if every τ_1 τ_2-g closed set is τ_1 τ_2-Ω closed and τ_2 τ_1-g closed set is τ_2 τ_1-Ω closed
- Pairwise $T_{\frac{1}{2}}^{\Omega}$ -space if every τ_1 τ_2-Ω closed set is τ_2-closed and τ_2 τ_1-Ω closed set is τ_1-closed

MAIN RESULTS

Definition: A bitopological space (X, τ_1, τ_2) is called a pairwise T_S-space if every τ_1 τ_2-s^*g closed set is τ_2-closed in X and every τ_2 τ_1-s^*g closed set is τ_1-closed in X.

Example: Let X = {a, b, c} , τ_1 = { ϕ, X, {a} }, τ_2 = { ϕ, X, { a },{ a, c } }. Then (X, τ_1, τ_2) is a pairwise T_S-space.

The necessary and sufficient condition for a bitopological space to be a pairwise T_S-space is obtained in the following theorem.

Theorem: A bitopological space (X , τ_1, τ_2) is a pairwise T_S-space if and only if the singleton {x} is either τ_i-open or τ_j-semi closed, i, j =1, 2 and i ≠ j

Proof: Let X be a pairwise T_S-space and suppose that {x} is not τ_j-semi closed. Then X-{x} is not τ_j-semi open. Consequently X is the only τ_j-semi open set containing the set X -{x}. Therefore, X-{x} is τ_j τ_i-s^*g closed in X. Since X is a pairwise T_S-space, we have X-{x} is τ_i-closed in X. Consequently, {x} is τ_i-open in X.

Conversely, suppose that {x} is either τ_i-open or τ_j-semi closed, i, j = 1, 2 and $i \neq j$. Let A be a τ_1 τ_2-s^*g closed in X. Obviously $A \subseteq \tau_2$-cl (A). Let $x \in \tau_2$-cl (A):

Case i: Suppose that {x} is τ_1-open. Since $x \in \tau_2$-cl (A), we have $x \in A$. Thus, τ_2-cl (A)$\subseteq$A.

Case ii: Suppose that {x} is τ_1-semi closed and $x \notin A$. Then τ_2-cl (A)-A contains the τ_1-semi closed set {x} . This is a contradiction to the fact that A is τ_1 τ_2-s^*g closed in X. Hence, $x \in A$, implies that τ_2-cl (A)$\subseteq$A . Therefore, τ_2-cl (A) = A. Similarly, we can prove every τ_2 τ_1-s^*g closed set is τ_1-closed. Hence X is a pairwise T_S-space.

Theorem: If a bitopological space (X , τ_1, τ_2) is pairwise T_c-space and (X, τ_i) is $T_{\frac{1}{2}}^*$, i = 1, 2, then X is a pairwise T_S-space.

Proof: Let A be a τ_i τ_j-s^*g closed set in X, i, j = 1, 2 and $1 \neq j$. Then A is a τ_i τ_j-g s closed set in X. Since X is a pairwise T_c-space, we have A is τ_j-g^* closed in X. Since (X,τ_i) is a $T_{\frac{1}{2}}^*$-space, we have A is τ_j-closed in X. Hence X is a pairwise T_S-space.

Theorem: In any bitopological space (X, τ_1, τ_2), every τ_i τ_j- $\delta\hat{g}$ closed set is τ_i τ_j-s^*g closed, i, j=1, 2 and $i \neq j$.

Proof: Let A be a τ_i τ_j-$\delta\hat{g}$ closed set in X. Let $A \subseteq U$ and U is τ_i-semi open in X. Since A is τ_i τ_j-$\delta\hat{g}$ closed in X, we have τ_j-cl_δ (A)$\subseteq$A . Since τ_j-cl(A)$\subseteq \tau_i$-cl_δ (A) , we have τ_j-cl(A)$\subseteq$U . Hence A is τ_i τ_j-s^*g closed in X.

Remark: Since every τ_i τ_j-s^*g closed set is τ_j-closed in a pairwise T_S-space, every τ_i τ_j-$\delta\hat{g}$ closed set is τ_j-closed in a pairwise T_S-space, i, j = 1, 2 and $i \neq j$.

Theorem: Every pairwise ${}_g\hat{T}_{\delta g}$-space (X, τ_1, τ_2) is pairwise $T_{\frac{1}{2}}$-space if it is pairwise T_S-space.

Proof: Let X be a pairwise ${}_g\hat{T}_{\delta g}$-space. Let A be a τ_i τ_j-g closed set in X, i, j = 1, 2 and $i \neq j$. Since X is a pairwise ${}_g\hat{T}_{\delta g}$-space, we have A is τ_i τ_j-$\delta\hat{g}$ closed in X. Consequently A is τ_i τ_j-s^*g-closed in X. Since X is a pairwise T_S -space, we have A is τ_j-closed in X. Hence X is a pairwise $T_{\frac{1}{2}}$-space.

Theorem: Every pairwise ${}_\alpha T_c$-space X is a pairwise T_S-space if (X, τ_i) is $T_{\frac{1}{2}}^*$-spaces, i = 1, 2.

Proof: Let X be a pairwise ${}_\alpha T_c$-space. Then every τ_i τ_j-α g closed set is τ_j-g^* closed in X, i, j = 1, 2 and $i \neq j$. Since (X, τ_j) is a $T_{\frac{1}{2}}^*$-space, we have every τ_j-g^* closed set is τ_j-closed in X. Hence every τ_i τ_j-α g closed set is τ_j-closed in X.
Consequently, X is a pairwise ${}_\alpha T_b$-space. Since every pairwise ${}_\alpha T_b$-space is a pairwise T_S-space, we have X is a pairwise T_S-space.

Theorem: Every pairwise $T_{\alpha gs}$-space X is a pairwise T_S-space.

Proof: Omitted.

Theorem: If (X, τ_1, τ_2) is a pairwise T_d-space and pairwise $T_{\frac{1}{2}}$-space then X is a pairwise T_S-space.

Proof: Let A be $\tau_i\tau_j$-s^*g closed in X , i, j = 1, 2 and $i \neq j$. Then A is τ_i τ_j-g s closed. Since X is pairwise T_d-space, A is τ_i τ_j-g closed in X. Since X is a pairwise $T_{\frac{1}{2}}$-space, we have A is τ_j-closed in X. Hence X is a pairwise T_S-space.

Theorem: If (X, τ_1, τ_2) is both pairwise ${}^\Omega T_{\frac{1}{2}}$-space and pairwise $T_{\frac{1}{2}}^\Omega$-space then X is a pairwise T_S-space.

Proof: Let A be τ_i τ_j-s^*g closed in X, i, j = 1, 2 and $i \neq j$. Then A is τ_i τ_j-g closed. Since X is pairwise ${}^\Omega T_{\frac{1}{2}}$-space, A is τ_i τ_j-Ω closed in X . Since X is a pairwise $T_{\frac{1}{2}}^\Omega$-space, we have A is τ_j-closed in X. Hence X is a pairwise T_S-space.

Theorem: If (X, τ_1, τ_2) is both pairwise T_c-space and pairwise $T_{\frac{1}{2}}^\Omega$-space, then X is a pairwise T_S-space.

Proof: Let A be τ_i τ_j-s^*g closed in X , i, j = 1, 2 and $i \neq j$. Then A is τ_i τ_j-gs closed. Since X is pairwise T_c-space, A is τ_i τ_j- Ωclosed in X. Since X is a pairwise $T_{\frac{1}{2}}^\Omega$-space, we have A is τ_j-closed in X. Hence X is a pairwise T_S-space.

CONCLUSION

Thus, we have studied some more characterizations of T_S-spaces in both unital and bitopological spaces. In addition, the necessary and sufficient condition for a bitopological space to be a pairwise T_S-space is obtained.

REFERENCES

Arya, S.P. and T. Nour, 1988. Separation axioms for bitopological spaces. Ind. J. Pure Appl. Math., 19(1): 42-50.

Bhattacharyya, P. and B.K. Lahiri, 1987. Semi generalized closed sets in topology. Ind. J. Pure Appl. Math., 29: 375-382.

Chandrasekhara Rao, K. and K. Joseph, 2000. Semi star generalized closed sets. B. Pure Appl. Sci., 19E(2): 281-290.

Chandrasekhara Rao, K. and P. Thangavelu, 2003. A note on complemented topological spaces. Appl. Sci. Periodicals, 1: 40-44.

Chandrasekhara Rao, K. and D. Narasimhan, 2006. Characterizations of pairwise complemented spaces. Antarctica J. Math., 3(1): 17-27.

Chandrasekhara Rao, K. and D. Narasimhan, 2007. T_S-Spaces. Proc. Nat. Acad. Sci., 77(2A): 363-366.

Chandrasekhara Rao, K. and D. Narasimhan, 2008. Pairwise T_S-Spaces. Thai J. Math., 6(1): 1-8.

Chandrasekhara Rao, K. and D. Narasimhan, 2009. Characterizations of T_S-Spaces. Int. Math. Forum, 4(21): 1033-1037.

Dontchev, J., 1995. On generalizing semi-preopen sets. Mem. Fac. Sci. Kochi Univ. Ser. A, Math., 16: 35-48.

Dontchev, J. and M. Ganster, 1996. On δ-generalized closed sets and $T_{\frac{3}{4}} - spaces$. Mem. Fac. Sci. Kochi Univ. Ser. A Math., 17: 15-31.

Dunham, W., 1977. $T_{\frac{1}{2}}$ - spaces, Kyungpook Math. J., 17: 161-169.

Fletcher, P., 1965. Pairwise uniform spaces. Notices Amer. Math. Soc., 83: 612.

Gnanambal, Y., 1997. On generalized pre regular closed sets in topological spaces. Ind. J. Pure Appl. Math., 28(3): 351-360.

Kelly, J.C., 1963. Bitopological spaces. Proc. London Math. Soc., 13: 71-89.

Kim, Y.W., 1968. Pseudo quasi metric spaces. Proc. Japan Acad., 44: 1009-1012.

Lal, S. and M.K. Gupta, 1999. On some separation properties on bitopological spaces. The Math. Stud., 68: 175-183.

Lane, E.P., 1967. Bitopological spaces and quasi uniform spaces. Proc. London Math. Soc., 17: 241-256.

Levine, N., 1963. Semi-open sets and semi-continuity in topological spaces. Amer. Math. Monthly, 70: 36-41.

Levine, N., 1970. Generalized closed sets in topology. Rend. Circ. Mat. Palermo, 19(2): 89-96.

Maki, H., R. Devi and K. Balachandran, (1993a). Generalized α-closed sets in topology. Bull. Fukuoka Univ. Ed. Part III, 42: 13-21.

Maki, H., R. Devi and K. Balachandran, (1993b). Semi-generalized closed maps and generalized semi-closed maps. Mem. Fac. Sci. Kochi Univ. Ser. A Math., 14: 41-54.

Njastad, O., 1965. On some classes of nearly open sets. Pacific J. Math., 15: 961-970.

Rajamani, M. and K. Vishwanathan, 2005. On α-generalized semi closed sets in bitopological spaces. Bull. Pure Appl. Sci., 24E(1): 39-53.

Sheik, J.M. and P. Sundaram, 2004. g^*-closed sets in Bitopological Spaces. Ind. J. Pure Appl. Math., 35(1): 71-80.

Veera Kumar, M.K.R.S., 2006a. δ $g^{\#}$-closed sets. Antarctica J. Math., 3(1): 85-99.

Veera Kumar, M.K.R.S., 2006b. *g-semi closed sets in topology. Antarctica J. Math., 3(2): 227-250.

Veera Kumar, M.K.R.S., 2000. Between closed sets and g-closed sets. Mem. Fac. Sci. Kochi Univ. Math., 21: 1-19.

Veera Kumar, M.K.R.S., 2002. g^*-pre closed sets. Acta Sci. Indica (M), 28(1): 51-60.