(I, j) - Rw Closed Sets in Bitopological Spaces

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ABSTRACT
In this paper we introduce and study the concept of a new class of closed set called (i, j)-regular weakly closed set (briefly (i,j) - rw closed set) in bitopological spaces and discuss some of their properties in bitopological spaces.

Keywords
(i, j) - rw closed sets

1. INTRODUCTION
A triple (X, τ1, τ2) where X is a non-empty set and τ1 and τ2 are topologies on X is called a bitopological space. Kelly [16] initiated the study of such spaces. In 1985, Fukutake [11] introduced the concepts of g - closed sets in bitopological spaces and after that several authors turned their attention towards generalizations of various concepts of topology by considering bitopological spaces. S.S. Benchalli and R.S Wali [6] introduced new class of sets called regular weakly - closed (briefly rw - closed) sets in topological spaces which lies between the class of all w - closed sets and the class of all regular g - closed sets.

2. PRELIMINARIES
In this section we recollect the following basic definitions which are used in this paper.

Definition 2.1: A subset A of a topological space (X, τ) is called

i) regular closed [29] if A = cl[int(A)]

ii) pre-closed [22] if cl[(int (A)] $\subseteq$ A

iii) semiclosed [9] if int[(cl (A)] $\subseteq$ A

iv) α-closed [21] if cl[int (cl(A))] $\subseteq$ A

v) Semi - pre open [2] (= β - open [1]) if A $\subseteq$ cl (int(cl(A))) and semi- pre-closed [2] (= β - closed [1]) if int [cl(int (A))] $\subseteq$ A

vi) Semi - generalized closed [7] (briefly sg - closed) if scl (A)) $\subseteq$ U whenever A $\subseteq$ U and U is semi open in X.

vii) Generalized α-closed [18 (briefly gα - closed) if αcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is α open in X.

viii) α - generalized closed [19] (briefly αg - closed) if αcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in X.

ix) Generalized pre-closed [20] (briefly gp - closed) if Pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in X.

x) Strongly generalized closed [30] (briefly g*- closed [32]) if cl(A)) $\subseteq$ U whenever A $\subseteq$ U and U is g - open in X.

xi) Mildly generalized closed [24] (briefly mildly g - closed) if cl(int(A)) $\subseteq$ U whenever A $\subseteq$ U and U is g - open in X.

xii) Regular weakly generalized closed [23] (briefly rwg - closed) if cl (int(A)) $\subseteq$ U whenever A $\subseteq$ U and U is regular open in X.

Notation: The following notation is used in this paper.
(i, j) denotes the pair of topologies (τi, τj)

Definition 2.2: A subset A of a bitopological space (X, τ_1, τ_2) is called

i) (i, j) -regular open [8] if A = i Int[jcl(A)]

ii) (i, j) -pre- open [14] if A$\subset$ i Int[jcl (A)]

iii) (i, j) -semi open [17] if A $\subset$ j cl[i Int (A)]

iv) (i, j) -α- open [15] if A $\subset$ i Int[j cl[i Int (A)]]

v) (i, j) - g - closed [11] if τ_j - cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is open in τ_i

vi) vi) (i, j) - w - closed [13] if τ_j - cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is semi open in τ_i

vii) (i, j) - wg - closed [12] if τ_j - cl[τ_j int (A)] $\subseteq$ U whenever A $\subseteq$ U and U $\in$ τ_i

viii) (i, j) - rg - closed [3] if τ_j - cl(A)$\subseteq$ U whenever A $\subseteq$ U and U is regular open in τ_i

ix) (i, j) - gpr -closed [13] if τ_j - pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is regular open in τ_i

x) (i, j) - g s- closed [10] if τ_j - scl(A) $\subseteq$ U whenever A $\subseteq$ U and U $\in$ τ_i

xi) (i, j) - g *- closed [28] if τ_j - cl(A) $\subseteq$ U whenever A $\subseteq$ U and U is τ_i-g-open

xii) (i, j) - g *p- closed [31] if τ_j - pcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is τ_i-g-open

3. (i,j) - RW CLOSED SETS IN BITOPOLOGICAL SPACES
In this section, we have introduced a new class of closed sets in bitopological spaces.

Definition 3.1: A subset A of a bitopological space (X, τ_1, τ_2) is called (i, j) - rw closed if τ_j - cl(A) $\subseteq$ U, whenever A $\subseteq$ U and U is regular semiopen in τ_i.

Theorem 3.2: Every τ_j - closed set in (X, τ_i, τ_j) is (i, j) - rw closed but not conversely.
Proof: Assume that A is τ_j - closed, A $\subseteq$ U and U is regular semiopen in τ_i. Since A is τ_j - closed, cl(A) = A. Therefore τ_j - cl(A) $\subseteq$ U. Hence A is (i, j) - rw closed.

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

Example 3.4 : Let X = { a, b, c, d} be a bitopological space with topologies τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {a, b} is (1, 2) - rw closed but not τ_2 - closed.

Theorem 3.5: Every (i, j) - w closed set in (X, τ_i, τ_j) is (i, j) - rw closed but not conversely.
Proof: Assume that A is (i, j) - w closed , A $\subseteq$ U and U is regular semiopen in τ_i.
Since every τ_i - regular semiopen is τ_i - semiopen , U is regular semiopen in τ_i.
Hence A is (i, j) - rw closed.

Remark 3.6: The converse of the above theorem need not be true as seen from the following example.

Example 3.7 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and
τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {a,b} is
(1, 2) - rw closed but not (1, 2) - w closed.

Theorem 3.8: Every (i, j) - rw closed set in (X, τ_i, τ_j) is (i, j) - regular generalized closed but not conversely.
Proof: Assume that A is (i, j) - rw closed , A $\subseteq$ U and U is regular open in τ_i.
Since every τ_i - regular open is τ_i - regular semiopen , U is regular semiopen in τ_i .
Hence A is (i, j) - regular generalized closed.

Remark 3.9: The converse of the above theorem need not be true as seen from the following example.

Example 3.10 : Let X = { a, b, c, d} be a bitopological space with topologies τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {c} is (1, 2) - rg closed but not (1, 2) - w closed.

Theorem 3.11: Every (i, j) - regular closed set in
(X, τ_i, τ_j) is (i, j) - rw closed but not conversely.
Proof: The proof follows fromTheorem 3.2

Remark 3.12: The converse of the above theorem need not be true as seen from the following example.

Example 3.13 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a, b}, {b}, {a,b,c}} and
τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {a,b} is
(1, 2) - rw closed but not (1, 2) - regular closed.

Theorem 3.14: Every (i, j) - rw closed set in
(X, τ_i, τ_j) is (i, j) - gpr closed but not conversely.
Proof: Assume that A is (i, j) - rw closed , A $\subseteq$ U and U is regular open in τ_i.
Since every τ_i - regular open is τ_i - regular semiopen and (i, j) - rw closed,
(i, j) - pcl(A) $\subseteq$ τ_j - cl(A) $\subseteq$ U . Therefore (i, j) - pcl(A) $\subseteq$ U. Hence A is
(i, j) - gpr closed.

Remark 3.15: The converse of the above theorem need not be true as seen from the following example.

Example 3.16 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a, b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {c}, {b}, {c,b}}. Then the set {a} is
(1, 2) - gpr closed but not (1,2) - rw closed.

Remark 3.17: The following example shows that (1, 2) - rw closed set is independent of (1, 2) - g^*- closed set.

Example 3.18 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - g^*- closed but not (1, 2) - rw closed and {a,b} is (1, 2) - rw closed but not
(1, 2) - g^*- closed.

Remark 3.19: The following example shows that (1, 2) - rw closed set is independent of (1, 2) - g - closed set.

Example 3.20 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - g -closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - g - closed.

Remark 3.21: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - wg - closed set.

Example 3.22 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - wg - closed but not (1, 2) - rw closed and
{a, b} is (1, 2) - rw closed but not
(1, 2) - wg - closed.

Remark 3.23: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - semiclosed set.

Example 3.24 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - semiclosed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - semiclosed.

Remark 3.25: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - α closed set.

Example 3.26 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}.
Then the set {d} is (1, 2) - α closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not (1, 2) - α closed.

Remark 3.27: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - gα closed set.

Example 3.28 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}.
Then the set {d} is (1, 2) - gα closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - gα closed.

Remark 3.29: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - αg closed set.

Example 3.30 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - αg closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - αg closed.

Remark 3.31: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - sg closed set.

Example 3.32 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - sg closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not (1, 2) - sg closed.

Remark 3.33: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - gs closed set.

Example 3.34 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - gs closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - gs closed.

Remark 3.35: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - gsp closed set.

Example 3.36 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - gsp closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - gsp closed.

Remark 3.37: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - β closed set.

Example 3.38 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - β closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - β closed.

Remark 3.39: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - preclosed set.

Example 3.40 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - preclosed but not (1, 2) - rw closed and
{a, b} is (1, 2) - rw closed but not
(1, 2) - preclosed.

Remark 3.41: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - gp closed set.

Example 3.42 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1={X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - gp closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not
(1, 2) - gp closed.

Remark 3.43: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - swg closed set.

Example 3.44 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Then the set {d} is
(1, 2) - swg closed but not (1, 2) - rw closed and
{a, b} is (1, 2) - rw closed but not
(1, 2) - swg closed.

Remark 3.45: The following example shows that
(1, 2) - rw closed set is independent of (1, 2) - mildly g-closed set.

Example 3.46 : Let X = { a, b, c, d} be a bitopological space with topologies
τ_1 = {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, { b}, {a, b}}. Then the set {d} is
(1, 2) - mildly g- closed but not (1, 2) - rw closed and {a, b} is (1, 2) - rw closed but not (1, 2) - mildly g- closed.

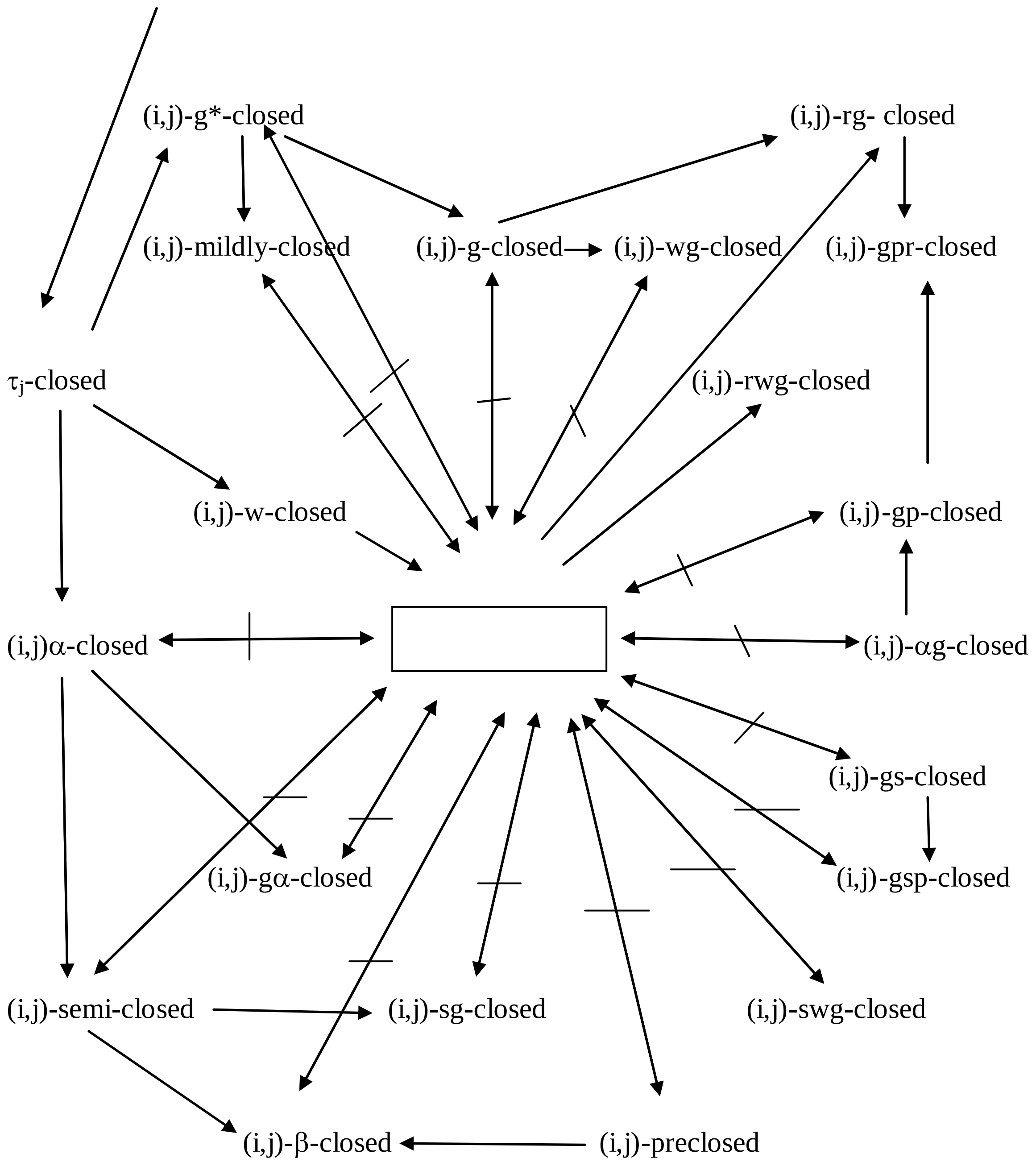

Fig 1: (i,j)-regular –closed

Theorem 3.48: In a bitopological space (X, τ_1, τ_2) let A and B are (i, j) - rw closed
set then $A \cup B$ is (i , j) - rw closed.

Proof: Assume that A and B are (i , j) - rw closed set in (X, τ_1, τ_2). Let U be a regular semiopen in τ_i such that $A \cup B \subseteq U$. Then $A \subseteq U$ and $B \subseteq U$. Since A and B are (i, j) - rw closed, τ_j - cl(A) $\subseteq$ U and τ_j - cl(B) $\subseteq$ U. Hence τ_j - cl($A\cup B$) $\subseteq \tau_j$ - cl(A) $\cup$ τ_j - cl(B) $\subseteq$ U. Therefore τ_j - cl($A\cup B$) $\subseteq$ U. Hence $A \cup B$ is (i, j) - rw closed.

Remark 3.49: The following example shows that the intersection of two (i, j) - rw closed sets in (X, τ_1, τ_2) is generally not an (i, j) - rw closed set.

Example 3.50 : Let X = { a, b, c, d} be a bitopological space with topologies τ_1= {X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. If A = {a, b} and B = {a, c, d} then A and B are (1, 2) - rw closed set in (X, τ_1, τ_2) but $A \cap B$ = {a} is not an (1, 2) - rw closed set in (X, τ_1, τ_2).

Theorem 3.51 : If a subset A of (X, τ_1, τ_2) is (i , j) - rw closed set, then τ_j - cl(A) –A does not contain any non-empty regular semiopen set in τ_i.

Proof: Suppose that A is (i , j) - rw closed. Let U be a regular semiopen in τ_i such that
τ_j - cl(A) –A $\supset$ U and U $\neq \phi$. Now U $\subset$ τ_j - cl(A) –A , U $\subset$ X – A,X – U $\supset$ A which implies A $\subset$ X – U. Since U is regular semiopen in τ_i , X – U is also regular semiopen in τ_i. By τ_j - cl(A) $\subseteq$ X – U, U $\subset$ X – τ_j - cl(A) and U $\subset$ τ_j - cl(A). Therefore
U $\subset$ τ_j - cl(A) $\cap$ (X – τ_j - cl(A)) = ϕ. Which implies U = ϕ which is a contradiction. Hence τ_j - cl (A) – A does not contain any non-empty regular semiopen set in τ_i.

Remark 3.52: The converse of the above theorem need not be true as seen from the following example.

Example 3.53: If τ_j - cl (A) –A contains no non-empty regular semiopen subset in
(X, τ_1, τ_2) . Then A need not be (1, 2) - rw closed. Consider X = { a, b, c, d} be a bitopological space with topologies τ_1={X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Let A = {c}. Then τ_j - cl (A) –A = {c, d} = {d} does not contain any non-empty regular semiopen set but A is not an (1, 2) - rw closed.

Theorem 3.54: For an element x $\in$ X the set X – {x} is (i, j) - rw closed or regular semiopen in τ_i.
Proof: Suppose X – {x} is not regular semiopen in τ_i, then X is the only regular semi open containing X – {x} which implies τ_j - cl [X – {x}] $\subseteq$ τ_j - cl (x) = X. Therefore
τ_j - cl [X – {x}] $\subseteq$ X. Thus X – {x} is (i, j) - rw closed.

Theorem 3.55: If A is an (i, j) - rw closed subset of (X, τ_1, τ_2) such that
A $\subset$ B $\subset$ τ_j - cl (A), then B is a (i, j) - rw closed set in (X, τ_1, τ_2) .
Proof: Let A be a (i, j) - rw closed set of X such that A $\subset$ B $\subset$ τ_j - cl (A). Let B $\subseteq$ U and U is regular semiopen in τ_i. Then A $\subseteq$ U. Since A is (i, j) - rw closed, τ_j - cl (A) $\subseteq$ U. Now τ_j - cl (B) $\subseteq$ τ_j - cl [τ_j - cl (A)] = τ_j - cl (A) $\subseteq$ U. Therefore τ_j - cl (B) $\subseteq$ U. Hence B is (i, j) - rw closed.

Remark 3.56: The converse of the above theorem need not be true as seen from the following example.

Example 3.57 : Consider X = { a, b, c, d} be a bitopological space with topologies τ_1={X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. Let A = {c, d} and B = {a, c, d}. Then A and B are
(1, 2) - rw closed but A $\subseteq$ B $\not\subset$ τ_j - cl (A).

Theorem 3.58: Let A be (i, j) - rw closed. Then A is τ_j - closed if and only τ_j - cl (A) –A is τ_i - regular semiopen.
Proof: Suppose A is τ_j-closed, then τ_j -cl (A) = A and τ_j - cl (A) –A = ϕ which is τ_i - Regular semiopen.

Converse: Suppose τ_j - cl (A) –A is τ_i - regular semiopen. Since A is (i, j) - rw closed by previous theorem, τ_j - cl (A) – A does not contain any non-empty τ_i - regular semiopen set. Then τ_j - cl (A) – A = ϕ which implies τ_j - cl (A) = A. Hence A is τ_j - closed.

Theorem 3.59: If A is τ_j - regular open and (i, j) - rg closed, then A is (i, j) - rw closed.
Proof: Let U be any τ_i - regular semiopen such that A $\subset$ U. Since A is τ_j - regular open and (i, j) - rg closed we have τ_j - cl (A) $\subset$ A. Then τ_j - cl (A) $\subset$ A $\subset$ U. Hence τ_j - cl (A) $\subseteq$ U. Thus A is (i, j) - rw closed.

Theorem 3.60: If a subset A of a bitopological space is both τ_i - regular semi open and
(i, j) - rw closed, then it is τ_j - closed.
Proof: Now A $\subset$ A. Then τ_j - cl (A) $\subseteq$ A, A $\subseteq$ τ_j - cl (A). Therefore τ_j - cl (A) = A.
Hence A is τ_j - closed.

Theorem 3.61: Let A be τ_i - regular semiopen and
(i, j) - rw closed in (X, τ_1, τ_2). Suppose that F is τ_j - closed in (X, τ_1, τ_2), then A $\cap$ F is an (i, j) - rw closed set in (X, τ_1, τ_2).
Proof: Let A be τ_i - regular semiopen and (i, j) - rw closed in (X, τ_1, τ_2) and F be
τ_j - closed. By previous theorem, A is τ_j - closed. So A $\cap$ F is τ_j -closed and hence A $\cap$ F is an (i, j) - rw closed set in (X, τ_1, τ_2).

Theorem 3.62: If A is both τ_j - open and (i, j) - g- closed, then it is (i, j) - rw closed.
Proof: Let A be a τ_j - open and (i, j) - g- closed. Let A $\subset$ U and U is τ_i - regular semiopen. By hypothesis τ_j - cl (A) $\subseteq$ A (ie) τ_j - cl (A) $\subseteq$ U. Thus A is (i, j) - rw closed.

Remark 3.63: If A is both τ_j - open and (i, j) - rw closed in (X, τ_1, τ_2), then A need not be
(i, j)- g- closed in general as seen from the following example.

Example 3.64 : Consider X = { a, b, c, d} be a bitopological space with topologies τ_1={X, ϕ, {a}, {a,b}, {b}, {a,b,c}} and τ_2 = {X, ϕ, {a}, {b}, {a,b}}. In this bitopological space the subset {a, b} is τ_j - open and (i, j) - rw closed, but not (i, j) - g- closed.

Theorem 3.65: If a subset A of a bitopological space is both τ_i - open and (i, j) - wg closed, then it is (i, j) - rw closed.
Proof: Suppose a subset A of X is both τ_i - open and (i, j) - wg closed. Let A $\subset$ U with U is τ_i - regular semiopen in X. Now A $\supset$ τ_i cl[int(A)] = A as A is τ_i - open. That is τ_j - cl (A) $\subset$ A $\subset$ U. Thus A is an (i, j) - rw closed set in X.

4. REFERENCES

[1] Abd El-Monsef .M.E., El-Deeb.S.N and Mahmoud.R.A., β – open sets and β – continuous mappings, Bul.Fac.Sci.Assisut Univ.12(1983),77-90

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

[3] Arockiarani. I, Studies on generalizations of generalized closed sets and maps in topological spaces, Ph.D., Thesis, Bharathiar Univ., Coimbatore,1997.

[4] Arya, S.P and Nour.T.M., Quasi Semi-components in bitopological spaces, Indian J.Pure Appl.Math., 21(1990), 649-652.

[5] Arya, S.P and Nour.T.M., Separation axioms for bitopological spaces, Indian J.Pure Appl.Math., 19(1998), 42-50.

[6] Benchalli.S.S and Wali.R.S., On Rω-closed sets in topological spaces, Bull.Malays.math.Sci.Soc(2) 30(2) (2007), 99-110.

[7] Bhattacharyya, P. and Lahiri, B.K., Semi-generalized closed sets in topology, Indian J.Math., 29(1987), 376-382.

[8] Bose.S., Sinha.D., Almost open, almost closed, Θ-continuous and almost compact mappings in bitopological spaces.Bull.Calcutta Math.Soc.73(1981), 345-354.

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

[10] El-Tantawy.O.A and Abu-Donia.H.M, Generalized Separation Axioms in Bitopological Spaces, The Arabian Π for Science and Engg.Vol.30,N0.1A,117-129(2005)

[11] Fukutake, T., On generalized closed sets in bitopological spaces, Bull.Fukuoka Univ.Ed.Part III, 35(1986), 19-28.

[12] Futake, T., Sundaram, P., and Nagaveni, N., On weakly generalized closed sets, weakly generalized continuous maps and Twg spaces in bitopological spaces, Bull.Fukuoka Univ.Ed.Part III, 48(1999), 33-40.

[13] Futake, T., Sundaram, P., and SheikJohn.M., 2002, ω-closed sets, ω-open sets and ω-continuity in bitopological spaces Bull.Fukuoka Univ.Ed.Vol.51.Part III 1-9.

[14] Jelic.M., A decomposition of pairwise continuity, J. Inst.Math.Comp.Sci.,3,25-29(1990).

[15] Jelic.M., Feebly p-continuous mappings.V International Meeting on Topology in Italy (Itaian) (Lecce,1990/Otranto,1990).Rend.Circ.Mat.Palermo(2) Suppl.No.24(1990),387-395.

[16] Kelly, J.C., Bitopological spaces, Proc.London Math.Soc.13(1963), 71-89.

[17] Maheswari, S.N., and Prasad, R., Semi open sets and semi continuous functions in bitopological spaces. Math Notae, 26, (1977/78),29-37.

[18] Maki, H., Devi, R., and Balachandran, K., Associated topologies of generalized α-closed sets, mem. Fac. Sci. Kochiuniv.Ser.A.math., 15(1994), 51-63.

[19] Maki, H., Devi, R., and Balachandran, K., generalized α-closed sets in topology, Bull. Fukuoka Univ. Ed. Part III, 42 (1993) 13-21.

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

[21] Mashhour.A.S., Hasanein.I.A and El-Deeb.S.N.,α- open mappings,Acta.Math.Hungar.41(1983),213-218.

[22] Mashhour.A.S., Abd El-Monsef .M.E. and El-Deeb.S.N.On pre continuous mappings and week pre-continuous mappings,Proc Math, Phys.Soc.Egypt 53(1982),47-53.

[23] Nagaveni.N., Studies on Generalizations of Homeorphisms in Topological Spaces,Ph.D. Thesis, Bharathiar University, Coimbatore, 1999.

[24] Park, J.K., and Park, J.H., Mildly generalized closed sets, almost normal and miklly. Chaos, Solitons and Fractals 20(2004), 1103-1111.

[25] Patty, C.W., Bitopological spaces, Dukemath.J.34(1967), 387-392.

[26] Pushpalatha, A., Studies on generalizations of mappings in topological spaces, Ph.D., Thesis, Bharathiar University, Coimbatore – 2000.

[27] Rajamani, M. and Viswanathan, K., On αgs-closed sets in bitopological spaces, Bull. Pure and applied Sciences. Vol. 24E (No.1) 2005: P.39-53.

[28] SheikJohn, M. and Sundaram, P., g*-closed sets in bitopological spaces, Indian J. Pure. Appl. Math., 35(1), 71-80(2004).

[29] Stone.M., Application of the Theory of Boolean rings to general Topology, Trans.Amer.Math.Soc.41(1937),374-481

[30] Sundaram, P. and SheikJohn.M., ON ω-closed sets in topology, Acta ciencia Indica 4(2000), 389-392.

[31] Veerakumar M.K.R.S., g*-preclosed sets in Topology.Acta Ciencia Indica,XXVIII(1):51:60,2002.

[32] Veerakumar M.K.R.S., Between closed sets and g-closed sets, Mem.Fac.Sci.Kochiuniv.(Math).21(2000),1-19.