**Palestine Journal of Mathematics**

**Vol 14(Special Issue II)(2025)** , 313–317 

# ON $\tau^*$ $ii$ - OPEN SETS IN TOPOLOGICAL SPACES

S. Rajakumar, J. Sebastian Lawrence and B. Ananda Priya

MSC 2010 Classifications: 54C40, 14E20.

Keywords and phrases: $\tau^*$ $ii$-open sets, $\tau^*$ $ii$-closed sets, $\tau^*$ $ii$-continuous mappings, $\tau^*$ $ii$-compact sets, $\tau^*$ $ii$-connected sets.

*The authors would like to thank the reviewers and editor for their constructive comments and valuable suggestions that improved the quality of our paper.*

**Corresponding Author: S. Rajakumar**

**Abstract** In this study, we introduce a novel category of open sets termed $\tau^*$ $ii$-open sets within the context of topological spaces. We elucidate the core properties of $\tau^*$ $ii$-open sets and explore their interrelations with various other types of open sets, including $\alpha$-open sets. Moreover, we present fresh findings concerning the continuity of mappings, compactness, and connectedness pertaining to $\tau^*$ $ii$ within topological spaces.

## 1 Introduction

The inception of i-open sets traces back to the seminal work of Mohammed and Askandar [1, 2, 3] in 2012. Their contributions extended to exploring separation axioms and $i$-continuous functions. Subsequently, Mohammed and Abdullah [4, 5] defined "$ii$-open sets" as subsets of $(X, \tau)$ satisfying specific conditions. Dunham [6] introduced $\tau^*$, a novel topology, along with the concept of the closure operator $cl^*$. This operator finds its definition in the $\cap$ of all $g$-closed sets encompassing $A$. $W$-closed sets and $\alpha w$-closed sets were further elucidated by Sundaram, Parimala [7, 8], and their colleagues in 2017. The exploration of preopen sets and precontinuous functions in topological spaces was undertaken by Velico, Levine, and Njastad [9, 10, 11] building upon their groundwork. This paper introduces $\tau^*$ $ii$-open sets and explores their core properties, including $\tau^*$ $ii$-continuous maps, $\tau^*$ $ii$-connectedness, and $\tau^*$ $ii$-compactness.

Throughout this article, the topological space $(X, \tau)$ is denoted as TS, with $Os(X)$ representing its open sets, $Cs(X)$ its closed sets, $int(A)$ and $cl(A)$ representing the interior and closure of a set $A$, respectively. Additionally, $\tau^*$ $ii$ -continuous maps are referred to as $\tau^*$ $ii$-$Cs$, $\tau^*$ $ii$-compactness is denoted as $\tau^*$ $ii$-Ct, $\tau^*$ $ii$-Connected as $\tau^*$ $ii$-Cd, Connected as Cd, $cl^*$ as $\mathfrak{C}l^*$ and mapping as Mpg.

## 2 On $\tau^*$ $ii$-Open Sets is Topological Spaces

**Definition 2.1.** A subset $\xi$ of a $TS$ is said to be $\tau^*$ $ii$-open set if $\exists$ an $\tau^*$-open set $\Gamma$ satisfying (1) $\Gamma \neq \emptyset$, $X$ (2) $\xi \subseteq \mathfrak{C}l^*(\xi \cap \Gamma)$ (3) $int(\xi) = \Gamma$.

**Example 2.2.** Let $X = \{l_1, l_2, l_3\}$ with $\tau = \{\emptyset, X, \{l_1\}\}$. Then $\{l_1\}$ is $\tau^*$ $ii$-$o_s(X)$.

**Theorem 2.3.** *Every $o_s(X)$ is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Let $\xi$ be a $o_s(\Gamma)$ satisfying $\xi \subseteq \mathfrak{C}l^*(\xi \cap \Gamma)$ and $int(\xi) = \Gamma$. Since every $o_s(X)$ is $\tau^*$-$o_s(X)$, $\xi$ is a $\tau^*$-$o_s(X)$. Choose $\Gamma = \xi$ as $\xi$ is itself a $\tau^*$-open set. Then $\mathfrak{C}l^*(\xi \cap \Gamma) = \mathfrak{C}l^*(\xi \cap \xi) = \mathfrak{C}l^*(\xi)$. Since $\xi \subseteq \mathfrak{C}l^*(\xi)$, $\xi \subseteq \mathfrak{C}l^*(\xi \cap \Gamma)$. Also, since $\xi$ is $o_s(\Gamma)$, $int(\xi) = \xi = \Gamma$. $\therefore \xi$ is $\tau^*$ $ii$-$o_s(X)$. □

**Remark 2.4.** The subsequent outcome indicates that the inverse aspect of the aforementioned theorem is incorrect. Consider $X = \{l_1, l_2, l_3\}$ with $\tau = \{X, \emptyset, \{l_1\}, \{l_1, l_2\}\}$. Here $\{l_1, l_3\}$ is $\tau^*$ $ii$-$o_s(X)$ but not $o_s(X)$.

**Theorem 2.5.** *Every $\alpha$-$o_s(X)$, is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Since every $\alpha$-$o_s(X)$ is $ii$-open set and by the Theorem 2.3, the proof is straight forward. □

**Theorem 2.6.** *Every $o_s(X)$ is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Since every semi-$o_s(X)$ is $ii$-$o_s(X)$ and by the Theorem 2.3, the proof is straightforward. □

**Theorem 2.7.** *Every $\delta$-$o_s(X)$ is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Let $\Gamma$ be a $\delta$-$o_s(X)$ then $X-\Gamma$ is $\delta$-closed.
Let $\xi$ be a $\delta$-$c_s(X)$ then $\xi = \mathfrak{Cl}_\delta(\xi)$.
Since $\xi \subseteq \mathfrak{Cl}_\delta(\xi)$.
Let $x \in (\xi \cap int(cl(\Gamma))) \neq \phi$.
$\Rightarrow x \in \xi$ and $x \in int(cl(\Gamma))$
$\Rightarrow x \in \xi$ and $x \in int(cl(\Gamma)) \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$.
Since $\Gamma \neq \phi$, $X$
$\Rightarrow x \in \xi$ and $x \in \mathfrak{Cl}^*(\xi \cap \Gamma) \Rightarrow \xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$.
To prove $int(\xi) = \Gamma$.
If $int(\xi) \neq \Gamma$ for all $\Gamma \in O(X)$ then $cl(int(\xi)) \neq \mathfrak{Cl}(\Gamma)$.
$\Rightarrow \xi \subseteq (\xi \cap int(cl(U))) = \phi$.
$\Rightarrow \xi \nsubseteq \mathfrak{Cl}_\delta(\xi)$..
This contradicts that $\xi$ is a $\delta$-$o_s(X)$. Hence $\xi$ is $\tau^*$ $ii$-$o_s(X)$. □

**Theorem 2.8.** *Every $\tau^*$ $ii$-$o_s(X)$ is $\Gamma g$-$c_s(X)$.*

*Proof.* By the Theorem 2.3, the proof is straightforward. □

**Remark 2.9.** $\tau^*$-$o_s(X)$ and $\tau^*$ $ii$-$o_s(X)$ are independent to each other.
Consider $X = \{l_1, l_2, l_3\}$ with $\tau = \{X, \emptyset, \{l_1\}, \{l_1, l_2\}\}$. Here $\{l_1, l_3\}$ is $\tau^*$ $ii$-$o_s(X)$ but not $\tau^*$-$o_s(X)$ and $b$ is $\tau^*$-$o_s(X)$ but not $\tau^*$ $ii$-$o_s(X)$.
This shows that $\tau^*$-$o_s(X)$ and $\tau^*$ $ii$-$o_s(X)$ are independent to each other.

**Theorem 2.10.** *Every $iw$-$c_s(X)$ is $\tau^*$ $ii$-$o_s(X)$..*

*Proof.* Consider an $iw$-$c_s(X)$ $\xi$ in $TS$ and $U$ be any other $i$-$o_s(X)$. then $wcl(\xi) \subseteq U$ whenever $\xi \subseteq U$. Since $\Gamma \neq \phi$, $X$ in $(x, \tau^*)$. $\xi \subseteq wcl(\xi) \subseteq U \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma) \Rightarrow \mathfrak{Cl}^*(\xi \cap \Gamma)$. Since $wcl(\xi) \subseteq U$, $U$ is $i$-open then

$$\Gamma \subseteq int(\xi) \ldots.. \tag{2.1}$$

Also $int(\xi) \subseteq wcl(\xi) \subseteq \mathfrak{Cl}(\xi) \subseteq U$

$$Int(\xi) \subseteq \Gamma \ldots... \tag{2.2}$$

From equations (2.1) & (2.2), $int(\xi) = \Gamma$.
Hence $\xi$ is $\tau^*$ $ii$-$os(X)$. □

**Theorem 2.11.** *Every $iiw$-$c_s(X)$. is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Consider an $iiw$-$c_s(X)$ $\xi$ in $TS$ and $U$ be $ii$-$o_s(X)$. Then $wcl(\xi) \subseteq U$ whenever $\xi \subseteq U$.
Since $\Gamma \neq \phi$, $x$ in $(x, \tau^*)$, $\xi \subseteq wcl(\xi) \subseteq U$. □

**Theorem 2.12.** *If $\xi$ is $ii$-$o_s(X)$ then $\xi$ is a $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Let $U$ be an $ii$-$o_s(X)$. Then $\exists$ an $o_s(X)$, $\Gamma \in O(x)$ s.t
1) $\Gamma \neq \phi$ (2) $\xi \subseteq \mathfrak{Cl}(\xi \cap \Gamma) \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma) \Rightarrow \mathfrak{Cl}^*(\xi \cap \Gamma) \Rightarrow int(\xi) = \Gamma$. Therefore $\xi$ is $\tau^*$

$ii$-$o_s(X)$.
$\Rightarrow \xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$. Since $wcl(\xi) \subseteq U$ whenever $U$ is $ii$-open set

$$\Rightarrow \Gamma \subseteq int(\xi) \dots . \tag{2.3}$$

Also $int(\xi) \subseteq wcl(\xi) \subseteq \mathfrak{Cl}(\xi) \subseteq U$

$$\Rightarrow int(\xi) \subseteq \Gamma \tag{2.4}$$

From equations (2.3) and (2.4) $int(\xi) = \Gamma$
Hence $\xi$ is $\tau^*$ $ii$-$o_s(X)$. □

**Remark 2.13.**

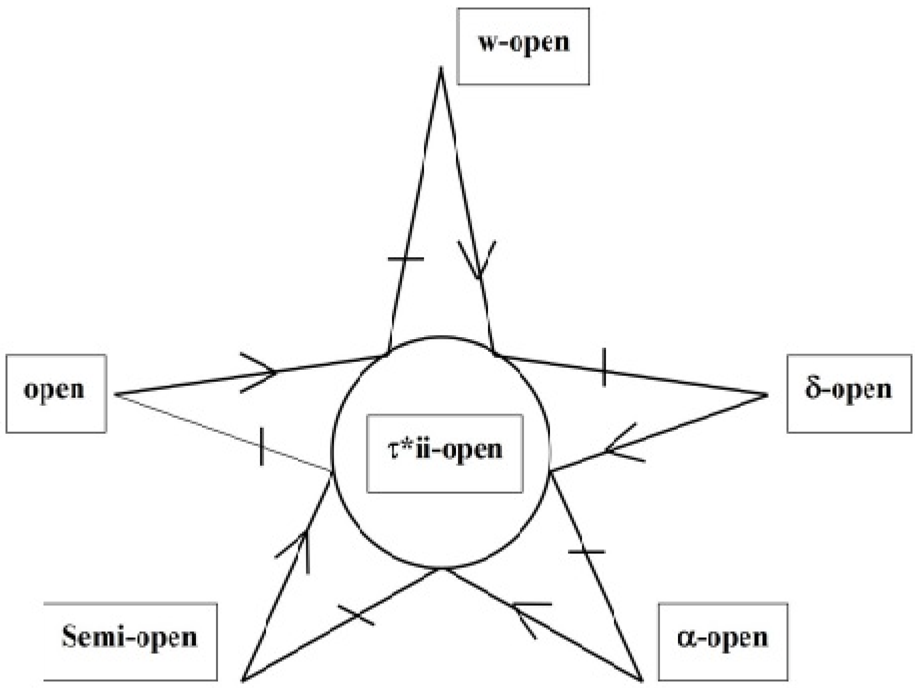


**Figure 1.**

**Theorem 2.14.** *Let $\xi \subseteq X$. $\xi$ is $ii$-$o_s(X)$ iff $\xi$ is $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Let $\xi$ be a $ii$-$o_s(X)$ in a $TS$. To prove $\xi$ is $\tau^*$ $ii$-$o_s(X)$, we need to find an $\tau^*$-$o_s(X)$, $\Gamma$ satisfying $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$, $int(\xi) = \Gamma$.
As $\xi$ is $ii$-$o_s(X)$, and by the definition of $ii$-$o_s(X)$, $\exists$ an $o_s(X)$, $\Gamma$ s-t $\xi \subseteq \mathfrak{Cl}(\xi \cap \Gamma)$. Since every open set is $\tau^*$-$o_s(X)$, $\Gamma$ is $\tau^*$-$o_s(X)$. Let $x \in \xi$. Since $\xi \subseteq \mathfrak{Cl}(\xi \cap \Gamma)$, $x \in \mathfrak{Cl}(\xi \cap \Gamma)$. This implies, $x \in$ the most closed set that includes $\xi \cap \Gamma$. Then, $x \in$ all closed sets containing intersection of $\xi$ and $\Gamma$. Then $x \in \xi \cap \Gamma$-closed sets containing $\xi \cap \Gamma$. $\Rightarrow x \in \mathfrak{Cl}^*(\xi \cap \Gamma)$. So $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$ and also by definition $int(\xi) = \Gamma$. Hence $\xi$ is $\tau^*$ $ii$-$o_s(X)$.

Conversely, suppose $\xi$ is $\tau^*$ $ii$-$o_s(X)$. Then $\exists$ an $\tau^*$-open set $\Gamma$ satisfying (1) $\Gamma \neq \emptyset, X$ (2) $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$ (3) $int(\xi) = \Gamma$. By condition (3), it implies $\Gamma$ is an open set. Since $\mathfrak{Cl}^*(\xi \cap \Gamma) \subseteq \mathfrak{Cl}(\xi \cap \Gamma)$ and by condition (2), $\xi \subseteq \mathfrak{Cl}(\xi \cap \Gamma)$. All 3 conditions of $ii$-$o_s(X)$ are satisfied. $\therefore \xi$ is $\tau^*$ $ii$-$o_s(X)$. □

**Theorem 2.15.** *If $\xi$ and $\gamma$ are $\tau^*$ $ii$-$o_s(X)$ then $\xi \cup \gamma$ is $\tau^*$ $ii$-$o_s(X)$*

*Proof.* Let $\xi, \gamma \subseteq (X, \tau)$. Let $\Gamma \neq \emptyset, X$ be a $\tau^*$-$o_s(X)$. Let $\xi, \gamma$ are $\tau^*$ $ii$-$o_s(X)$ then $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$ and $\gamma \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$. Since $\mathfrak{Cl}^*(\xi \cap \Gamma) \cup \mathfrak{Cl}^*(\gamma \cap \Gamma) \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma) \cup (\gamma \cap \Gamma)) \subseteq \mathfrak{Cl}^*((\xi \cup \gamma) \cap \Gamma)$. $\xi \cup \gamma \subseteq \mathfrak{Cl}^*((\xi \cup \gamma) \cap \Gamma)$. $\Rightarrow int(\xi \cup \gamma) \subseteq \Gamma$ and $\Gamma \subseteq (\xi \cup \gamma)$. $\Rightarrow int(\xi \cup \gamma) = \Gamma$. □

**Theorem 2.16.** *$\xi \cap \gamma$ is $\tau^*$ $ii$-$o_s(X)$ if $\xi$ and $\gamma$ are $\tau^*$ $ii$-$o_s(X)$.*

*Proof.* Let $\xi, \gamma \subseteq (X, \tau)$. Let $\Gamma \neq \emptyset$, $X$ be a $\tau^*$-$o_s(X)$. Let $\xi, \gamma$ are $\tau^*$ $ii$-$o_s(X)$ then $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$ and $\gamma \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$. $\xi \cap \gamma \subseteq \mathfrak{Cl}^*(\xi \cap \gamma \cap \Gamma) \subseteq \mathfrak{Cl}^*(\xi \cap \gamma \cap \Gamma)$. $\xi \cap \gamma \subseteq \mathfrak{Cl}^*(\xi \cap \gamma \cap \Gamma) \subseteq \mathfrak{Cl}^*(\xi \cap \gamma \cap \Gamma)$. $\Rightarrow \xi \cap \gamma \subseteq \mathfrak{Cl}^*(\xi \cap \gamma \cap \Gamma)$. □

**Corollary 2.17.** *If $\xi_1, \xi_2, \xi_3 \ldots\ldots..\xi_n$ are $\tau^*$ $ii$-$o_s(X)$ then $\xi \subseteq \mathfrak{Cl}^*(\xi \cap \Gamma)$,*

*(i) $\xi_1 \cap \xi_2 \cap \xi_3 \cap \xi_4 \cap \ldots.. \cap \xi_n$ is a $\tau^*$ $ii$-$o_s(X)$*

*(ii) $\xi_1 \cap \xi_2 \cap \xi_3 \cap \xi_4 \cap \ldots \cap \xi_n$ is a $\tau^*$ $ii$-$o_s(X)$.*

## 3 On $\tau^*$ $ii$-compact

**Definition 3.1.** A subset $\xi$ of a $TS$ is considered $\tau^*$ $ii$-$Ct$ if every open cover of $\xi$ using $\tau^*$ $ii$-$o_s(X)$ contains a finite subcover.

**Definition 3.2.** A Mpg $f : (X, \tau_1) \to (Y, \tau_2)$ is said to b e $\tau^*$ $ii$-$Cs$ iff the inverse image of every $\tau^*$ $ii$-$o_s(X)$, $\Gamma$ in $(Y, \tau_2)$ is $\tau^*$ $ii$-$o_s(X)$ in $(X, \tau_1)$.

**Theorem 3.3.** *Let $\xi$ be a $\tau^*$ $ii$-closed subset of $\tau^*$ $ii$-Ct TS X. Then $\xi$ is $\tau^*$ $ii$-$Ct$.*

*Proof.* Let $\{V_i\}$ be any collection of $\tau^*$ $ii$-open sets in $X$ covering $\xi$. Now, $\tau^*$ $ii$-open set $X \backslash \xi$ together with $\{V_i\}$ forms an open cover of $X$ by $\tau^*$ $ii$-open sets. This collection of open sets covering by $X$ is $\tau^*$ $ii$-open sets possesses a finite sub cover $X \backslash \xi \cup \{V_i\}_{i=1}^n$, since $X$ is $Ct$. Then $\xi$ is covered by $\{V_i\}_{i=1}^n$. $\therefore \xi$ is $\tau^*$ $ii$-$Ct$. □

**Theorem 3.4.** *Finite union of $\tau^*$ $ii$-$Ct$ sets is $\tau^*$ $ii$-$Ct$.*

*Proof.* Let $\xi_1, \xi_2, \ldots, \xi_n$ be $\tau^*$ $ii$-$Ct$ sets in a $TSX$ and $\{U_i\}$ be any cover by $\tau^*$ $ii$-open sets of $\xi_1 \cup \xi_2 \cup \ldots \cup \xi_n$. Then since $\cup U_i \supseteq \xi_l$ and $\xi_l$ is $\tau^*$ $ii$-$Ct$, for each $l = 1, 2, \cdots, n$, there exists finite set of indices $i_1, i_2, \ldots, i_m$ such that ${U_{i_k}}_{k=1}^m \supseteq \xi_l$, for each $l = 1, 2, \cdots, n$. Clearly, ${U_{i_k}}_{k=1}^m \supseteq \cup_{l=1}^n \xi_j$ Therefore, $\xi_1 \cup \xi_2 \cup \ldots \cup \xi_n$ is $\tau^*$ $ii$-$Ct$. □

**Theorem 3.5.** *For any $\tau^*$ $ii$-$Cs$ Mpg, if $\xi$ is $\tau^*$ $ii$-$Ct$ then $f(\xi)$ is $\tau^*$ $ii$-$Ct$.*

*Proof.* A Mpg $f : (X, \tau_1) \to (Y, \tau_2)$ is $\tau^*$ $ii$-continuous. Let $\Gamma_i$ be any collection of $\tau^*$ $ii$-open sets which cover $f(\xi)$. Then $f^{-1}(\Gamma_i)$ is the collection of $\tau^*$ $ii$-open sets which cover $\xi$, since $f$ is $\tau^*$ $ii$-continuous. Since $\xi$ is $\tau^*$ $ii$-compact, $f^{-1}(\Gamma_i)_{i=1}^n$ covers $\xi$ (i.e.,) $\cup_{i=1}^n f^{-1}(\Gamma_i) \supseteq \xi$. Then we have, $f^{-1}(\cup_{i=1}^n \Gamma_i) \supseteq \xi$ and this implies $\cup_{i=1}^n \Gamma_i \supseteq f(\xi)$, a finite subcover of $f(\xi)$. Hence $f(\xi)$ is $\tau^*$ $ii$-compact. □

## 4 On $\tau^*$ $ii$-connected Sets

**Definition 4.1.** A subset $\xi$ of $TS$ $X$ is called $\tau^*$ $ii$-connected ($\tau^*$ $ii$-$Cd$) if there are no $\tau^*$ $ii$-$o_s(X)$ $U$ and $V$ $(\neq \emptyset)$ s-t $\xi = U \cup V, U \cap V \neq \emptyset$.

**Theorem 4.2.** *A $TS$ $X$ is $\tau^*$ $ii$-$Cd$ iff $\emptyset$ and $X$ are the only $\tau^*$ $ii$-clopen sets.*

*Proof.* Suppose $\xi$ is $\tau^*$ $ii$-clopen set in $X$, but $\xi$ is neither empty nor equal to $X$. Then $\xi$ and $X - \xi$ are nonempty, $\tau^*$ $ii$-open and disjoint with $\xi \cup (X - \xi) = X$, so $X$ is not $\tau^*$ $ii$-$Cd$. Conversely, suppose $\xi, \gamma$ are nonempty, $\tau^*$ $ii$-open and disjoint with $\xi \cup \gamma = X$. This means that $\xi$ is neither empty nor equal to $X$. On the other hand, $\gamma = X - \xi$ is $\tau^*$ $ii$-$o_s(X)$, so $\xi$ is $\tau^*$ $ii$-clopen in $X$. □

**Theorem 4.3.** *Every $\tau^*$ $ii$-$Cd$ is $Cd$ subset of $X$.*

*Proof.* Assume that $\xi$ is not a $Cd$ subset of $X$. Then $\exists$ $U, V \neq \emptyset$ disjoint open subset of $X$ s-t $\xi = U \cup V$. By Theorem 4.2., $U$ and $V$ are $\tau^*$ $ii$-open sets, whose union is $X$. Then $\xi$ is not a $\tau^*$ $ii$-$Cd$ set. □

**Theorem 4.4.** *A $\tau^*$ $ii$-$Cs$ image of any $\tau^*$ $ii$-$Cd$ subset of $X$ is $\tau^*$ $ii$-$Cd$.*

*Proof.* Assume that $\delta : (X, \tau_1) \to (Y, \tau_2)$ is $\tau^*$ $ii$-$Cs$ mapping and $\xi$ is $\tau^*$ $ii$-$Cd$ subset of $X$. Let us assume that $\delta(\xi)$ is not $\tau^*$ $ii$-$Cd$. Then $\exists$ disjoint $\tau^*$ $ii$-open sets $U, V (\neq \emptyset) \ni \xi = U \cup V$. By the definition of $\tau^*$ $ii$-$Cs$, $\delta^{-1}(U)$ and $\delta^{-1}(V)$ are non-empty disjoint $\tau^*$ $ii$-open sets of $\xi \subseteq \delta^{-1}(U \cup V) = \delta^{-1}(U) \cup \delta^{-1}(V)$. Then $\xi$ is not $\tau^*$ $ii$-$Cd$, a contradiction. □

## 5 Conclusion Remarks

By utilizing the $ii$-open set, a new open set called $\tau^*$ $ii$-open sets is introduced through this article. Study was done on the relationship with $\tau^*$ $ii$-open sets and other sets. It facilitates the expansion of our study into more topological spaces, such as soft topology, fuzzy topological spaces, Nano topological spaces, and bi-topological spaces. As a result, the findings can be used in any kind of future research.

## References

[1] A.A. Mohammed and S.W. Askandar, *On i-open sets*, UAE Math Day Conference, Univ. of Sharjah, (2012).

[2] S.W. Askandar, *On i-continuous functions*, Science Journal, College of Education for Pure Science, University of Mosul, (2018).

[3] A.A. Mohammed and S.W. Askandar, *i-Open Sets and Separating Axioms Spaces*, J. Education and Science Journal, College of Education for Pure Science, university of Mosul.

[4] Beyda S. Abdullah and Amir A. Mohammed, *On Standard Concepts Using ii-Open Sets*, Open Access Library Journal, **6** e5604.

[5] Amir A. Mohammed and Beyda S. Abdullah, *ii-Open Sets in Topological Spaces*, International Mathematical Forum, **14**(1), 41–48, (2019).

[6] Dunham, *A new closure operator for non-$T_1$ Topologies*, Kyoongpook Math., **22**, 55–60, (1982).

[7] P. Sundaram and M. Sheik John, *On w-closed sets in topology*, Acta ciencia indica, **4**, 389–392, (2000).

[8] M. Parimala, R. Udhayakumar, R. Jeevitha and V. Biju, *On $\alpha\omega$-closed set in topological spaces*, International Journal of Pure and Applied Mathematics, **115**(5), 1049–1056, (2017).

[9] N.V. Velicko, *H-closed topological spaces*, Amer. Math. Soc. Transl., **78**, 103–118, (1968).

[10] N. Levine, *Semi-open sets and semi-continuity in topological spaces*, The American Mathematical Monthly, **70**(1), 36–41, (1963).

[11] O. Njastad, *On some classes of nearly open sets*, Pacific Journal of Mathematics, **15**(3), 961–970, (1965).

### Author information

S. Rajakumar, Sri Manakula Vinayagar Engineering College (Autonomous), Puducherry - 605107, India.
E-mail: `srkumar277@gmail.com`

J. Sebastian Lawrence, SRM TRP Engineering College, Irungalur, Tiruchirappalli - 621 105, Tamil nadu, India.
E-mail: `lawrence.seba@gmail.com and sebastian.j@trp.srmtrichy.edu.in`

B. Ananda Priya, Ayya Nadar Janaki Ammal College (Autonomous), Sivakasi - 626 123, India.
E-mail: `priyaraghul1331@gmail.com`