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Article

Almost Continuous and Open Maps Via M-open Sets in n-Cylindrical Neutrosophic Topological Spaces

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Abstract: In this paper, we introduce and examine n-cylindrical neutrosophic almost M-continuous respective open and closed mappings in n-cylindrical neutrosophic topological spaces, and we study several properties of n-cylindrical neutrosophic M-continuous mappings.

Keywords and phrases: n-$CyNMos$, n-$CyNAlmMCts$ map, n-$CyNAlmMO$ map and n - $CyNAlmMC$ map.
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1. Introduction

Following Zadehs introduction of the fuzzy set (fs) in 1965 [23], Chang [6] developed fuzzy topological spaces (fts), prompting many researchers to adapt classical topological concepts to the fuzzy setting. Atanassov's intuitionistic fuzzy set (ifs) (1986) [4] constituted a major generalization of fuzzy sets, and Coker [7] subsequently defined intuitionistic fuzzy topological spaces ($ifts$) based on ifs. Jeon et al. [9] later studied intuitionistic fuzzy continuity and pre-continuity within this framework.

With Smarandache's advent of neutrosophy and neutrosophic sets [17, 16], uncertainty modeling broadened further. Salama and Alblowi [12] introduced neutrosophic crisp sets and neutrosophic topological spaces (Nts), extending $ifts$ by assigning membership, indeterminacy, and non-membership degrees to each element. This neutrosophic approach has since become a foundation for theories that generalize both crisp and fuzzy structures.

Smarandache also discussed dependence degrees among fuzzy and neutrosophic components. Arokiarani et al. [3] proposed a neutrosophic set (NS) formulation where the sum of the three membership values does not exceed 3. In the same year, Veereswari [22] introduced neutrosophic topological spaces (Nts) and examined their basic operations.

More recently, Saranya et al. [13] introduced n-cylindrical neutrosophic sets (n-$CyNS$), in which the components α and γ are dependent while β is independent. Aside from NS, n-$CyNS$ provides the most extensive generalization of fuzzy sets (fs). In this framework the positive (α), neutral (β), and negative (γ) membership functions satisfy $0 \leq \beta_A \leq 1$ and $0 \leq \alpha_A^n(x) + \gamma_A^n(x) \leq 1, n > 1$, where n is an integer greater than 1.

Saranya et al. [15] later defined n-CyN continuity for maps between n-cylindrical neutrosophic topological spaces (n-$CyNts$), and introduced the n-CyN interior (n-$CyNint$) and n-CyN closure (n-$CyNcl$) of subsets in n-$CyNts$.

Separately, El-Maghrabi and Al-Juhani [8] introduced M-open sets in classical topological spaces and explored their properties. The class of M-open sets has proven useful across various mathematical contexts and applications. Padma et al. [11] studied M-open sets in nano topological spaces, while Vadivel et al. [18, 19, 20] examined related open-set concepts in fuzzy nano and neutrosophic nano topologies. Kalaiyarsan et al. [10] and Vadivel et al. [21] further extended M-open sets to fuzzy and neutrosophic nano topological settings.

The remainder of this paper is organized as follows. Section 2 reviews essential definitions for intuitionistic fuzzy sets (ifs), neutrosophic sets (NS), n-cylindrical neutrosophic sets ($n\text{-}CyNS$), and mappings on n-cylindrical neutrosophic topological spaces ($n\text{-}CyNts$). Sections 3 and 4 introduce $n\text{-}CyN$ almost M-continuous maps ($n\text{-}CyNAlmMCts$) and $n\text{-}CyN$ almost M-irresolute maps ($n\text{-}CyNAlmMIrr$) in $n\text{-}CyNts$ and explore their basic properties with illustrative examples. Section 5 concludes with a summary of the main results.

2. Preliminaries

This section covers some basic definitions and examples that will be useful in subsequent discussions.

Definition 2.1 *[23] A fuzzy set (briefly, fs) A in X is defined by membership function $\mu_A: A \to [0,1]$ whose membership value $\mu_A(x)$ shows the degree to which $x \in X$ includes in the fuzzy set A, for all $x \in X$.*

Definition 2.2 *[6] A fuzzy topological space (briefly, fts) is a pair (X, τ), where X is any set and τ is a family of fuzzy sets in X satisfying following axioms:*

1. $\phi, X \in \tau$,
2. If $A, B \in \tau$, then $A \cap B$ in τ,
3. If $A_i \in \tau$ for each $i \in I$, then $\cup A_i \in \tau$.

Definition 2.3 *[4] An intuitionistic fuzzy set (briefly, ifs) A on X is an object of the form $A = \{\langle x, \alpha_A(x), \gamma_A(x) : x \in X\rangle\}$ where $\alpha_A(x) \in [0,1]$ is called the degree of positive membership of x in A, $\gamma_A(x) \in [0,1]$ is called the degree of negative membership of x in A, and where $\alpha_A(x)$ and $\gamma_A(x)$ satisfy (for all $x \in X$) $(\alpha_A(x) + \gamma_A(x) \leq 1)$ $ifs(X)$ denotes the set of all the ifs's on X.*

Definition 2.4 *[17] An neutrosophic set A on X is an object of the form $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$, where $\alpha_A(x), \beta_A(x), \gamma_A(x) \in [0,1], 0 \leq \alpha_A(x) + \beta_A(x) + \gamma_A(x) \leq 3$, for all $x \in X$. $\alpha_A(x)$ is the degree of positive membership, $\beta_A(x)$ is the degree of neutral and $\gamma_A(x)$ is the degree of negative membership. Here, $\alpha_A(x)$ and $\gamma_A(x)$ are dependent components and $\beta_A(x)$ is an independent component.*

Definition 2.5 *[12] An neutrosophic topology (Nt) on a non-empty set X is a family τ_N of neutrosophic subsets in X satisfying the following axioms:*

1. $0_N, 1_N \in \tau_N$,
2. $G_1 \cap G_2 \in \tau_N$ for any $G_1, G_2 \in \tau_N$,
3. $\cup G_i \in \tau_N$, for all $\{G_i : i \in J\} \subseteq \tau_N$.

In this case the pair (X, τ_N) is called a neutrosophic topological spaces (briefly, Nts) and any neutrosophic set in τ is known as neutrosophic open set (briefly, Nos) in X. The elements of τ_X are called neutrosophic open sets. A neutrosophic set F is closed if and only if $C(F)$ is neutrosophic open.

Definition 2.6 *[13] An n-cylindrical neutrosophic set (briefly, $n\text{-}CyNS$) A on X is an object of the form $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$, where $\alpha_A(x) \in [0,1]$ called the degree of positive membership of x in A, $\beta_A(x) \in [0,1]$ called the degree of neutral membership of x in A and $\gamma_A(x) \in [0,1]$ called the degree of negative membership of x in A, which satisfies the condition: (for all $x \in X$) ($0 \leq \beta_A(x) \leq 1$) and $0 \leq \alpha_A^n(x) + \gamma_A^n(x) \leq 1, n > 1$, is an integer. Here, $\alpha_A(x)$ and $\gamma_A(x)$ are dependent neutrosophic components and $\beta_A(x)$ is 100% independent.*

For the convenience, $\langle \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle$ is called as n-cylindrical neutrosophic number (briefly, $n\text{-}CyNN$) and is denoted as $A = \{\langle \alpha_A, \beta_A, \gamma_A\rangle\}$.

Definition 2.7 *[13] Let $\{A_i : i \in I\}$ be an arbitrary family of $n\text{-}CyNS$ in X. Then, $\cap A_i = \{\langle x, inf(\alpha_{A_i}(x)), inf(\beta_{A_i}(x)), sup(\gamma_{A_i}(x))\rangle : x \in X\}$. $\cup A_i = \{\langle x, sup(\alpha_{A_i}(x)), sup(\beta_{A_i}(x)), inf(\gamma_{A_i}(x))\rangle : x \in X\}$.*

Definition 2.8 *[13] $0_{CyN} = \{\langle x, 0,0,1\rangle : x \in X\}$ and $1_{CyN} = \{\langle x, 1,1,0\rangle : x \in X\}$*

Definition 2.9 *[13]* **(The Basic Connectives)** *Let $\tau_{CyN}(X)$ denote the family of all $n\text{-}CyNS$'s on X.*

1. **Inclusion:** For every two $A, B \in \tau_{CyN}(X)$, the inclusion of two $n\text{-}CyNS$'s A and B is $A \subseteq B$ iff (for all $x \in X$, $\alpha_A(x) \leq \alpha_B(x)$ and $\beta_A(x) \leq \beta_B(x)$ and $\gamma_A(x) \geq \gamma_B(x)$) and ($A \subseteq B$ and $B \subseteq A$).

2. **Union:** For every two $A, B \in \tau_{CyN}(X)$, the union of two $n\text{-}CyNS$'s A and B is $A \cup B(x) = \{\langle x, \max(\alpha_A(x), \alpha_B(x)), \max(\beta_A(x), \beta_B(x)), \min(\gamma_A(x), \gamma_B(x))\rangle : x \in X\}$.

3. **Intersection:** For every two $A, B \in \tau_{CyN}(X)$, the intersection of two $n\text{-}CyNS$'s A and B is

$A \cap B(x) = \{\langle x, \min(\alpha_A(x), \alpha_B(x)), \min(\beta_A(x), \beta_B(x)), \max(\gamma_A(x), \gamma_B(x))\rangle : x \in X\}$.

4. **Complementary:** For every $A \in \tau_{CyN}(X)$, the complement of an $n\text{-}CyNS$ A is $A^c = \{\langle x, \gamma_A(x), 1 - \beta_A(x), \alpha_A(x)\rangle : x \in X\}$.

Remark 2.1 *[13]*

1. If $A \subseteq B$ and $B \subseteq C$ then $A \subseteq C$,
2. $A \cup B = B \cup A$ & $A \cap B = B \cap A$,
3. $(A \cup B) \cup C = A \cup (B \cup C)$ & $(A \cap B) \cap C = A \cap (B \cap C)$,
4. $(A \cup B) \cap C = (A \cap C) \cup (B \cap C)$ & $(A \cap B) \cup C = (A \cup C) \cap (B \cap C)$,
5. $A \cap A = A$ & $A \cup A = A$,
6. De Morgan's Law for A & B ie., $(A \cup B)^c = A^c \cap B^c$ & $(A \cap B)^c = A^c \cup B^c$.

Definition 2.10 *[15] An n-cylindrical neutrosophic topology (briefly, $n\text{-}CyNt$) on a non-empty set X is a family, τ_{CyN}, of $n\text{-}CyNS$ in X which satisfies the following conditions:* 1. $0_{CyN}, 1_{CyN} \in \tau_{CyN}$, 2. $A_1 \cap A_2 \in \tau_{CyN}$,

3. $\cup A_i \in \tau_{CyN}$, for any arbitrary family $A_i \in \tau_{CyN}, i \in I$.

The pair (X, τ_{CyN}) is called an n-cylindrical neutrosophic topological Spaces (briefly, $n\text{-}CyNts$) and any $n\text{-}CyNS$ belongs to τ_{CyN} is called an n-cylindrical neutrosophic open set (briefly, $n\text{-}CyNos$) and the complement of $n\text{-}CyNos$ is called n-cylindrical neutrosophic closed set (briefly, $n\text{-}CyNcs$) in X. Like classical topological spaces and fuzzy topological spaces, the family $\{0_{CyN}, 1_{CyN}\}$ is called indiscrete $n\text{-}CyNts$ and the topology containing all the $n\text{-}CyN$ subsets is called discrete $n\text{-}CyNts$.

Remark 2.2 *[15] Obviously any fuzzy topological spaces or intuitionistic fuzzy topological spaces or Pythagorean fuzzy topological spaces is an $n\text{-}CyNts$ as any subsets of the fuzzy spaces, intuitionistic fuzzy space, and Pythagorean fuzzy space can be viewed as $n\text{-}CyN$ subsets.*

Definition 2.11 *[15] Let A and B be two n-cylindrical neutrosophic subsets of an $n\text{-}CyNts$. B is called neighbourhood of A if there exists an $n\text{-}CyNos$, O such that $A \subset O \subset B$.*

Proposition 2.1 *[15] $A \subset X$ is n-cylindrical neutrosophic open in (X, τ_{CyN}) if and only if it carries a neighbourhood of its subsets.*

Definition 2.12 *[15] Let (X, τ_{CyN}) be an $n\text{-}CyNts$ and let $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ is an $n\text{-}CyNS$ in X. Then, the n-cylindrical neutrosophic interior (briefly, $n\text{-}CyNint$) is defined as the $n\text{-}CyN$ union of all $n\text{-}CyN$ open subsets of X. ie, $n\text{-}CyNint(A) = \bigcup \{G : G \in \tau_{CyN}$ and $G \subseteq A\}$.*

Clearly, $n\text{-}CyNint(A)$ is the biggest $n\text{-}CyNos$ that is contained by A.

Definition 2.13 *[15] Let (X, τ_{CyN}) be an $n\text{-}CyNts$ and let $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ is an $n\text{-}CyNS$ in X. Then, the n-cylindrical neutrosophic closure (briefly, $n\text{-}CyNcl$) is defined as the $n\text{-}CyN$ intersection of all $n\text{-}CyN$ closed subsets of X. ie, $n\text{-}CyNcl(A) = \bigcap \{K : K \in \tau_{CyN}$ and $A \subseteq A\}$.*

Clearly, $n\text{-}CyNcl(A)$ is the smallest $n\text{-}CyNcs$ that contains A.

Definition 2.14 *[14] Let (X, τ_1) and (Y, τ_2) be two $n\text{-}CyNts$ and let $f : (X, \tau_1) \to (Y, \tau_2)$ be a $n\text{-}CyN$ function. Then, f said to be $n\text{-}CyN$ continuous (briefly, $n\text{-}CyNCts$) map if for any n-cylindrical neutrosophic* *subset A of X and for any neighbourhood $\mathfrak{V}$ of $f(A)$ there exists a neighbourhood $\mathfrak{U}$ of A such that $f(\mathfrak{U}) \subset \mathfrak{V}$.*

Definition 2.15 *[1] Let (X, τ_{CyN}) be an n-$CyNts$ and A be an n-$CyNS$. Then, A is said to be an n-CyN*

1. regular open set (briefly, n-$CyNros$), if $A = n\text{-}CyNint(n\text{-}CyNcl(A))$,
2. regular closed set (briefly, n-$CyNrcs$), if $A = n\text{-}CyNcl(n\text{-}CyNint(A))$.

Definition 2.16 *[1] Let (X, τ_{CyN}) be an n-$CyNts$ and $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ be an n-$CyNS$ in X. Then, the n-cylindrical neutrosophic δ-interior of A and the n-cylindrical neutrosophic δ-closure of A are denoted by n-$CyN\delta int(A)$ and n-$CyN\delta cl(A)$ are defined as follows:*

1. $n\text{-}CyN\delta int(A) = \bigcup \{G | G$ isan n-$CyNros$ and $G \subseteq A\}$,
2. $n\text{-}CyN\delta cl(A) = \bigcap \{K | K$ isan n-$CyNrcs$ and $A \subseteq K\}$.

Definition 2.17 *[1] Let (X, τ_{CyN}) be an n-$CyNts$ and $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ be an n-$CyNS$ in X. Then, the n-cylindrical neutrosophic θ-interior of A and the n-cylindrical neutrosophic θ-closure of A are denoted by n-$CyN\theta int(A)$ and n-$CyN\theta cl(A)$ are defined as follows:*

1. $n\text{-}CyN\theta int(A) = \bigcup \{n - CyNint(B) : B \subseteq A$ & B isa $n - CyNcs$ in $X\}$,
2. $n\text{-}CyN\theta cl(A) = \bigcap \{n - CyNcl(B) : A \subseteq B$ & B isa $n - CyNos$ in $X\}$.

Definition 2.18 *[1] Let (X, τ_{CyN}) be an n-$CyNts$ and $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ be an n-$CyNS$ in X. A set A is said to be n-CyN*

1. δ-open set (briefly, n-$CyN\delta os$), if $A = n\text{-}CyN\delta int(A)$,
2. δ-pre open set (briefly, n-$CyN\delta\mathcal{P}os$), if $A \subseteq n\text{-}CyNint(n\text{-}CyN\delta cl(A))$,
3. δ-semi open set (briefly, n-$CyN\delta\mathcal{S}os$), if $A \subseteq n\text{-}CyNcl(n\text{-}CyN\delta int(A))$,
4. θ-open set (briefly, n-$CyN\theta os$), if $A = n\text{-}CyN\theta int(A)$,
5. θ-semi open set (briefly, n-$CyN\theta\mathcal{S}os$), if $A \subseteq n\text{-}CyNcl(n\text{-}CyN\theta int(A))$,
6. e-open set (briefly, n-$CyNeos$), if $A = n\text{-}CyNcl(n\text{-}CyN\delta int(A)) \cup n\text{-}CyNint(n\text{-}CyN\delta cl(A))$,
7. M-open set (briefly, n-$CyNMos$), if $A \subseteq n\text{-}CyNcl(n\text{-}CyN\theta int(A)) \cup n\text{-}CyNint(n\text{-}CyN\delta cl(A))$.

The complement of a n-$CyNMos$ (resp. n-$CyN\delta os$, n-$CyN\delta\mathcal{P}os$, n-$CyN\delta\mathcal{S}os$, n-$CyN\theta os$, n-$CyN\theta\mathcal{S}os$ & n-$CyNeos$) is called a n-$CyNM$ (resp. n-$CyN\delta$, n-$CyN\delta\mathcal{P}$, n-$CyN\delta\mathcal{S}$, n-$CyN\theta$, n-$CyN\theta\mathcal{S}$ & n-$CyNe$) closed set (briefly, n-$CyNMcs$ (resp. n-$CyN\delta cs$, n-$CyN\delta\mathcal{P}cs$, n-$CyN\delta\mathcal{S}cs$, n-$CyN\theta cs$, n-$CyN\theta\mathcal{S}cs$ & n-$CyNecs$)) in X.

The family of all n-$CyNMos$ (resp. n-$CyN\delta os$, n-$CyN\delta\mathcal{P}os$, n-$CyN\delta\mathcal{S}os$, n-$CyN\theta os$, n-$CyN\theta\mathcal{S}os$ & n-$CyNeos$) of X is denoted by n-$CyNMOS(X)$, (resp. n-$CyNMCS(X)$, n-$CyN\delta OS(X)$, n-$CyN\delta CS(X)$, n-$CyN\delta\mathcal{P}OS(X)$, n-$CyN\delta\mathcal{P}CS(X)$, n-$CyN\delta\mathcal{S}OS(X)$, n-$CyN\delta\mathcal{S}CS(X)$, n-$CyN\theta OS(X)$, n-$CyN\theta CS(X)$, n-$CyN\theta\mathcal{S}OS(X)$, n-$CyN\theta\mathcal{S}CS(X)$, n-$CyNeOS(X)$ & n-$CyNeCS(X)$).

Definition 2.19 *[1] Let (X, τ_{CyN}) be an n-$CyNts$ and $A = \{\langle x, \alpha_A(x), \beta_A(x), \gamma_A(x)\rangle : x \in X\}$ be an n-$CyNS$ in X. Then, the n-CyN*

1. M-interior (resp. n-$CyN\delta$-interior, n-$CyN\delta\mathcal{P}$-interior, n-$CyN\delta\mathcal{S}$-interior, n-$CyN\theta$-interior, n-$CyN\theta\mathcal{S}$-interior & n-$CyNe$-interior) of A (briefly, n-$CyNMint(A)$ (resp. n-$CyN\delta int(A)$, n-$CyN\delta\mathcal{P}int(A)$, n-$CyN\delta\mathcal{S}int(A)$, n-$CyN\theta\ int(A)$, n-$CyN\theta\mathcal{S}int(A)$ & n-$CyNeint(A)$)) is defined by n-$CyNMint(A)$ (resp. n-$CyN\delta int(A)$, n-$CyN\delta\mathcal{P}int(A)$, n-$CyN\delta\mathcal{S}int(A)$, n-$CyN\theta int(A)$, n-$CyN\theta\mathcal{S}int(A)$ & n-$CyNeint(A)$) $= \bigcup \{G : G \subseteq A$ and G is a n-$CyNMos$ (resp. n-$CyN\delta os$, n-$CyN\delta\mathcal{P}os$, n-$CyN\delta\mathcal{S}os$, n-$CyN\theta os$, n-$CyN\theta\mathcal{S}os$ & n-$CyNeos$) in $X\}$,

2. M-closure (resp. n-$CyN\delta$-closure, n-$CyN\delta\mathcal{P}$-closure, n-$CyN\delta\mathcal{S}$-closure, n-$CyN\theta$-closure, n-$CyN\theta\mathcal{S}$-closure & n-$CyNe$-closure) of A (briefly, n-$CyNMcl(A)$ (resp. n-$CyN\delta cl(A)$, n-$CyN\delta\mathcal{P}cl(A)$, n-$CyN\delta\mathcal{S}cl(A)$, n-$CyN\theta cl(A)$, n-$CyN\theta\mathcal{S}cl(A)$ & n-$CyNecl(A)$)) is defined by n-$CyNMcl(A)$ (resp. n-$CyN\delta cl(A)$,

$n\text{-}CyN\delta\mathcal{P}cl(A)$, $n\text{-}CyN\delta\mathcal{S}cl(A)$, $n\text{-}CyN\theta cl(A)$, $n\text{-}CyN\theta\mathcal{S}cl(A)$ & $n\text{-}CyNecl(A)) = \bigcap$ $\{K: K \subseteq A$ and K is a $n\text{-}CyNMcs$ (resp. $n\text{-}CyN\delta cs$, $n\text{-}CyN\delta\mathcal{P}cs$, $n\text{-}CyN\delta\mathcal{S}cs$,$n\text{-}CyN\theta cs$, $n\text{-}CyN\theta\mathcal{S}cs$ & $n\text{-}CyNecs$) in $X\}$.

Definition 2.20 *[2] Let (X, τ_1) and (Y, τ_2) be any two $n\text{-}CyNts$'s. A map $f: (X, \tau_1) \to (Y, \tau_2)$ is said to be a $n\text{-}CyN$*

1. δ-continuous map (briefly, $n\text{-}CyN\delta Cts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyN\delta os$ in (X, τ_1),
2. δ-pre continuous map (briefly, $n\text{-}CyN\delta\mathcal{P}Cts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyN\delta\mathcal{P}os$ in (X, τ_1),
3. δ-semi continuous map (briefly, $n\text{-}CyN\delta\mathcal{S}Cts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyN\delta\mathcal{S}os$ in (X, τ_1),
4. θ-continuous map (briefly, $n\text{-}CyN\theta Cts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyN\theta os$ in (X, τ_1),
5. θ-semi continuous map (briefly, $n\text{-}CyN\theta\mathcal{S}os$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyN\theta\mathcal{S}Cts$ in (X, τ_1),
6. e-continuous map (briefly, $n\text{-}CyNeCts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyNeos$ in (X, τ_1),
7. M-continuous map (briefly, $n\text{-}CyNMCts$ map), if the inverse image of every $n\text{-}CyNos$ in (Y, τ_2) is a $n\text{-}CyNMos$ in (X, τ_1).

Definition 2.21 *[2] Let (X, τ_1) and (Y, τ_2) be any two $n\text{-}CyNts$'s. A map $f: (X, \tau_1) \to (Y, \tau_2)$ is said to be a $n\text{-}CyN$*

1. δ-irresolute map (briefly, $n\text{-}CyN\delta Irr$ map), if $f^{-1}(B)$ is a $n\text{-}CyN\delta os$ in (X, τ_1) for every $n\text{-}CyN\delta os$ B of (Y, τ_2),
2. δ-pre irresolute map (briefly, $n\text{-}CyN\delta\mathcal{P}Irr$ map), if $f^{-1}(B)$ is a $n\text{-}CyN\delta\mathcal{P}os$ in (X, τ_1) for every $n\text{-}CyN\delta\mathcal{P}os$ B of (Y, τ_2),
3. δ-semi irresolute map (briefly, $n\text{-}CyN\delta\mathcal{S}Irr$ map), if $f^{-1}(B)$ is a $n\text{-}CyN\delta\mathcal{S}os$ in (X, τ_1) for every $n\text{-}CyN\delta\mathcal{S}os$ B of (Y, τ_2),
4. θ-irresolute map (briefly, $n\text{-}CyN\theta Irr$ map), if $f^{-1}(B)$ is a $n\text{-}CyN\theta os$ in (X, τ_1) for every $n\text{-}CyN\theta os$ B of (Y, τ_2),
5. θ-semi irresolute map (briefly, $n\text{-}CyN\theta\mathcal{S}Irr$ map), if $f^{-1}(B)$ is a $n\text{-}CyN\theta\mathcal{S}os$ in (X, τ_1) for every $n\text{-}CyN\theta\mathcal{S}os$ B of (Y, τ_2),
6. e-irresolute map (briefly, $n\text{-}CyNeIrr$ map), if $f^{-1}(B)$ is a $n\text{-}CyNeos$ in (X, τ_1) for every $n\text{-}CyNeos$ B of (Y, τ_2),
7. M-irresolute map (briefly, $n\text{-}CyNMIrr$ map), if $f^{-1}(B)$ is a $n\text{-}CyNMos$ in (X, τ_1) for every $n\text{-}CyNMos$ B of (Y, τ_2).

3. Almost M-continuous maps in $n\text{-}CyNts$

We will introduce n-cylindrical neutrosophic almost M-continuous maps and look at some of its feature in this section.

Definition 3.1 *Let (X, τ_1) and (Y, τ_2) be any two $n\text{-}CyNts$'s. A map $f: (X, \tau_1) \to (Y, \tau_2)$ is said to be a $n\text{-}CyN$ almost*

1. continuous map (briefly, $n\text{-}CyNAlmCts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y, τ_2) is a $n\text{-}CyNos$ in (X, τ_1),
2. δ-continuous map (briefly, $n\text{-}CyN\delta AlmCts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y, τ_2) is a $n\text{-}CyN\delta os$ in (X, τ_1),

3. δ-pre continuous map (briefly, $n\text{-}CyNAlm\delta\mathcal{P}Cts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyN\delta\mathcal{P}os$ in (X,τ_1),

4. δ-semi continuous map (briefly, $n\text{-}CyNAlm\delta\mathcal{S}Cts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyN\delta\mathcal{S}os$ in (X,τ_1),

5. θ-continuous map (briefly, $n\text{-}CyNAlm\theta Cts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyN\theta os$ in (X,τ_1),

6. θ-semi continuous map (briefly, $n\text{-}CyNAlm\theta\mathcal{S}os$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyN\theta\mathcal{S}os$ in (X,τ_1),

7. e-continuous map (briefly, $n\text{-}CyNAlmeCts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyNeos$ in (X,τ_1),

8. M-continuous map (briefly, $n\text{-}CyNAlmMCts$ map), if the inverse image of every $n\text{-}CyNros$ in (Y,τ_2) is a $n\text{-}CyNMos$ in (X,τ_1).

Example 3.1 *Let $X=\{x_1,x_2\}=Y=\{y_1,y_2\}$ and the n-cylindrical neutrosophic sets A_1,A_2,A_3,A_4 in (X,τ_1) and B_1,B_2 in (Y,τ_2) are defined as*

$$A_1=\{\langle x_1,0.1250732,0.50,0.1850738\rangle,\langle x_2,0.1450734,0.50,0.1650736\rangle\},$$

$$A_2=\{\langle x_1,0.1150731,0.50,0.1950739\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$A_3=\{\langle x_1,0.1950739,0.50,0.1150731\rangle,\langle x_2,0.1750737,0.50,0.1350733\rangle\},$$

$$A_4=\{\langle x_1,0.1250732,0.50,0.1850738\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_1=\{\langle y_1,0.1150731,0.50,0.1950739\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_2=\{\langle y_1,0.1950739,0.50,0.1150731\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\}.$$

Then, $\tau_1=\{0_X,1_X,A_1,A_2,A_3,A_4\}$ and $\tau_2=\{0_Y,1_Y,B_1,B_2\}$. Let $f:(X,\tau_1)\to(Y,\tau_2)$ be an identity map. We claim f is $n\text{-}CyNAlmMCts$ map. Every $n\text{-}CyNros$ set of (Y,τ_2) - namely $0_Y,1_Y,B_1,B_2$ - has an $n\text{-}CyNMos$ inverse image in (X,τ_1) - namely $0_X,1_X,A_2,A_3$ respectively. By Definition 3.1 (viii), this property is precisely the requirement for f to be an $n\text{-}CyNAlmMCts$. Therefore f is $n\text{-}CyNAlmMCts$.

Proposition 3.1

The statements are true, but the converse need not be true.

1. Every $n\text{-}CyNAlm\theta Cts$ map is a $n\text{-}CyNAlmCts$ map,
2. Every $n\text{-}CyNAlm\theta Cts$ map is a $n\text{-}CyNAlm\theta\mathcal{S}Cts$ map,
3. Every $n\text{-}CyNAlm\theta\mathcal{S}Cts$ map is a $n\text{-}CyNAlmMCts$ map,
4. Every $n\text{-}CyNAlm\delta Cts$ map is a $n\text{-}CyNAlmCts$ map,
5. Every $n\text{-}CyNAlm\delta Cts$ map is a $n\text{-}CyNAlm\delta\mathcal{P}Cts$ map,
6. Every $n\text{-}CyNAlm\delta Cts$ map is a $n\text{-}CyNAlm\delta\mathcal{S}Cts$ map,
7. Every $n\text{-}CyNAlm\delta\mathcal{S}Cts$ map is a $n\text{-}CyNAlmeCts$ map,
8. Every $n\text{-}CyNAlm\delta\mathcal{P}Cts$ map is a $n\text{-}CyNAlmMCts$ map,
9. Every $n\text{-}CyNAlmMCts$ map is a $n\text{-}CyNAlmeCts$ map.

Proof.

1. Let B be a $n\text{-}CyNros$ in (Y,τ_2). Since, f is $n\text{-}CyNAlm\theta Cts$ map, $f^{-1}(B)$ is $n\text{-}CyN\theta os$ in (X,τ_1). Since, every $n\text{-}CyN\theta os$ are $n\text{-}CyNos$. $f^{-1}(B)$ is $n\text{-}CyNos$ in (X,τ_1). Hence, f is a $n\text{-}CyNAlmCts$ map.

2. Let B be a $n\text{-}CyNros$ in (Y,τ_2). Since, f is $n\text{-}CyNAlm\theta Cts$ map, $f^{-1}(B)$ is $n\text{-}CyN\theta os$ in (X,τ_1). Since, every $n\text{-}CyN\theta os$ are $n\text{-}CyN\theta\mathcal{S}os$. $f^{-1}(B)$ is $n\text{-}CyN\theta\mathcal{S}os$ in (X,τ_1). Hence, f is a n-

$CyNAlm\theta \mathcal{S}Cts$ map.

3. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\theta \mathcal{S}Cts$ map, $f^{-1}(B)$ is n-$CyN\theta \mathcal{S}os$ in (X,τ_1). Since, every n-$CyN\theta \mathcal{S}os$ are n-$CyNMos$. $f^{-1}(B)$ is n-$CyNMos$ in (X,τ_1). Hence, f is a n-$CyNAlmMCts$ map.

4. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\delta Cts$ map, $f^{-1}(B)$ is n-$CyN\delta os$ in (X,τ_1). Since, every n-$CyN\delta os$ are n-$CyNos$. $f^{-1}(B)$ is n-$CyNos$ in (X,τ_1). Hence, f is a n-$CyNAlmCts$ map.

5. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\delta Cts$ map, $f^{-1}(B)$ is n-$CyN\delta os$ in (X,τ_1). Since, every n-$CyN\delta os$ are n-$CyN\delta \mathcal{P}os$. $f^{-1}(B)$ is n-$CyN\delta \mathcal{P}os$ in (X,τ_1). Hence, f is a n-$CyNAlm\delta \mathcal{P}Cts$ map.

6. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\delta Cts$ map, $f^{-1}(B)$ is n-$CyN\delta os$ in (X,τ_1). Since, every n-$CyN\delta os$ are n-$CyN\delta \mathcal{S}os$. $f^{-1}(B)$ is n-$CyN\delta \mathcal{S}os$ in (X,τ_1). Hence, f is a n-$CyNAlm\delta \mathcal{S}Cts$ map.

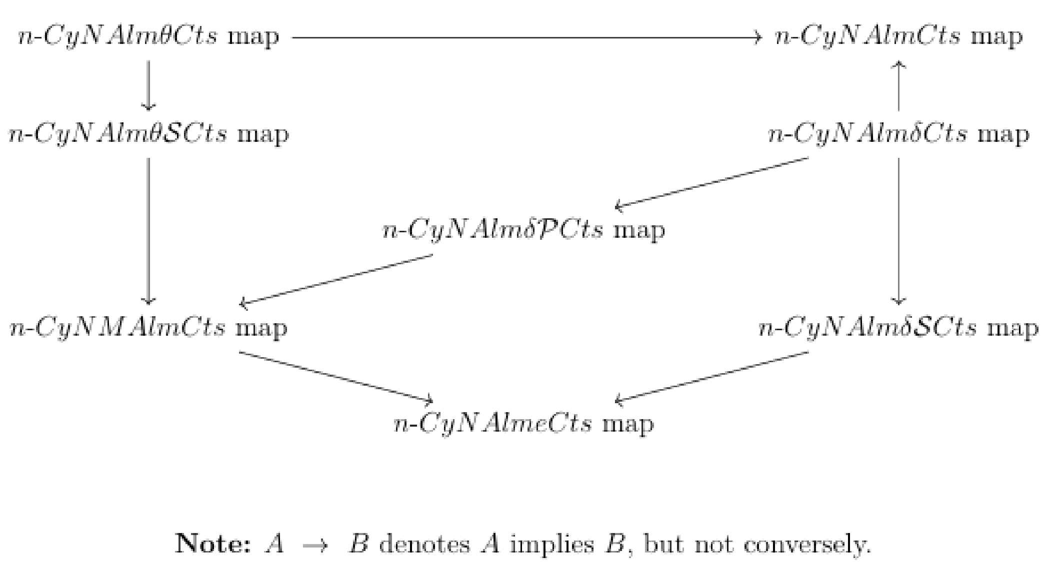
7. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\delta \mathcal{S}Cts$ map, $f^{-1}(B)$ is n-$CyN\delta \mathcal{S}os$ in (X,τ_1). Since, every n-$CyN\delta \mathcal{S}os$ are n-$CyNeos$. $f^{-1}(B)$ is n-$CyNeos$ in (X,τ_1). Hence, f is a n-$CyNAlmeCts$ map.

8. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlm\delta \mathcal{P}Cts$ map, $f^{-1}(B)$ is n-$CyN\delta \mathcal{P}os$ in (X,τ_1). Since, every n-$CyN\delta \mathcal{P}os$ are n-$CyNMos$. $f^{-1}(B)$ is n-$CyNMos$ in (X,τ_1). Hence, f is a n-$CyNAlmMCts$ map.

9. Let B be a n-$CyNros$ in (Y,τ_2). Since, f is n-$CyNAlmMCts$ map, $f^{-1}(B)$ is n-$CyNMos$ in (X,τ_1). Since, every n-$CyNMos$ are n-$CyNeos$. $f^{-1}(B)$ is n-$CyNeos$ in (X,τ_1). Hence, f is a n-$CyNAlmeCts$ map.

It is also true for their respective closed sets

Remark 3.1 *From the results above, we obtain the following diagram.*



Note: $A \rightarrow B$ denotes A implies B, but not conversely.

Example 3.2 *Let* $X=\{x_1,x_2\}=Y=\{y_1,y_2\}$ *and the n-cylindrical neutrosophic sets* A_1,A_2,A_3,A_4 *in* (X,τ_1) *and* B_1,B_2,B_3 *in* (Y,τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1450734,0.50,0.1650736\rangle\},$$
$$A_2 = \{\langle x_1, 0.1150731,0.50,0.1950739\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$A_3 = \{\langle x_1, 0.1950739,0.50,0.1150731\rangle, \langle x_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$A_4 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$B_1 = \{\langle y_1, 0.1150731,0.50,0.1950739\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$B_2 = \{\langle y_1, 0.1950739,0.50,0.1150731\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$B_3 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3, A_4\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is $n\text{-}CyNAlmCts$ map but not $n\text{-}CyNAlm\theta Cts$ map, since $f^{-1}(B_3) = A_4$ is an $n\text{-}CyNos$ but fails to be an $n\text{-}CyN\theta os$.

Example 3.3 *Let $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2, A_3, A_4 in (X, τ_1) and B_1, B_2 in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1150731,0.50,0.1950739\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$A_2 = \{\langle x_1, 0.1950739,0.50,0.1150731\rangle, \langle x_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$A_3 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$A_4 = \{\langle x_1, 0.1850738,0.50,0.1250732\rangle, \langle x_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$B_1 = \{\langle y_1, 0.1150731,0.50,0.1950739\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$B_2 = \{\langle y_1, 0.1850738,0.50,0.1250732\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is $n\text{-}CyNAlm\theta SCts$ map but not $n\text{-}CyNAlm\theta Cts$ map, since $f^{-1}(B_2) = A_4$ is an $n\text{-}CyN\theta Sos$ but fails to be an $n\text{-}CyN\theta os$.

Example 3.4 *Let $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2, A_3, A_4 in (X, τ_1) and B_1, B_2 in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1450734,0.50,0.1650736\rangle\},$$
$$A_2 = \{\langle x_1, 0.1150731,0.50,0.1950739\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$A_3 = \{\langle x_1, 0.1950739,0.50,0.1150731\rangle, \langle x_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$A_4 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$B_1 = \{\langle y_1, 0.1950739,0.50,0.1150731\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\},$$
$$B_2 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3, A_4\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$, and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is an $n\text{-}CyNAlmMCts$ map but not $n\text{-}CyNAlm\theta SCts$ map, since $f^{-1}(B_2) = A_4$ is a $n\text{-}CyNMos$ but not an $n\text{-}CyN\theta Sos$.

Example 3.5 *Let $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2, A_3 in (X, τ_1) and B in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1450734,0.50,0.1650736\rangle\},$$
$$A_2 = \{\langle x_1, 0.1150731,0.50,0.1950739\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$A_3 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$
$$B = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3\}$ and $\tau_2 = \{0_Y, 1_Y, B\}$, and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is an $n\text{-}CyNAlmCts$ map but not an $n\text{-}CyNAlm\delta Cts$ map, since $f^{-1}(B) = A_3$ is an $n\text{-}CyNos$ but not an $n\text{-}CyN\delta os$.

Example 3.6 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2, A_3 *in* (X, τ_1) *and* B *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$A_2 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_3 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3\}$ and $\tau_2 = \{0_Y, 1_Y, B\}$, and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is an $n\text{-}CyNAlm\delta\mathcal{P}Cts$ map but not an $n\text{-}CyNAlm\delta Cts$ map, since $f^{-1}(B) = A_3$ is an $n\text{-}CyN\delta\mathcal{P}os$ but not an $n\text{-}CyN\delta os$.

Example 3.7 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2, A_3, A_4 *in* (X, τ_1) *and* B_1, B_2 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1150731, 0.50, 0.1950739\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_2 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_3 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_4 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is an $n\text{-}CyNAlm\delta\mathcal{S}Cts$ map but not an $n\text{-}CyNAlm\delta Cts$ map, since $f^{-1}(B_1) = A_4$ is an $n\text{-}CyN\delta\mathcal{S}os$ but not an $n\text{-}CyN\delta os$.

Example 3.8 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2, A_3, A_4 *in* (X, τ_1) *and* B_1, B_2 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$A_2 = \{\langle x_1, 0.1150731, 0.50, 0.1950739\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_3 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_4 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1950739, 0.50, 0.1150731\rangle, \langle y_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$B_2 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3, A_4\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is $n\text{-}CyNAlmeCts$ map but not $n\text{-}CyNAlm\delta\mathcal{S}Cts$ map, since $f^{-1}(B_2) = A_4$ is a $n\text{-}CyNeos$ but not an $n\text{-}CyN\delta\mathcal{S}os$.

Example 3.9 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2, A_3, A_4 *in* (X, τ_1) *and* B_1, B_2 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1150731, 0.50, 0.1950739\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_2 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_3 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_4 = \{\langle x_1, 0.1850738, 0.50, 0.1250732\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_2 = \{\langle y_1, 0.1850738, 0.50, 0.1250732\rangle, \langle y_2, 0.1750737, 0.50, 0.1350733\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is

n-$CyNAlmMCts$ map but not n-$CyNAlm\delta\mathcal{P}Cts$ map, since $f^{-1}(B_2) = A_4$ is an n-$CyNMos$ but not an n-$CyN\delta\mathcal{P}os$.

Example 3.10 *Let $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2, A_3, A_4, A_5 in (X, τ_1) and B_1, B_2 in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$A_2 = \{\langle x_1, 0.1150731, 0.50, 0.1950739\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_3 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_4 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$A_5 = \{\langle x_1, 0.1450734, 0.50, 0.1250732\rangle, \langle x_2, 0.1450734, 0.50, 0.1450734\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_2 = \{\langle y_1, 0.1450734, 0.50, 0.1250732\rangle, \langle y_2, 0.1450734, 0.50, 0.1450734\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2, A_3, A_4\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2\}$ and let $f: (X, \tau_1) \to (Y, \tau_2)$ be an identity map. Then, f is n-$CyNAlmeCts$ map but not n-$CyNAlmMCts$ map, since $f^{-1}(B_2) = A_4$ is a n-$CyNeos$ but not an n-$CyNMos$.

Theorem 3.1 *A map $f: (X, \tau_1) \to (Y, \tau_2)$ is n-$CyNAlmMCts$ map iff the inverse image of each n-$CyNrcs$ in (Y, τ_2) is n-$CyNMcs$ in (X, τ_1).*

Theorem 3.2 *Let $f: (X, \tau_1) \to (Y, \tau_2)$ be a n-$CyNAlmMCts$ map and $g: (Y, \tau_2) \to (Z, \tau_3)$ be a n-$CyNAlmCts$ map, then $g \circ f.$ $(X, \tau_1) \to (Z, \tau_3)$ is a n-$CyNAlmMCts$ map.*

Theorem 3.3 *Let $f: (X, \tau_1) \to (Y, \tau_2)$ be a n-$CyNAlmMCts$ map. The following conditions are then satisfied [(i)]*

1. $f(n\text{-}CyNMcl(A)) \subseteq n\text{-}CyNcl(f(A))$, for all n-$CyNrcs(A)$ in (X, τ_1),
2. $n\text{-}CyNMcl(f^{-1}(B)) \subseteq f^{-1}(n\text{-}CyNcl(B))$, for all n-$CyNrcs(B)$ in (Y, τ_2).

Proof.

1. Since, n-$CyNMcl(f(A))$ is a n-$CyNMcs$ in (Y, τ_2) and f is n-$CyNAlmMCts$ map, then $f^{-1}(n\text{-}CyNMcl(f(A)))$ is n-$CyNMos$ in (X, τ_1). Now, since $A \subseteq f^{-1}(n\text{-}CyNcl(f(A)))$, $n\text{-}CyNMcl(A) \subseteq f^{-1}(n\text{-}CyNMcl(f(A)))$. Therefore, $f(n\text{-}CyNMcl(A)) \subseteq n\text{-}CyNcl(f(A))$.

2. By replacing A with B in (i). We obtain $f(n\text{-}CyNMcl(f^{-1}(B))) \subseteq n\text{-}CyNcl(f(f^{-1}(B))) \subseteq n\text{-}CyNcl(B)$. Hence, $n\text{-}CyNMcl(f^{-1}(B)) \subseteq f^{-1}(n\text{-}CyNcl(B))$.

Theorem 3.4 *If f is n-$CyNAlmMCts$ map iff $f^{-1}(n\text{-}CyNint(B)) \subseteq n\text{-}CyNMint(f^{-1}(B))$, for all n-$CyNcs(B)$ in (Y, τ_2).*

Proof. Let f be a n-$CyNAlmMCts$ map and $B \in (Y, \tau_2)$. n-$CyNint(B)$ is n-$CyNros$ in (Y, τ_2) and hence, $f^{-1}(n\text{-}CyNint(B))$ is n-$CyNMcs$ in (X, τ_1). Therefore, $n\text{-}CyNMint(f^{-1}(n\text{-}CyNMint(B)) = f^{-1}(n\text{-}CyNint(B))$. Also, $n\text{-}CyNint(B) \subseteq B$, implies that $f^{-1}(n\text{-}CyNint(B)) \subseteq f^{-1}(B)$. Therefore, $n\text{-}CyNMint(f^{-1}(n\text{-}CyNint(B))) \subseteq n\text{-}CyNMint(f^{-1}(B))$. That is, $f^{-1}(n\text{-}CyNint(B)) \subseteq n\text{-}CyNMint(f^{-1}(B))$.

Conversely, let $f^{-1}(n\text{-}CyN(B)) \subseteq n\text{-}CyNMint(f^{-1}(B))$, for all subset B of (Y, τ_2). If B is n-$CyNros$ in (Y, τ_2), then $n\text{-}CyNint(B) = B$. By assumption, $f^{-1}(n\text{-}CyNint(B)) \subseteq n\text{-}CyNMint(f^{-1}(B))$. Thus, $f^{-1}(B) \subseteq n\text{-}CyNMint(f^{-1}(B))$. But $n\text{-}CyNMint(f^{-1}(B)) \subseteq f^{-1}(B)$. Therefore, $n\text{-}CyNMint\ (f^{-1}(B)) = f^{-1}(B)$. That is, $f^{-1}(B)$ is n-$CyNMos$ on (X, τ_1), for all n-$CyNros(B)$ in (Y, τ_2). Therefore, f is n-$CyNAlmMCts$ map on (X, τ_1).

4. Almost M-open mappings in n-$CyNts$

In this section, we introduce the concept of n-cylindrical neutrosophic almost M-open mappings and examine some of their fundamental properties.

Definition 4.1 *Let (X, τ_1) and (Y, τ_2) be any two n-$CyNts$'s. A map $f: (X, \tau_1) \to (Y, \tau_2)$ is said to be a*

n-CyN almost [(i)]

1. open mapping (briefly, $n\text{-}CyNAlmO$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyNos$ in (Y,τ_2),
2. δ-open mapping (briefly, $n\text{-}CyNAlm\delta O$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyN\delta os$ in (Y,τ_2),
3. δ-pre open mapping (briefly, $n\text{-}CyNAlm\delta\mathcal{P}O$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyN\delta\mathcal{P}os$ in (Y,τ_2),
4. δ-semi open mapping (briefly, $n\text{-}CyNAlm\delta\mathcal{S}O$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyN\delta\mathcal{S}os$ in (Y,τ_2),
5. θ-open mapping (briefly, $n\text{-}CyNAlm\theta O$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyN\theta os$ in (Y,τ_2),
6. θ-semi open mapping (briefly, $n\text{-}CyNAlm\theta\mathcal{S}O$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyN\theta\mathcal{S}os$ in (Y,τ_2),
7. e-open mapping (briefly, $n\text{-}CyNAlmeO$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyNeos$ in (Y,τ_2),
8. M-open mapping (briefly, $n\text{-}CyNAlmMO$ map), if the image of every $n\text{-}CyNros$ in (X,τ_1) is a $n\text{-}CyNMos$ in (Y,τ_2).

Example 4.1 *Let $X=\{x_1,x_2\}$, $Y=\{y_1,y_2\}$ and the n-cylindrical neutrosophic sets A_1,A_2 in (X,τ_1) and B_1,B_2,B_3,B_4 in (Y,τ_2) are defined as*

$$A_1=\{\langle x_1,0.1150731,0.50,0.1950739\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$A_2=\{\langle x_1,0.1950739,0.50,0.1150731\rangle,\langle x_2,0.1750737,0.50,0.1350733\rangle\},$$

$$B_1=\{\langle y_1,0.1850738,0.50,0.1250732\rangle,\langle y_2,0.1650736,0.50,0.1450734\rangle\},$$

$$B_2=\{\langle y_1,0.1950739,0.50,0.1150731\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\},$$

$$B_3=\{\langle y_1,0.1150731,0.50,0.1950739\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_4=\{\langle y_1,0.1850738,0.50,0.1250732\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\}.$$

Let $\tau_1=\{0_X,1_X,A_1,A_2\}$ and $\tau_2=\{0_Y,1_Y,B_1,B_2,B_3,B_4\}$. Consider the identity mapping $f:(X,\tau_1)\to(Y,\tau_2)$. Then, f is $n\text{-}CyNAlm\mathcal{C}MO$ map. We claim f is $n\text{-}CyNAlmMO$ map. Every $n\text{-}CyNros$ set of (X,τ_1) - namely $0_X,1_X,A_1,A_2$ - has an $n\text{-}CyNMos$ image in (Y,τ_2) - namely $0_Y,1_Y,B_2,B_3$ respectively. By Definition 3.1 (viii), this property is precisely the requirement for f to be an $n\text{-}CyNAlmMO$. Therefore f is $n\text{-}CyNAlmMO$.

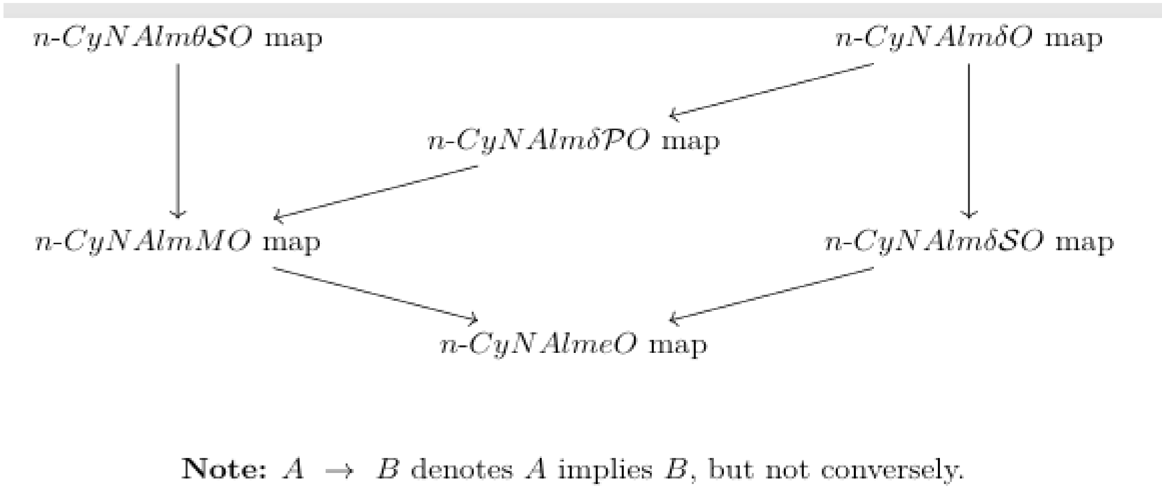
Theorem 4.1 *The statements are hold but the converse does not true.*

1. Every $n\text{-}CyNAlm\theta O$ mapping is a $n\text{-}CyNAlmO$ mapping,
2. Every $n\text{-}CyNAlm\theta O$ mapping is a $n\text{-}CyNAlm\theta\mathcal{S}O$ mapping,
3. Every $n\text{-}CyNAlm\theta\mathcal{S}O$ mapping is a $n\text{-}CyNAlmMO$ mapping,
4. Every $n\text{-}CyNAlm\delta O$ mapping is a $n\text{-}CyNAlmO$ mapping,
5. Every $n\text{-}CyNAlm\delta O$ mapping is a $n\text{-}CyNAlm\delta\mathcal{P}O$ mapping,
6. Every $n\text{-}CyNAlm\delta O$ mapping is a $n\text{-}CyNAlm\delta\mathcal{S}O$ mapping,
7. Every $n\text{-}CyNAlm\delta\mathcal{S}O$ mapping is a $n\text{-}CyNAlmeO$ mapping,
8. Every $n\text{-}CyNAlm\delta\mathcal{P}O$ mapping is a $n\text{-}CyNAlmMO$ mapping,
9. Every $n\text{-}CyNAlmMO$ mapping is a $n\text{-}CyNAlmeO$ mapping.

Proof. Only (viii) is proven; the others are similar.

[(viii)] Let A be a $n\text{-}CyNros$ in (X,τ_1). Since, f is $n\text{-}CyNAlm\delta\mathcal{P}O$ mapping. $f(A)$ is a $n\text{-}CyN\delta\mathcal{P}os$ in (Y,τ_2). Since, every $n\text{-}CyN\delta\mathcal{P}os$ is a $n\text{-}CyNMos$, $f(A)$ is a $n\text{-}CyNMos$ in (Y,τ_2). Hence, f is a $n\text{-}CyNAlmMO$ mapping.

Remark 4.1 *From the above mentioned results. We get the diagram below.*



Note: $A \rightarrow B$ denotes A implies B, but not conversely.

Example 4.2 *Let* $X=\{x_1,x_2\}$, $Y=\{y_1,y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1,A_2,A_3 *in* (X,τ_1) *and* B_1,B_2,B_3,B_4 *in* (Y,τ_2) *are defined as*

$$A_1=\{\langle x_1,0.1150731,0.50,0.1950739\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$A_2=\{\langle x_1,0.1950739,0.50,0.1150731\rangle,\langle x_2,0.1750737,0.50,0.1350733\rangle\},$$

$$A_3=\{\langle x_1,0.1250732,0.50,0.1850738\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_1=\{\langle y_1,0.1250732,0.50,0.1850738\rangle,\langle y_2,0.1450734,0.50,0.1650736\rangle\},$$

$$B_2=\{\langle y_1,0.1150731,0.50,0.1950739\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_3=\{\langle y_1,0.1950739,0.50,0.1150731\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\},$$

$$B_4=\{\langle y_1,0.1250732,0.50,0.1850738\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\}.$$

Let $\tau_1=\{0_X,1_X,A_1,A_2,A_3,\}$ and $\tau_2=\{0_Y,1_Y,B_1,B_2,B_3,B_4\}$. Consider the identity mapping $f:(X,\tau_1)\rightarrow(Y,\tau_2)$. Then, f is a $n\text{-}CyNAlmO$ map but not $n\text{-}CyNAlm\theta O$ map, since $f^{-1}(A_3)=B_4$ is a $n\text{-}CyNos$ but not $n\text{-}CyN\theta os$.

Example 4.3 *Let* $X=\{x_1,x_2\}=Y=\{y_1,y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1,A_2 *in* (X,τ_1) *and* B_1,B_2,B_3,B_4 *in* (Y,τ_2) *are defined as*

$$A_1=\{\langle x_1,0.1150731,0.50,0.1950739\rangle,\langle x_2,0.1350733,0.50,0.1750737\rangle\},$$

$$A_2=\{\langle x_1,0.1850738,0.50,0.1250732\rangle,\langle x_2,0.1750737,0.50,0.1350733\rangle\},$$

$$B_1=\{\langle y_1,0.1150731,0.50,0.1950739\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_2=\{\langle y_1,0.1950739,0.50,0.1150731\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\},$$

$$B_3=\{\langle y_1,0.1250732,0.50,0.1850738\rangle,\langle y_2,0.1350733,0.50,0.1750737\rangle\},$$

$$B_4=\{\langle y_1,0.1850738,0.50,0.1250732\rangle,\langle y_2,0.1750737,0.50,0.1350733\rangle\}.$$

Let $\tau_1=\{0_X,1_X,A_1,A_2\}$ and $\tau_2=\{0_Y,1_Y,B_1,B_2,B_3,B_4\}$. Consider the identity mapping $f:(X,\tau_1)\rightarrow(Y,\tau_2)$. Then, f is an $n\text{-}CyNAlm\theta SO$ map but not $n\text{-}CyNAlm\theta O$ map, since $f^{-1}(A_2)=B_4$ is a $n\text{-}CyN\theta Sos$ but not an $n\text{-}CyN\theta os$.

Example 4.4 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2 *in* (X, τ_1) *and* B_1, B_2, B_3, B_4 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_2 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1150731, 0.50, 0.1950739\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_3 = \{\langle y_1, 0.1950739, 0.50, 0.1150731\rangle, \langle y_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$B_4 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3, B_4\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is an $n\text{-}CyNAlmMO$ map but not $n\text{-}CyNAlm\theta SO$ map, since $f^{-1}(A_2) = B_4$ is a $n\text{-}CyNMos$ but not an $n\text{-}CyN\theta\mathcal{S}os$.

Example 4.5 *Let* $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A *in* (X, τ_1) *and* B_1, B_2, B_3 *in* (Y, τ_2) *are defined as*

$$A = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1150731, 0.50, 0.1950739\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_3 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is an $n\text{-}CyNAlmO$ map but not $n\text{-}CyNAlm\delta O$ map, since $f^{-1}(A) = B_3$ is a $n\text{-}CyNos$ but not $n\text{-}CyN\delta os$.

Example 4.6 *Let* $X = \{x_1, x_2\}$, $Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A *in* (X, τ_1) *and* B_1, B_2, B_3 *in* (Y, τ_2) *are defined as*

$$A = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1950739, 0.50, 0.1150731\rangle, \langle y_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$B_3 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is an $n\text{-}CyNAlm\delta\mathcal{P}O$ map but not $n\text{-}CyNAlm\delta O$ map, since $f^{-1}(A) = B_3$ is a $n\text{-}CyN\delta\mathcal{P}os$ but not $n\text{-}CyN\delta os$.

Example 4.7 *Let* $X = \{x_1, x_2\}$, $Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2 *in* (X, τ_1) *and* B_1, B_2, B_3, B_4 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1450734, 0.50, 0.1650736\rangle\},$$

$$A_2 = \{\langle x_1, 0.1250732, 0.50, 0.1850738\rangle, \langle x_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1150731, 0.50, 0.1950739\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_2 = \{\langle y_1, 0.1950739, 0.50, 0.1150731\rangle, \langle y_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$B_3 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1350733, 0.50, 0.1750737\rangle\},$$

$$B_4 = \{\langle y_1, 0.1250732, 0.50, 0.1850738\rangle, \langle y_2, 0.1450734, 0.50, 0.1650736\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2,\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is $n\text{-}CyNAlm\delta\mathcal{S}O$ map but not $n\text{-}CyNAlm\delta O$ map, since $f^{-1}(A_1) = B_4$ is a $n\text{-}CyN\delta\mathcal{S}os$ but not $n\text{-}CyN\delta os$.

Example 4.8 *Let* $X = \{x_1, x_2\}$, $Y = \{y_1, y_2\}$ *and the* n*-cylindrical neutrosophic sets* A_1, A_2 *in* (X, τ_1) *and* B_1, B_2, B_3, B_4 *in* (Y, τ_2) *are defined as*

$$A_1 = \{\langle x_1, 0.1950739, 0.50, 0.1150731\rangle, \langle x_2, 0.1750737, 0.50, 0.1350733\rangle\},$$

$$A_2 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1450734,0.50,0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1150731,0.50,0.1950739\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_3 = \{\langle y_1, 0.1950739,0.50,0.1150731\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\},$$

$$B_4 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3, B_4\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is $n\text{-}CyNAlmeO$ map but not $n\text{-}CyNAlm\delta\mathcal{S}O$ map, since $f^{-1}(A_2) = B_4$ is a $n\text{-}CyNeos$ but not $n\text{-}CyN\delta\mathcal{S}os$.

Example 4.9 *Let $X = \{x_1, x_2\} = Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2 in (X, τ_1) and B_1, B_2, B_3, B_4 in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$A_2 = \{\langle x_1, 0.1850738,0.50,0.1250732\rangle, \langle x_2, 0.1750737,0.50,0.1350733\rangle\},$$

$$B_1 = \{\langle y_1, 0.1150731,0.50,0.1950739\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_2 = \{\langle y_1, 0.1950739,0.50,0.1150731\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\},$$

$$B_3 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_4 = \{\langle y_1, 0.1850738,0.50,0.1250732\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is $n\text{-}CyNAlmMO$ map but not $n\text{-}CyNAlm\delta\mathcal{P}O$ map, since $f^{-1}(A_2) = B_4$ is a $n\text{-}CyNMos$ but not $n\text{-}CyN\delta\mathcal{P}os$.

Example 4.10 *Let $X = \{x_1, x_2\}$, $Y = \{y_1, y_2\}$ and the n-cylindrical neutrosophic sets A_1, A_2 in (X, τ_1) and B_1, B_2, B_3, B_4, B_5 in (Y, τ_2) are defined as*

$$A_1 = \{\langle x_1, 0.1250732,0.50,0.1850738\rangle, \langle x_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$A_2 = \{\langle x_1, 0.1450734,0.50,0.1250732\rangle, \langle x_2, 0.1450734,0.50,0.1450734\rangle\},$$

$$B_1 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1450734,0.50,0.1650736\rangle\},$$

$$B_2 = \{\langle y_1, 0.1150731,0.50,0.1950739\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_3 = \{\langle y_1, 0.1950739,0.50,0.1150731\rangle, \langle y_2, 0.1750737,0.50,0.1350733\rangle\},$$

$$B_4 = \{\langle y_1, 0.1250732,0.50,0.1850738\rangle, \langle y_2, 0.1350733,0.50,0.1750737\rangle\},$$

$$B_5 = \{\langle y_1, 0.1450734,0.50,0.1250732\rangle, \langle y_2, 0.1450734,0.50,0.1450734\rangle\}.$$

Let $\tau_1 = \{0_X, 1_X, A_1, A_2\}$ and $\tau_2 = \{0_Y, 1_Y, B_1, B_2, B_3, B_4\}$. Consider the identity mapping $f: (X, \tau_1) \to (Y, \tau_2)$. Then, f is $n\text{-}CyNAlmeO$ map but not $n\text{-}CyNAlmMO$ map, since $f^{-1}(A_2) = B_5$ is a $n\text{-}CyNeos$ but not $n\text{-}CyNMos$.

Theorem 4.2 *A mapping $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmMO$ mapping iff for every $n\text{-}CyNros$ A of (X, τ_1), $f(n\text{-}CyNrint(A)) \subseteq n\text{-}CyNMint(f(A))$.*

Proof. Necessity: Let f be a $n\text{-}CyNAlmMO$ mapping and A be a $n\text{-}CyNros$ in (X, τ_1). Now, $n\text{-}CyNrint(A) \subseteq A$ implies $f(n\text{-}CyNrint(A)) \subseteq f(A)$. Since, f is a $n\text{-}CyNAlmMO$ mapping. $f(n\text{-}CyNrint(A))$ is $n\text{-}CyNMos$ in (Y, τ_2) such that $f(n\text{-}CyNrint(A)) \subseteq f(A)$. Therefore, $f(n\text{-}CyNrint(A)) \subseteq n\text{-}CyNMint(f(A))$.

Sufficiency: Assume, A is a $n\text{-}CyNros$ of (X, τ_1). Then, $f(A) = f(n\text{-}CyNrint(A)) \subseteq n\text{-}CyNM\,int(f(A))$. But $n\text{-}CyNMint(f(A)) \subseteq f(A)$. So, $f(A) = n\text{-}CyNMint(A)$ which implies $f(A)$ is a $n\text{-}CyNMos$ of (Y, τ_2) and hence, f is a $n\text{-}CyNAlmMO$ mapping.

Theorem 4.3 *If $f: (X, \tau_1) \to (Y, \tau_2)$ is a $n\text{-}CyNAlmMO$ mapping then $n\text{-}CyNrint(f^{-1}(A)) \subseteq f^{-1}(n\text{-}CyNMint(A))$ for every $n\text{-}CyNros$ A of (Y, τ_2).*

Proof. Let A be a $n\text{-}CyNros$ of (Y, τ_2). Then $n\text{-}CyNrint(f^{-1}(A))$ is a $n\text{-}CyNros$ in (X, τ_1). Since, f is $n\text{-}CyNAlmMO$ mapping. $f(n\text{-}CyNrint(f^{-1}(A)))$ is $n\text{-}CyNMos$ in (Y, τ_2) and hence, $f(n\text{-}CyNrint(f^{-1}(A))) \subseteq n\text{-}CyNMint(f(f^{-1}(A))) \subseteq n\text{-}CyNMint(A)$. Thus, $n\text{-}CyNrint(f^{-1}(A)) \subseteq f^{-1}(n\text{-}CyNM\ int(A$

Theorem 4.4 *A mapping $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmMO$ mapping iff for each $n\text{-}CyNS$ B of (Y, τ_2) and for each $n\text{-}CyNrcs$ A of (X, τ_1) containing $f^{-1}(B)$ there is a $n\text{-}CyNMcs$ C of (Y, τ_2) such that $B \subseteq A$ and $f^{-1}(C) \subseteq A$.*

Proof. Necessity: Assume f is a $n\text{-}CyNAlmMO$ mapping. Let B be the $n\text{-}CyNrcs$ of (Y, τ_2) and A is a $n\text{-}CyNrcs$ of (X, τ_1) such that $f^{-1}(B) \subseteq A$. Then, $C = (f^{-1}(A)^c)^c$ is $n\text{-}CyNMcs$ of (Y, τ_2) such that $f^{-1}(C) \subseteq A$.

Sufficiency: Assume A is a $n\text{-}CyNros$ of (X, τ_1). Then, $f^{-1}((f(A))^c) \subseteq A^c$ and A^c is $n\text{-}CyNrcs$ in (X, τ_1). By hypothesis, there is a $n\text{-}CyNMcs$ C of (Y, τ_2) such that $(f(A))^c \subseteq C$ and $f^{-1}(C) \subseteq A^c$. Therefore, $A \subseteq (f^{-1}(C))^c$. Hence $C^c \subseteq f(A) \subseteq f((f^{-1}(C))^c) \subseteq C^c$ which implies $f(A) = C^c$. Since, C^c is $n\text{-}CyNMos$ of (Y, τ_2). $f(A)$ is $n\text{-}CyNMos$ in (Y, τ_2) and thus f is $n\text{-}CyNAlmMO$ mapping.

Theorem 4.5 *A mapping $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmMO$ mapping iff $f^{-1}(n\text{-}CyNMcl(B)) \subseteq n\text{-}CyNrcl(f^{-1}(B))$ for every $n\text{-}CyNS$ B of (Y, τ_2).*

Proof. Necessity: Assume, f is a $n\text{-}CyNAlmMO$ mapping. For any $n\text{-}CyNS$ B of (Y, τ_2), $f^{-1}(B \subseteq n\text{-}CyNrcl\ (f^{-1}(B))$. Therefore, by Theorem 4.4, there exists a $n\text{-}CyNMcs$ A in (Y, τ_2) such that $B \subseteq A$ and $f^{-1}(A) \subseteq n\text{-}CyNrcl(f^{-1}(B))$. Therefore, we obtain that $f^{-1}(n\text{-}CyNMcl(B)) \subseteq f^{-1}(A) \subseteq n\text{-}CyNrcl(f^{-1}(B))$.

Sufficiency: Assume, B is a $n\text{-}CyNS$ of (Y, τ_2) and A is a $n\text{-}CyNrcs$ of (X, τ_1) containing $f^{-1}(B)$. Put $C = n\text{-}CyNrcl(B)$, then $B \subseteq C$ and C is $n\text{-}CyNMcs$ and $f^{-1}(C) \subseteq n\text{-}CyNrcl(f^{-1}(B)) \subseteq A$. Then, by Theorem 4.4, f is a $n\text{-}CyNAlmMO$ mapping. **Theorem 4.6** *If $f: (X, \tau_1) \to (Y, \tau_2)$ and $g: (Y, \tau_2) \to (Z, \tau_3)$ be two mappings and $g \circ f: (X, \tau_1) \to (Z, \tau_3)$ is $n\text{-}CyNAlmMO$ mapping. If $g: (Y, \tau_2) \to (Z, \tau_3)$ is a $n\text{-}CyNMIrr$ mapping, then $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmMO$ mapping.*

Proof. Let A be a $n\text{-}CyNros$ in (X, τ_1). Then, $(g \circ f)(A)$ is a $n\text{-}CyNMos$ of (Z, τ_3) because $g \circ f$ is a $n\text{-}CyNAlmMO$ mapping. Since, g is a $n\text{-}CyNMIrr$ mapping and $(g \circ f)(A)$ is a $n\text{-}CyNMos$ of (Z, τ_3), $g^{-1}((g \circ f)(A)) = f(A)$ is a $n\text{-}CyNMos$ in (Y, τ_2). Hence, f is a $n\text{-}CyNAlmMO$ mapping.

Theorem 4.7 *If $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmO$ mapping and $g: (Y, \tau_2) \to (Z, \tau_3)$ is a $n\text{-}CyNMO$ mapping, then $g \circ f: (X, \tau_1) \to (Z, \tau_3)$ is a $n\text{-}CyNAlmMO$ mapping.*

Proof. Let A be a $n\text{-}CyNros$ in (X, τ_1). Then, $f(A)$ is a $n\text{-}CyNos$ of (Y, τ_2) because f is a $n\text{-}CyNAlmO$ mapping. Since, g is a $n\text{-}CyNAlmMO$ mapping. $g(f(A)) = (g \circ f)(A)$ is a $n\text{-}CyNMos$ of (Z, τ_3). Hence, $g \circ f$ is a $n\text{-}CyNAlmMO$ mapping.

5. Almost M-closed mappings in $n\text{-}CyNts$

We will introduce n-cylindrical neutrosophic almost M-closed mappings and look at some of its feature in this section.

Definition 5.1 *Let (X, τ_1) and (Y, τ_2) be any two $n\text{-}CyNts$'s. A map $f: (X, \tau_1) \to (Y, \tau_2)$ is said to be a $n\text{-}CyN$ almost*

1. closed mapping (briefly, $n\text{-}CyNAlmC$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyNcs$ in (Y, τ_2),
2. δ-closed mapping (briefly, $n\text{-}CyNAlm\delta C$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyN\delta cs$ in (Y, τ_2),
3. δ-pre closed mapping (briefly, $n\text{-}CyNAlm\delta\mathcal{P}C$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyN\delta\mathcal{P}cs$ in (Y, τ_2),
4. δ-semi closed mapping (briefly, $n\text{-}CyNAlm\delta\mathcal{S}C$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyN\delta\mathcal{S}cs$ in (Y, τ_2),
5. θ-closed mapping (briefly, $n\text{-}CyNAlm\theta C$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyN\theta cs$ in (Y, τ_2),

6. θ-semi closed mapping (briefly, $n\text{-}CyNAlm\theta\mathcal{S}C$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyN\theta\mathcal{S}cs$ in (Y, τ_2),

7. e-closed mapping (briefly, $n\text{-}CyNAlmeC$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyNecs$ in (Y, τ_2),

8. M-closed mapping (briefly, $n\text{-}CyNAlmMC$ map), if the image of every $n\text{-}CyNrcs$ in (X, τ_1) is a $n\text{-}CyNMcs$ in (Y, τ_2).

Theorem 5.1

The statements are hold but the converse does not true.

1. Every $n\text{-}CyNAlm\theta C$ mapping is a $n\text{-}CyNAlmC$ mapping,
2. Every $n\text{-}CyNAlm\theta C$ mapping is a $n\text{-}CyNAlm\theta\mathcal{S}C$ mapping,
3. Every $n\text{-}CyNAlm\theta\mathcal{S}C$ mapping is a $n\text{-}CyNAlmMC$ mapping,
4. Every $n\text{-}CyNAlm\delta C$ mapping is a $n\text{-}CyNAlmC$ mapping,
5. Every $n\text{-}CyNAlm\delta C$ mapping is a $n\text{-}CyNAlm\delta\mathcal{P}C$ mapping,
6. Every $n\text{-}CyNAlm\delta C$ mapping is a $n\text{-}CyNAlm\delta\mathcal{S}C$ mapping,
7. Every $n\text{-}CyNAlm\delta\mathcal{S}C$ mapping is a $n\text{-}CyNAlmeC$ mapping,
8. Every $n\text{-}CyNAlm\delta\mathcal{P}C$ mapping is a $n\text{-}CyNAlmMC$ mapping,
9. Every $n\text{-}CyNAlmMC$ mapping is a $n\text{-}CyNAlmeC$ mapping.

Proof. Only (viii) is proven; the others are similar.

[(viii)] Let A be a $n\text{-}CyNrcs$ in (X, τ_1). Since, f is $n\text{-}CyNAlm\delta\mathcal{P}C$ mapping. $f(A)$ is a $n\text{-}CyN\delta\mathcal{P}cs$ in (Y, τ_2). Since, every $n\text{-}CyN\delta\mathcal{P}cs$ is a $n\text{-}CyNMcs$, $f(A)$ is a $n\text{-}CyNMcs$ in (Y, τ_2). Hence, f is a $n\text{-}CyNAlmMC$ mapping.

Example 5.1 *In Example 4.2, A^c is $n\text{-}CyNAlmC$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\theta C$ mapping in (Y, τ_2).*

Example 5.2 *In Example 4.3, A^c is $n\text{-}CyNAlm\theta\mathcal{S}C$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\theta C$ mapping in (Y, τ_2).*

Example 5.3 *In Example 4.4, A^c is $n\text{-}CyNAlmMC$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\theta\mathcal{S}C$ mapping in (Y, τ_2).*

Example 5.4 *In Example 4.5, A^c is $n\text{-}CyNAlmC$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\delta C$ mapping in (Y, τ_2).*

Example 5.5 *In Example 4.6, A^c is $n\text{-}CyNAlm\delta\mathcal{P}C$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\delta C$ mapping in (Y, τ_2).*

Example 5.6 *In Example 4.7, A^c is $n\text{-}CyNAlm\delta\mathcal{S}C$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\delta C$ mapping in (Y, τ_2).*

Example 5.7 *In Example 4.8, A^c is $n\text{-}CyNAlmeC$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\delta\mathcal{S}C$ mapping in (Y, τ_2).*

Example 5.8 *In Example 4.9, A^c is $n\text{-}CyNAlmMC$ mapping in (X, τ_1) but not $n\text{-}CyNAlm\delta\mathcal{P}C$ mapping in (Y, τ_2).*

Example 5.9 *In Example 4.10, A^c is $n\text{-}CyNAlmeC$ mapping in (X, τ_1) but not $n\text{-}CyNAlmMC$ mapping in (Y, τ_2).*

Theorem 5.2 *A mapping $f: (X, \tau_1) \to (Y, \tau_2)$ is $n\text{-}CyNAlmMC$ mapping iff for each $n\text{-}CyNros$ B of (Y, τ_2) and for each $n\text{-}CyNros$ A of (X, τ_1) containing $f^{-1}(B)$ there is a $n\text{-}CyNMos$ C of (Y, τ_2) such that $B \subseteq C$ and $f^{-1}(C) \subseteq A$.*

Proof. Necessity: Assume f is a $n\text{-}CyNAlmMC$ mapping. Let B be the $n\text{-}CyNrcs$ of (Y,τ_2) and A is a $n\text{-}CyNros$ of (X,τ_1) such that $f^{-1}(B) \subseteq A$. Then, $C = 1_Y - f^{-1}(A)^c$ is $n\text{-}CyNMos$ of (Y,τ_2) such that $f^{-1}(C) \subseteq A$.

Sufficiency: Assume A is a $n\text{-}CyNrcs$ of (X,τ_1). Then, $(f(A))^c$ is a $n\text{-}CyNS$ of (Y,τ_2) and A^c is $n\text{-}CyNros$ in (X,τ_1) such that $f^{-1}((f(A))^c) \subseteq A^c$. By hypothesis, there is a $n\text{-}CyNMos$ C of (Y,τ_2) such that $(f(A))^c \subseteq C$ and $f^{-1}(C) \subseteq A^c$. Therefore, $A \subseteq (f^{-1}(C))^c$. Hence $C^c \subseteq f(C) \subseteq f((f^{-1}(C))^c) \subseteq C^c$ which implies $f(A) = C^c$. Since, C^c is a $n\text{-}CyNMcs$ of (Y,τ_2). $f(A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2) and thus f is a $n\text{-}CyNAlmMC$ mapping.

Theorem 5.3 *If $f:(X,\tau_1) \to (Y,\tau_2)$ is a $n\text{-}CyNAlmMC$ mapping, then $n\text{-}CyNMcl(f(A)) \subseteq f(n\text{-}CyNrcl(A))$ for every subset A of (X,τ_1).*

Proof. Let A be a subset of (X,τ_1). By definition, $n\text{-}CyNrcl(A)$ is a $n\text{-}CyNrcs$ in (X,τ_1). Since f is a $n\text{-}CyNAlmMC$ mapping, $f(n\text{-}CyNrcl(A))$ is a $n\text{-}CyNMcs$ in (Y,τ_2).

Now, $A \subseteq n\text{-}CyNrcl(A)$ implies $f(A) \subseteq f(n\text{-}CyNrcl(A))$. Taking $n\text{-}CyNM$-closure on both sides, $n\text{-}CyNMcl(f(A)) \subseteq n\text{-}CyNMcl(f(n\text{-}CyNrcl(A)))$. But $f(n\text{-}CyNrcl(A))$ is itself a $n\text{-}CyNMcs$ in (Y,τ_2), so $n\text{-}CyNMcl(f(n\text{-}CyNrcl(A))) = f(n\text{-}CyNrcl(A))$.

Therefore, $n\text{-}CyNMcl(f(A)) \subseteq f(n\text{-}CyNrcl(A))$.

Theorem 5.4 *If $f:(X,\tau_1) \to (Y,\tau_2)$ is a $n\text{-}CyNAlmC$ mapping and $g:(Y,\tau_2) \to (Z,\tau_3)$ is a $n\text{-}CyNMC$ mapping. Then, $g \circ f:(X,\tau_1) \to (Z,\tau_3)$ is a $n\text{-}CyNAlmMC$ mapping.*

Proof. Let A be a $n\text{-}CyNrcs$ in (X,τ_1). Then, $f(A)$ is $n\text{-}CyNcs$ of (Y,τ_2) because f is $n\text{-}CyNAlmC$ mapping. Now, $(g \circ f)(A) = g(f(A))$ is $n\text{-}CyNMcs$ in (Z,τ_3) because g is a $n\text{-}CyNMC$ mapping. Thus, $g \circ f$ is a $n\text{-}CyNAlmMC$ mapping.

Theorem 5.5 *Let $f:(X,\tau_1) \to (Y,\tau_2)$ and $g:(Y,\tau_2) \to (Z,\tau_3)$ are $n\text{-}CyNAlmMC$ mapping. If every $n\text{-}CyNMcs$ of (Y,τ_2) is a $n\text{-}CyNrcs$ then $g \circ f:(X,\tau_1) \to (Z,\tau_3)$ is a $n\text{-}CyNAlmMC$ mapping.*

Proof. Let A be a $n\text{-}CyNrcs$ in (X,τ_1). Then, $f(A)$ is a $n\text{-}CyNMcs$ of (Y,τ_2) because f is $n\text{-}CyNAlmMC$ mapping. By hypothesis, $f(A)$ is a $n\text{-}CyNrcs$ of (Y,τ_2). Now, $g(f(A)) = (g \circ f)(A)$ is $n\text{-}CyNMcs$ in (Z,τ_3) because g is a $n\text{-}CyNAlmMC$ mapping. Thus, $g \circ f$ is a $n\text{-}CyNAlmMC$ mapping.

Theorem 5.6 *Let $f:(X,\tau_1) \to (Y,\tau_2)$ be a bijective mapping. Then, the following statements are equivalent:*

1. f is a $n\text{-}CyNAlmMO$ mapping,
2. f is a $n\text{-}CyNAlmMC$ mapping,
3. f^{-1} is a $n\text{-}CyNAlmMCts$ mapping.

Proof.

i. $\to$ (ii): Assume f is a $n\text{-}CyNAlmMO$ mapping. Let A be a $n\text{-}CyNrcs$ in (X,τ_1). Then, $1_X - A$ is a $n\text{-}CyNros$ in (X,τ_1). By assumption, $f(1_X - A)$ is a $n\text{-}CyNMos$ in (Y,τ_2). Since f is bijective, $f(1_X - A) = 1_Y - f(A)$, and hence $1_Y - f(A)$ is a $n\text{-}CyNMos$ in (Y,τ_2). That is, $f(A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2). Since A was an arbitrary $n\text{-}CyNrcs$ in (X,τ_1), f is a $n\text{-}CyNAlmMC$ mapping.

ii $\to$ (iii): Assume f is a $n\text{-}CyNAlmMC$ mapping. By Theorem 4.1, $f^{-1}:(Y,\tau_2) \to (X,\tau_1)$ is a $n\text{-}CyNAlmMCts$ mapping if and only if $(f^{-1})^{-1}(A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2) for every $n\text{-}CyNrcs$ A of (X,τ_1). Since f is bijective, $(f^{-1})^{-1}(A) = f(A)$. By (ii), $f(A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2) for every $n\text{-}CyNrcs$ A of (X,τ_1). Hence $(f^{-1})^{-1}(A)$ is $n\text{-}CyNMcs$ in (Y,τ_2) for every $n\text{-}CyNrcs$ A of (X,τ_1), and therefore, by Theorem 4.1, f^{-1} is a $n\text{-}CyNAlmMCts$ mapping.

iii. $\to$ (i): Assume f^{-1} is a $n\text{-}CyNAlmMCts$ mapping. Let A be a $n\text{-}CyNros$ in (X,τ_1), so that $1_X - A$ is a $n\text{-}CyNrcs$ in (X,τ_1). By Theorem 4.1, $(f^{-1})^{-1}(1_X - A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2). Since f is bijective, $(f^{-1})^{-1}(1_X - A) = f(1_X - A) = 1_Y - f(A)$, so $1_Y - f(A)$ is a $n\text{-}CyNMcs$ in (Y,τ_2), i.e., $f(A)$ is a $n\text{-}CyNMos$ in (Y,τ_2). Since A was an arbitrary $n\text{-}CyNros$ in (X,τ_1), f is a $n\text{-}CyNAlmMO$ mapping

6. Conclusion

In this paper we discussed the concepts of n-$CyNAlmMCts$ mappings, n-$CyNAlmMO$ mappings, and n-$CyNAlmMC$ mappings in n-cylindrical neutrosophic topological spaces. For future research, we aim to investigate n-cylindrical neutrosophic almost contra M-open mappings and n-cylindrical neutrosophic almost contra M-closed mappings.

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