Forms of supra $g^{\#}\alpha$ - Continuous Functions

V.Kokilavani, N.R.Bhuvaneswari

***Abstract*: This paper encompasses and particularly throws light on the new classes of functions called strongly supra $g^{\#}\alpha$ -Continuous and perfectly supra $g^{\#}\alpha$ - continuous functions and to analyze some of the unique properties and relations amid them. Subsequently, the conception of almost supra $g^{\#}\alpha$ -continuous function is also conferred and the relationship of these functions with other functions were investigated and portrayed. Furthermore, a mildly supra $g^{\#}\alpha$ -normal space have been defined and analyzed.**

***Keywords* : supra $g^{\#}\alpha$ -closed (open) sets, supra $g^{\#}\alpha$ -continuous, supra $g^{\#}\alpha$ -irresolute, strongly supra $g^{\#}\alpha$ -continuous and perfectly supra $g^{\#}\alpha$ – continuous and almost supra $g^{\#}\alpha$ -continuous function.**

I. INTRODUCTION

The concept Supra topological spaces and studied S-continuous maps and S*- continuous maps was introduced by Mashhour et al [2] in 1983. Moreover, in 2008, Devi et al. [1] initiated and studied a class of sets called supra α-open and a class of maps called sα-continuous maps between topological spaces, respectively. In addition to in 2011, G.Ramkumar et al [3] explored Supra g -Closed set and supra g-continuity maps.

In lieu with the above concept, Kokilavani and Bhuvaneswari have introduced and investigated supra $g^{\#}\alpha$ –closed sets and supra $g^{\#}\alpha$ continuous functions. Subsequently in this paper we tend to introduce strongly supra $g^{\#}\alpha$ -continuous and perfectly supra $g^{\#}\alpha$ -continuous functions and also we have arrived a concept of almost supra $g^{\#}\alpha$ -continuous function and further investigated the relationship with other functions in supra topological spaces. Finally, a new type of normal space called mildly supra $g^{\#}\alpha$ -normal space is also defined and its properties have been investigated.

II. PRELIMINARIES

Definition: 2.1[5] A subfamily of μ of X is said to be a supra topology on X, if (i) X, $\phi \in \mu$

(ii) if $A_i \in \mu$ for all $i \in J$ then $\cup A_i \in \mu$.

The pair (X, μ) is called supra topological space. The elements of μ are called supra open sets in (X, μ) and complement of a supra open set is called a supra closed set.

Definition: 2.2[5] (i) The supra closure of a set A is denoted by $cl^{\mu}(A)$ and is defined as

$cl^{\mu}(A) = \cap\{B : B$ is a supra closed set and $A \subseteq B\}$.

(ii) The supra interior of a set A is denoted by $int^{\mu}(A)$ and defined as

$int^{\mu}(A) = \cup\{B: B$ is a supra open set and $A \supseteq B\}$.

Definition: 2.3[5] Let (X, τ) be a topological spaces and μ be a supra topology on X. We call μ a supra topology associated with τ if $\tau \subset \mu$.

Definition: 2.4 [2] Let (X,μ) be a supra topological space. A Subset A of X is called supra α − open set if $A \subseteq int^{\mu}(cl^{\mu}(int^{\mu}(A)))$. The complement of supra α - open set is supra α - closed set.

Definition: 2.5 [5] Let (X, μ) be a supra topological space. A Subset A of X is called g-closed set if $cl^{\mu}(A) \subseteq U$,whenever $A\subseteq U$ and U is supra open set of X.

Definition: 2.6 [5] Let (X, μ) be a supra topological space .A Subset A of X is called gs–closed set if $scl^{\mu}(A) \subseteq U$ whenever $A\subseteq U$ and U is supra open set of X.

Definition: 2.7[6] Let (X,μ) be a supra topological space. A Subset A of X is called supra g^* closed set if $cl^{\mu}(A) \subseteq U$ whenever $A\subseteq U$ and U is supra g-open set of X. The complement of

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Dr.V.Kokilavani Assistant professor & Head , Department of Mathematics,Kongunadu Arts and Science College,Coimbatore,(TN),India
N.R.Bhuvaneswari Associate professor,Department of MathematicsSNS College of Technology, Coimbatore, (TN), India
srisaitechnologymadurai@gmail.com

supra g^* - closed set is supra g^* - open set.

Definition: 2.8[6] Let (X, μ) be a supra topological space.A Subset A of X is called supra αg- closed set if $\alpha cl^{\mu}(A) \subseteq U$,whenever A⊆ U and U is open set of X.

Definition: 2.9[3] Let (X, μ) be a supra topological space .A Subset A of X is called supra $g^{\#}\alpha$-closed set if $\alpha cl^{\mu}(A) \subseteq U$,whenever A⊆ U and U is supra g- open set of X. The

complement of supra $g^{\#}\alpha$ - closed set is called supra $g^{\#}\alpha$ -open set.

Definition 2.10[9] Let (X, μ) be a supra topological space . A set A of X is called supra regular open if $A = int^{\mu}(cl^{\mu}(A))$ and supra regular closed if $A = cl^{\mu}(intl^{\mu}(A))$.

Definition: 2.11 Let (X, μ) and (Y, σ) be two topological spaces and τ ⊂ μ. A map

f:(X, τ) →(Y,σ) is called

(i) supra continuous [2] if the inverse image of each open set of Y is a supra open set in X.

(ii) supra α-continuous [2] if the inverse image of each open set of Y is a supra α -open set in X.

(iii) supra g-continuous [6] if the inverse image of each closed set of Y is a supra g-closed set in X.

(iv)Supra gs-continuous [6] if the inverse image of each closed set of Y is a supra gs-closed set in X.

(v) Supra αg-continuous [7] if the inverse image of each closed set of Y is a supra αg-closed set in X.

Definition: 2.12 Let (X, μ) and (Y, σ) be two topological spaces and τ ⊂ μ. A map

f: (X, τ) → (Y, σ) is called

(i) Supra closed [2] if the image of each closed set of X is a supra closed set in Y.

(ii) Supra α-closed [2] if the image of each closed set of X is a supra α -closed set in Y.

(iii) Supra g-closed [5] if the image of each closed set of X is a supra g-closed set in Y.

(iv)Supra gs-closed [3] if the image of each closed set of X is a supra gs-closed set in Y.

(v)Supra αg -closed [4] if the image of each closed set of X is a supra αg -closed set in Y.

(vi) supra regular open[7], if $int^{\mu}cl^{\mu}(A)$ The complement of the above mentioned sets are their

respective open and closed sets and vice-versa.

Definition 2.13 Let (X, μ) and (Y, σ) be two topological spaces and τ ⊂ μ. A map

f: (X, τ) → (Y, σ) is called

(i) Supra irresolute [3] if $f^{-1}(v)$ is supra closed in X for every supra closed set V of Y.

(ii)Supra α -irresolute [7] if $f^{-1}(v)$ is supra a-closed in X for every supra α -closed set V of Y.

(iii) Supra αg -irresolute [4] if $f^{-1}(v)$ is supra αg-closed in X for every supra αg -closed set V of Y.

Definition: 2.14[3] Let (X, τ) and (Y, σ) be two topological spaces and μ be an associated supra topology with τ . A function f: (X, τ) → (Y, σ) is called supra $g^{\#}\alpha$ - Continuous if $f^{-1}(V)$ is $g^{\#}\alpha$-closed in (X,μ) for every closed set V of (Y, σ).

Definition: 2.15 [3] Let (X, τ) and (Y, σ) be two topological spaces and μ be an associated supra topology with τ . A function f: (X, τ) → (Y, σ) is called $g^{\#}\alpha$ - irresolute if

$f^{-1}(V)$ is supra $g^{\#}\alpha$ -closed in

(X,μ) for every supra $g^{\#}\alpha$ -closed set V of (Y, σ).

III. .STRONGLY SUPRA $g^{\#}\alpha$ CONTINUOUS AND PERFECTLY SUPRA $g^{\#}\alpha$ CONTINUOUS.

Definition 3.1 Let (X,τ) and (Y,σ) be two topological spaces and μ be an associated supra topology with τ. A function f:(X,τ)→(Y,σ) is called Strongly supra $g^{\#}\alpha$ -Continuous if the inverse image of every supra $g^{\#}\alpha$ -closed in Y is supra closed in X .

Definition 3.2 Let (X,τ) and (Y,σ) be two topological spaces and μ be an associated supra topology with τ. A function f:(X,τ)→(Y,σ) is called perfectly supra $g^{\#}\alpha$ - Continuous if the inverse image of every supra $g^{\#}\alpha$ - closed in Y is both supra closed and supra open in X.

Theorem 3.3 L e t (X,τ) be a topological spaces and μ be an associated supra topology with τ. A function f:(X,τ)→(Y,σ) is Strongly supra $g^{\#}\alpha$ - Continuous then it is supra $g^{\#}\alpha$ -Continuous.

Example 3.4 Let X=Y={a,b,c}, τ= {X,ϕ,{a}} and σ={Y,ϕ ,{b},{a,b}}.

Let f:(X,τ)→(Y,σ) be an identity map.

Then f is supra $g^{\#}\alpha$ - continuous but not strongly supra $g^{\#}\alpha$ - continuous, since for the supra $g^{\#}\alpha$ - closed set V = {a} in Y, f^{-1}(V) =f^{-1}({a}) = {a} is not supra closed in X.

Theorem 3.5 A function f:(X,τ)→(Y,σ) be strongly supra $g^{\#}\alpha$ - continuous if and only if the inverse image of every supra $g^{\#}\alpha$ - closed set in Y is supra closed in X.

Theorem 3.6 If a function f :X→Y is strongly supra $g^{\#}\alpha$ -continuous and a map g: Y→Z is supra $g^{\#}\alpha$ - Continuous, then the composition gof: X→Z is strongly $g^{\#}\alpha$ - continuous

Theorem 3.7 If a function f :X→Y is supra continuous then it is strongly supra $g^{\#}\alpha$ - continuous but not conversely.

Converse of the above theorem need not be true as seen from the following example.

Example 3.8 Let X=Y={a,b,c }, τ= {X,ϕ,{a}} and σ ={Y,ϕ ,{b},{a,b}}.

Let f:(X,τ)→(Y,σ) be an identity map. Then f is Strongly supra $g^{\#}\alpha$ - continuous, V = {a} is supra $g^{\#}\alpha$ -closed in Y, f^{-1}(V) =f^{-1}({a}) = {a} is supra closed in X. Since V={a} is not supra closed in Y, f is not supra continuous.

Theorem 3 .9 L e t (X,τ) be a topological spaces and μ be an associated supra topology with τ. A function f:(X,τ)→(Y,σ) is perfectly supra $g^{\#}\alpha$ Continuous then it is strongly supra $g^{\#}\alpha$ -Continuous.

Example 3.10 Let X=Y={a,b,c }, τ= {X,ϕ,{a},{a,b}} and σ={Y,ϕ ,{a}, {c},{a,b},{a,c}}.Let f:(X,τ)→(Y,σ) be an identity map. Then f is strongly supra $g^{\#}\alpha$ - continuous but not perfectly supra $g^{\#}\alpha$ - continuous, since for the supra $g^{\#}\alpha$ - closed set V = {a,c} in Y, f^{-1}(V) =f^{-1}({a,c}) = {a,c} is not in both supra open and supra closed in X.

Theorem 3.11 A function f:(X,τ)→(Y,σ) be perfectly supra $g^{\#}\alpha$ - continuous if and only if the inverse image of set in Y is both supra open and supra closed in X.

Theorem 3.12 If a function X→Y is strongly supra $g^{\#}\alpha$

-continuous then it is supra $g^{\#}\alpha$ -irresolute but not conversely.

Converse of the above theorem need not be true as seen from the following example.

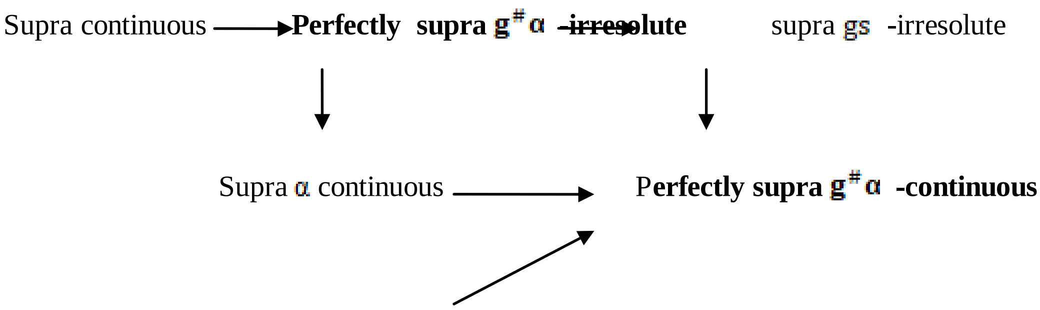
Example 3.13 Let X=Y={a,b,c }, τ= {X,ϕ,{a}} and σ={Y,ϕ ,{b},{a,b}}.

Theorem 3.14 If a function X→Y is perfectly supra $g^{\#}\alpha$ -continuous then it is supra $g^{\#}\alpha$ -irresolute but not conversely.

Example 3.15 Let X=Y={a,b,c }, τ= {X,ϕ,{a}} and σ={Y,ϕ ,{b},{a,b}}. Let f:(X,τ)→(Y,σ) be an identity map.

Then f is supra $g^{\#}\alpha$ -irresolute but not perfectly supra $g^{\#}\alpha$ - continuous, since for the supra $g^{\#}\alpha$ - closed set V = {b} in Y, f^{-1}(V) =f^{-1}({b}) = {b} is not in both supra open and supra closed in

Let f:(X,τ)→(Y,σ) be an identity map. Then f is supra g



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supra g^*-continuous ⟶ supra gs -continuous

4. ALMOST SUPRA $g^{\#}\alpha$ -CONTINUOUS FUNCTION

Definition 4.1 A map f:(X, τ) → (Y, σ) is called Almost supra continuous function if $f^{-1}(V)$ is supra open set in (X, τ) for every supra regular open set V of (Y, σ).

Definition 4.2 A map f:(X, τ) → (Y, σ) is called Almost supra $g^{\#}\alpha$ -continuous function if $f^{-1}(V)$ is supra $g^{\#}\alpha$ -open in (X, τ) for every supra regular open set V of (Y, σ).

Theorem 4.3 For a function f:(X, τ) → (Y, σ), the following are equivalent:

i) f is almost supra $g^{\#}\alpha$ -continuous.

ii) $f^{-1}(V)$ is supra $g^{\#}\alpha$ -closed in X for every supra regular closed set V of Y.

iii) $f^{-1}(cl^{\mu}int^{\mu}(V))$ is supra $g^{\#}\alpha$ -closed in X, for every supra closed set V of Y

iv) $f^{-1}(int^{\mu}cl^{\mu}(V))$ is supra $g^{\#}\alpha$ -open in X, for every supra open set V of Y.

Proof

(i)⇒ (ii) Let V be supra regular closed set in Y. Then Y-V is supra regular open set in Y. Since f is almost supra $g^{\#}\alpha$ -continuous, f^{-1} (Y-V)=X- f^{-1} (V) is supra $g^{\#}\alpha$ -open in X. Hence f^{-1} (V) is supra $g^{\#}\alpha$ -closed in X.

(ii)⇒ (iii) Let V be supra closed set in Y. Then V= $int^{\mu}cl^{\mu}(V)$ is supra regular closed set in Y, then by hypothesis, $f^{-1}(int^{\mu}cl^{\mu}(V))$ is supra $g^{\#}\alpha$ -closed in X.

(iii)⇒ (iv) Let V be supra open set in Y. Then V= $int^{\mu}cl^{\mu}(V)$ is supra regular open set in Y.Then Y- $int^{\mu}cl^{\mu}(V)$ is supra regular closed set in Y. Then by hypothesis, $f^{-1}(Y-int^{\mu}cl^{\mu}(V))=X-f^{-1}(int^{\mu}cl^{\mu}(V))$ is supra $g^{\#}\alpha$ -closed in X. Hence $f^{-1}(int^{\mu}cl^{\mu}(V))$ is supra $g^{\#}\alpha$ -open in X.

(iv)⇒ (i) Let V be supra open set in Y. Then V= $int^{\mu}cl^{\mu}(V)$ is supra regular open set and every regular open set is open set in Y. Then by hypothesis, $f^{-1}(int^{\mu}cl^{\mu}(V)) = f^{-1}(V)$ is supra $g^{\#}\alpha$ -open in X. Hence f is almost supra $g^{\#}\alpha$ -continuous.

Theorem 4.4 Every supra $g^{\#}\alpha$ -continuous function is almost supra $g^{\#}\alpha$ -continuous function.

Example 4.5 Let X=Y={a, b, c} and τ = {X, ϕ, {a} , {a, b}} , σ = {Y, ϕ , {a} , {b} , {a, b} , {b, c}}. $g^{\#}\alpha$ -open set in (X,τ) are {X, ϕ , {a} , {b} , {a, b} , {a, c}}. $g^{\#}\alpha$ -open set in (Y,σ) are {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. f:(X, τ) → (Y, σ) be the function defined by f(a)=b, f(b)=c, f(c)=a. Here f is almost supra $g^{\#}\alpha$ -continuous but not supra $g^{\#}\alpha$ -continuous, since V={a, b} is supra open in (Y, σ) but f^{-1} ({a, b})= {b, c} is not supra $g^{\#}\alpha$ -open set in (X,τ)

Theorem 4.6 Every strongly supra $g^{\#}\alpha$ -continuous function is almost supra $g^{\#}\alpha$ - continuous function.

Example 4.7 Let X=Y={a, b, c} and τ = {X, υ, {a} , {a, b}} , σ = {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. $g^{\#}\alpha$ -open set in (X,τ) are {X, ϕ, {a} , {b} , {a, b} , {a, c}}. $g^{\#}\alpha$

-open set in (Y,σ) are {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. f:(X, τ) → (Y, σ) be the function defined by f(a)=b, f(b)=c, f(c)=a. Here f is almost supra $g^{\#}\alpha$ -continuous but not strongly supra $g^{\#}\alpha$ -continuous, since V={a, b} is supra $g^{\#}\alpha$ -open in (Y, σ) but f^{-1} ({a, b}) = {b, c} is not supra open set in (X,τ).

Theorem 4.8 Every perfectly supra $g^{\#}\alpha$ -continuous function is almost supra $g^{\#}\alpha$ - continuous function.

Example 4.9 Let X=Y={a, b, c} and τ = {X, υ, {a} , {a, b}} , σ = {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. $g^{\#}\alpha$ -open set in (X ,τ) are {X, ϕ, {a} , {b} , {a, b} , {a, c}}. $g^{\#}\alpha$ -open set in (Y,σ) are {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. f:(X, τ) → (Y, σ) be the function defined by f(a)=b, f(b)=c, f(c)=a. Here f is almost supra $g^{\#}\alpha$ -continuous but not perfectly supra $g^{\#}\alpha$ -continuous, since V={a, b} is supra $g^{\#}\alpha$ -open in (Y, σ) but f^{-1} ({a, b}) = {b, c} is not supra clopen set in (X,τ).

Theorem 4.10 Every almost supra continuous function is almost supra $g^{\#}\alpha$ -continuous function.

Example 4.11 Let X=Y={a, b, c} and τ = {X, ϕ, {a} , {a, b}} , σ = {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. $g^{\#}\alpha$ -open set in (X,τ) are {X, ϕ, {a} , {b} , {a, b} , {a, c}}.$g^{\#}\alpha$ -open set in (Y,σ) are {Y, ϕ, {a} , {b} , {a, b} , {b, c}}. f:(X, τ) → (Y, σ) be the function defined by f(a)=b, f(b)=c, f(c)=a. Here f is almost supra $g^{\#}\alpha$ -continuous but not almost supra continuous, since V={a} is supra regular open in (Y, σ) but f^{-1} ({a}) = {c} is not supra open set in (X,τ).

Theorem 4.12 If f:(X, τ) → (Y, σ) is supra $g^{\#}\alpha$ -irresolute and g:(Y, σ) → (Z, η) is almost supra $g^{\#}\alpha$ -continuous then g∘f:(X, τ) → (Z, η) is almost supra $g^{\#}\alpha$-continuous.

Theorem 4.13 If f:(X, τ) → (Y, σ) is strongly supra $g^{\#}\alpha$ -continuous and g:(Y, σ) → (Z, η) is almost supra $g^{\#}\alpha$ -continuous then g ∘ f :(X, τ) → (Z, η) is almost supra $g^{\#}\alpha$ - continuous.

Theorem 4.14 If f:(X, τ) → (Y, σ) is contra supra $g^{\#}\alpha$ -irresolute and g:(Y, σ) → (Z, η) is almost contra supra $g^{\#}\alpha$-continuous then g∘f: (X, τ) → (Z, η) is almost supra $g^{\#}\alpha$ -continuous.

Definition 4.15 (i) A Space (X, τ) is said to be normal if for any pair of disjoint closed sets A and B,there exist disjoint supra open sets U and V such that A⊂U and B⊂V

(ii) A Space (X, τ) is said to be supra $g^{\#}\alpha$ normal if for any pair of disjoint closed sets A and B,there exist disjoint supra $g^{\#}\alpha$ open sets U and V such that A⊂U and B⊂V

(iii) A space X is said to be mildly supra $g^{\#}\alpha$ -normal if for every pair of disjoint supra regular closed sets A and B of X, there exist disjoint supra $g^{\#}\alpha$ -open sets U and V such that A⊂U and B⊂V.

Theorem 4.16 Every supra normal space is mildly supra $g^{\#}\alpha$ -normal.

Example 4.17 Let X={a, b, c, d} and τ = {X, ϕ, {a} , {d} , {a, b} , {c, d} , {a, b, c} , {b, c, d}} supra $g^{\#}\alpha$ -open sets in (X ,τ) are {X, ϕ, {a} , {b} , {c} , {d} , {a, b} , {a, d} , {b, d} , {c, d} ,{b, c} , {a, c} , {a, b, c} , {a, b, d} , {b, c, d} , {a, c, d}}.Here (X,τ) is mildly supra $g^{\#}\alpha$ - normal but not supra normal, since A={a, b} and B={d} is supra closed in (X,τ) but A and B is not contained in disjoint supra open sets.

Theorem 4.18 Every supra $g^{\#}\alpha$ -normal space is mildly supra $g^{\#}\alpha$ -normal.

Example 4.19 Let X={a, b, c, d} and τ = {X, ϕ, {a} , {d} , {a, b} , {c, d} , {a, b, c} , {b, c, d}} supra $g^{\#}\alpha$ -open sets in (X,τ) are {X, ϕ, {a} , {b} , {c} , {d} , {a, b} , {a, d} , {b, d} ,

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{c, d} ,{b, c} , {a, c} , {a, b, c} , {a, b, d} , {b, c, d} , {a, c, d}}.Here (X,τ) is mildly supra $g^{\#}\alpha$ - normal but not supra $g^{\#}\alpha$ -normal, since A={a, b} and B={d} is supra closed in (X,τ) but A and B is not contained in disjoint supra $g^{\#}\alpha$ -open sets.

Theorem 4.20 Every weakly supra $g^{\#}\alpha$ -normal space is mildly supra $g^{\#}\alpha$-normal.

Example 4.21 Let X={a, b, c, d} and τ = {X, ϕ, {a} , {d} , {a, b} , {c, d} , {a, b, c} , {b, c, d}} supra $g^{\#}\alpha$ -open sets in (X,τ) are{X, ϕ, {a} , {b} , {c} , {d} , {a, b} , {a, d} , {b, d} , {c, d} , {b, c} , {a, c} , {a, b, c} , {a, b, d} , {b, c, d} , {a, c, d}}.Here (X,τ) is mildly supra $g^{\#}\alpha$ -normal but not weakly supra $g^{\#}\alpha$ -normal, since A={a, b} and B={d} is supra $g^{\#}\alpha$ - closed in (X,τ) but A and B is not contained in disjoint supra open sets.

Theorem 4.22 If f :(X, τ) → (Y, σ) be supra $g^{\#}\alpha$ -open map, almost supra $g^{\#}\alpha$ - continuous surjective, and if X is weakly supra $g^{\#}\alpha$ -normal, then Y is mildly supra $g^{\#}\alpha$ -normal.

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AUTHORS PROFILE

Dr.V.Kokilavani Assistant professor & Head , Department of Mathematics,Kongunadu Arts and Science College,Coimbatore,(TN),India

N.R.Bhuvaneswari *Associate professor,Department of MathematicsSNS College of Technology, Coimbatore, (TN), India*