VOLUME XII
ISBN No.: 978-93-94004-01-6
Physical Science

NALLAMUTHU GOUNDER MAHALINGAM COLLEGE

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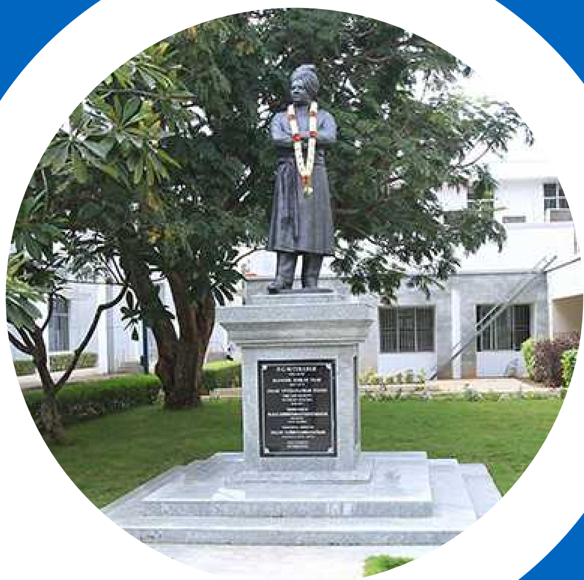

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Department of Biological Science, Physical Science and Computational Science

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Estd. 1957

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ABOUT THE INSTITUTION

A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

ABOUT CONFERENCE

The International conference on “Emerging Trends in Science and Technology (ETIST-2021)” is being jointly organized by Departments of Biological Science, Physical Science and Computational Science - Nallamuthu Gounder Mahalingam College, Pollachi along with ISTE, CSI, IETE, IEE & RIYASA LABS on 27th OCT 2021. The Conference will provide common platform for faculties, research scholars, industrialists to exchange and discus the innovative ideas and will promote to work in interdisciplinary mode.

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Magnitude based Ordering of triangular neutrosophic numbers

[1]K.Radhika*, [2]K.Arun Prakash, [3]R.Santhi

ABSTRACT: Ranking of neutrosophic number plays an important part in linguistic decision problems. But ranking neutrosophic number is a difficult task. Different strategies have been proposed till now to order triangular neutrosophic number. In this work a new ranking method is introduced to rank triangular neutrosophic number by using its magnitude value. Properties of the ranking method is also studied. The new ranking method is justified for its better result by comparing with the existing method.

KEYWORDS:Neutrosophic sets, neutrosophic number, triangular neutrosophic number, Magnitude ranking.

1. INTRODUCTION

Since most of the problems in real life consist of uncertainty and vagueness we need a suitable tool to handle such problems. Zadeh [1] introduced Fuzzy set theory to deal uncertainty and vagueness. Later Atanassov [2] extended to intuitionistic fuzzy set in which he considered membership and non-membership function. Fuzzy sets and intuitionistic fuzzy sets cannot produce accuracy where the data is adequate, and uncertain. Neutrosophic sets was first introduced by Smarandache [3,4] to overcome the drawbacks in fuzzy sets and intuitionistic fuzzy sets. Neutrosophic logic is characterized by three components namely (i) truth membership degree (ii) indeterminacy-membership degree and (iii) falsity-membership degree. Smarandache further extended neutrosophic probability, to neutrosophic measure, neutrosophic integral [5]. This gives a way to apply neutrosophic logic in all mathematical concept especially engineering problems. After many researcher's showed interest in this area. To represent an interval number or real number in uncertain situation neutrosophic numbers was introduced. To apply neutrosophic numbers in decision making problems and linear programming problems ranking of neutrosophic numbers is essential. Deli, Subas[6] ranked single valued neutrosophic number and applied in decision making problems. Chakraborty [7] studied representation of triangular neutrosophic numbers in different forms and also introduced a new de-fuzzification technique. Ye [8] applied single valued neutrosophic numbers to find shortest path. Said Broumi [9] considered shortest path of network in the view of triangular neutrosophic number. TuhinBera [10] introduced single valued neutrosophic number ranked the same and applied in linear programming problems.

Novelty and Motivation:

Fuzzy sets, intuitionistic fuzzy sets, interval valued fuzzy sets, and other structures have been used to deal with ambiguous data in recent years. Neutrosophic sets, which were introduced

K.Radhika[1], Mathematics, Kongu Engineering College, Erode, Tamil Nadu, India, radhikavisu@gmail.com
Dr.K.Arun Prakash[2], Mathematics, Kongu Engineering College, Erode, Tamilnadu, India, arunfuzzy@gmail.com
Dr.R.Santhi[3], Mathematics, NGM College, Pollachi, Tamilnadu, India,santhifuzzy@yahoo.co.in

recently, have proven to be better adapted to dealing with vagueness than previous set theoretical structures. Only uncertainty can be measured by a fuzzy number, however intuitionistic and interval valued intuitionistic fuzzy numbers can measure both uncertainty and vagueness, but not hesitation. Only the neutrosophic number can effectively measure all three characteristics. As a result, the triangular neutrosophic number garners more attention and opens the door to new study.

Structure of the work

Section 1 of this paper discusses the fundamental concepts of neutrosophic set theory, as well as a study of existing neutrosophic numbers, their ranking mechanism, and their application in real-world applications. The preliminaries are included in Section 2. Section 3 generates a triangular neutrosophic number and related arithmetic operations. We present a novel method for ranking triangular neutrosophic numbers based on their magnitude. Section 4 provides a numerical example, while section 5 provides a conclusion.

2. PRELIMINARIES

The basic and crucial definitions of neutrosophic set and neutrosophic numbers are outlined in this section.

Definition 2.1: [11] Let X be the universal of discourse. A neutrosophic set A in X is defined by truth membership function$A_T(x)$, indeterminacy-membership function$A_I(x)$, and falsity membership function $A_F(x)$, so that $A_T(x)$,$A_I(x)$,$A_T(x)$,→]-0,1$^+$[.Also $0 \leq supA_T(x) + supA_I(x) + supA_F(x) \leq 3^+$.

Definition 2.2: [11] Let X be the universal of discourse. A single valued neutrosophic set A in X is defined as $A = \{< x, A_T(x), A_I(x), A_F(x) > x \in X \; and \; A_T(x), A_I(x), A_F(x) \in [0,1]\}$ with $0 \leq supA_T(x) + supA_I(x) + supA_F(x) \leq 3$.

Definition 2.3: [12] (α,β,γ)-cut of a neutrosophic set is defined as $C_{\alpha,\beta,\gamma} = \{x \in X: C_T(x) \geq \alpha, C_I(x) \leq \beta, C_F(x) \leq \gamma\}$ with $\alpha, \beta, \gamma \in [0,1]$ and $\alpha + \beta + \gamma \leq 3$.

Definition 2.4:[12]A neutrosophic set A defined on the universal set of real numbers R is said to be neutrosophic number if it has the following properties.

(i) A is normal
(ii) A is convex set for truth function.
(iii) A is concave for the indeterministic function and false function.

3. TRIANGULAR NEUTROSOPHIC NUMBERS

Here single valued neutrosophic number and its arithmetic operation are discussed.

Definition 3.1.1: A single valued neutrosophic number
$\tilde{A} = \{< (a_1, a_2, a_3; p), (b_1, b_2, b_3; q), (c_1, c_2, c_3); r >\}$ is a subset of single valued neutrosophic set on R whose truth membership function$A_T(x)$,indeterminacy-membership function$A_I(x)$,and falsity membership function $A_F(x)$ is defined as

$$\tilde{A}_T(x) = \begin{cases} A_{T,}^{L} & a_1 \le x \le a_2 \\ p, & x = a_2 \\ A_T^R, & a_2 \le x \le a_3 \end{cases}$$

$$\tilde{A}_I(x) = \begin{cases} A_{I,}^{L} & b_1 \le x \le b_2 \\ q, & x = b_2 \\ A_I^R, & b_2 \le x \le b_3 \end{cases}$$

$$\tilde{A}_F(x) = \begin{cases} A_{F,}^{L} & c_1 \le x \le c_2 \\ r, & x = c_2 \\ A_F^R, & c_2 \le x \le c_3 \end{cases}$$

Where $p, q, r \in [0,1]$ and $A_T^L(x), A_I^R(x), A_F^R(x)$ are continuous strictly monotonically increasing function, $A_T^R(x), A_I^L(x), A_F^L(x)$ are continuous strictly monotonically decreasing function. Inverse function $A_T^{L'}(\alpha), A_T^{R'}(\alpha), A_I^{L'}(\alpha), A_I^{R'}(\alpha), A_F^{L'}(\alpha), A_F^{R'}(\alpha)$exist and is integrable in [0, 1].

Definition 3.1.2: A single valued triangular neutrosophic number

$\tilde{A} = \{< (a_1, a_2, a_3; p), (b_1, b_2, b_3; q), (c_1, c_2, c_3); r >\}$is a subset of single valued neutrosophic set on R whose truth membership function$A_T(x)$,indeterminacy-membership function$A_I(x)$,and falsity membership function $A_F(x)$ is defined as

$$A_T(x) = \begin{cases} p\left(\dfrac{x - a_1}{a_2 - a_1}\right), & a_1 \le x \le a_2 \\ p & x = a_2 \\ p\left(\dfrac{a_3 - x}{a_3 - a_2}\right), & a_2 \le x \le a_3 \end{cases}$$

$$A_{\mathrm{I}}(x) = \begin{cases} \left(\dfrac{q(x - b_1) + (b_2 - x)}{b_2 - b_1}\right), & b_1 \le x \le b_2 \\ q & x = b_2 \\ \left(\dfrac{(x - b_2) + q(b_3 - x)}{b_3 - b_2}\right), & b_2 \le x \le b_3 \end{cases}$$

$$A_{\mathrm{F}}(x) = \begin{cases} \left(\dfrac{r(x - c_1) + (c_2 - x)}{c_2 - c_1}\right), & c_1 \le x \le c_2 \\ r & x = c_2 \\ \left(\dfrac{(x - c_2) + r(c_3 - x)}{c_3 - c_2}\right), & c_2 \le x \le c_3 \end{cases}$$

whose inverse is as follows

$$A_T^{L'}(\alpha) = a_1 + \alpha\frac{(a_2 - a_1)}{p}, A_I^{R'}(\alpha) = a_3 + \frac{(a_2 - a_3)\alpha}{p}$$

$$A_I^{L'}(\alpha) = \frac{b_1(q - \alpha) + b_2(\alpha - 1)}{q - 1}, A_I^{R'}(\alpha) = \frac{b_2(1 - \alpha) + b_3(\alpha - q)}{1 - q}$$

$$A_F^{L'}(\alpha) = \frac{c_1(r - \alpha) + c_2(\alpha - 1)}{r - 1}, \quad A_F^{R'}(\alpha) = \frac{c(1 - \alpha) + c_3(\alpha - r)}{1 - r}$$

3.2 Arithmetic operation of triangular neutrosophic number

We define the arithmetic operation on triangular neutrosophic number by extending the arithmetic operation defined in [13].

Consider two triangular neutrosophic number

$A = \{< (a_1, a_2, a_3; p), (b_1, b_2, b_3; q), (c_1, c_2, c_3); r >\}$ and
$B = \{< (d_1, d_2, d_3; s), (e_1, e_2, e_3; t), (f_1, f_2, f_3); u >\}$

(i**) Addition of two triangular neutrosophic number:**

Addition of two triangular neutrosophic number $A + B = \{< (a_1 + d_1, a_2 + d_2, a_3 + d_3; v), (b_1 + e_1, b_2 + e_2, b_3 + e_3; w)(c_1 + f_1, c_2 + f_2, c_3 + f_3; z) >\}$
Where $v = \min\{p, s\}, w = \max\{q, t\}, z = \max\{r, u\}$.

(ii) **Subtraction of two triangular neutrosophic number:**

Subtraction of two triangular neutrosophic number$A - B = \{< (a_1 - d_3, a_2 - d_2, a_3 - d_1; v), (b_1 - e_3, b_2 - e_2, b_3 - e_1; w)(c_1 - f_3, c_2 - f_2, c_3 - f_1; z) >\}$
Where $v = \min\{p, s\}, w = \max\{q, t\}, z = \max\{r, u\}$.

(iii) **Multiplication of triangular neutrosophic number by scalar:**

Scalar multiplication of a triangular neutrosophic number

$$A\lambda = \begin{cases} \{< (\lambda a_1, \lambda a_2, \lambda a_3; p), (\lambda b_1, \lambda b_2, \lambda b_3; q), (\lambda c_1, \lambda c_2, \lambda c_3); r >, \lambda > 0 \\ \{< (\lambda a_3, \lambda a_2, \lambda a_1; p), (\lambda b_3, \lambda b_2, \lambda b_1; q), (\lambda c_3, \lambda c_2, \lambda c_1); r >, \lambda < 0 \end{cases}$$

3.3 Ranking of triangular neutrosophic number

In this section, the magnitude of the triangular neutrosophic number is used to rank it, and a ranking procedure is also provided.

3.3.1 Ranking function

For an arbitrary triangular neutrosophic number $A = \{< (A_T^L(x), A_T^R(x)), (A_I^L(x), A_I^R(x))(A_F^L(x), A_F^R(x)>$whose inverse is $A' = \{< (A_T'^L(\alpha), A_T'^R(\alpha)), (A_I'^L(\alpha), A_I'^R(\alpha))(A'^L_F(\alpha), A_F'^R(\alpha)\ )>\}$ we define magnitude of triangular neutrosophic number A as

$$Mag(A) = \frac{1}{2}\left[\int_0^p A_T'^L(\alpha) + A_T'^R(\alpha) + a_2 + \int_q^1 A_I'^L(\alpha) + A_I'^R(\alpha) + b_2 A'^L_F(\alpha) + \int_r^1 A'^L_F(\alpha) + A_F'^R(\alpha) + c_3\right] f(\alpha)d\alpha$$

$$= \frac{1}{12}\{[p^2[a_1 + 10a_2 + a_3]] - ([b_1 + b_3][q^2 + q - 2]) + b_2[-10q^2 + 2q + 8] - ([c_1 + c_3][r^2 + r - 2]) + c_2[-10r^2 + 2r + 8]\}$$

where the function $f(\alpha)$ is non-negative and increasing function on [0, 1] with $f(0) = 0, f(1) = 1$ and $\int_0^1 f(\alpha) = \frac{1}{2}$. Here the function $f(\alpha)$ is a weighted function and can be chosen by considering the situation. In this paper we have considered $f(\alpha) = \alpha$.The scalar obtained from $Mag(A)$ is used to rank triangular neutrosophic number.

3.3.2 Ranking procedure

For any two triangular neutrosophic number A,B

(i) $Mag(A) > Mag(B)\ if\ and\ only\ if\ A > B$
(ii) $Mag(A) < Mag(B)\ if\ and\ only\ if\ A < B$
(iii) $Mag(A) = Mag(B)\ if\ and\ only\ if\ A = B$

3.3.3 Reasonable Properties of the ranking function

Theorem 3.1: For any arbitrary triangular neutrosophic number A $Mag(-A) = -Mag(A)$.
Theorem 3.2: For any two arbitrary triangular neutrosophic number
$A = \{< (a_1, a_2, a_3), (b_1, b_2, b_3), (c_1, c_2, c_3) >\}$and
$B = \{< (d_1, d_2, d_3), (e_1, e_2, e_3), (f_1, f_2, f_3) >\}$
$Mag(A \pm B) = Mag(A) \pm Mag(B)$.
Theorem 3.3: For any two arbitrary triangular neutrosophic number
$A = \{< (a_1, a_2, a_3), (b_1, b_2, b_3), (c_1, c_2, c_3) >\}$
$B = \{< (d_1, d_2, d_3), (e_1, e_2, e_3), (f_1, f_2, f_3) >\}$,
$C = \{< (g_1, g_2, g_3), (h_1, h_2, h), (i_1, i_2, i_3) >\}$
$Mag(A + C) > Mag(B + C)$ Implies $A + C > B + C$.
Proof: By Theorem 3.2,$Mag(A + B) = Mag(A) + Mag(B)$
Similarly $Mag(B + C) = Mag(B) + Mag(C)$
Therefore if $A > B$
$Mag(A + C) > Mag(B + C)$
Hence $A + C > B + C$.

4. NUMERICAL EXAMPLES

This section provides some numerical illustrations to explain the above ranking procedure.

Example 4.1 Consider the triangular neutrosophic number [14]

$$A = \{< (0.37, 0.52, 0.72), (0.02, 0.06, 0.15), (0.12, 0.25, 0.42) >\},$$

$B = \{< (0.19, 0.44, 0.58), (0.06, 0.12, 0.25), (0.02, 0.06, 0.18) >\}$
$C = \{< (0.44, 0.76, 0.85), (0.03, 0.1, 0.18), (0.01, 0.08, 0.15) >\}$
By our new ranking approach $Mag(A) = .849, Mag(B) = .635, Mag(C) = 922$.
Hence $C > A > B$. However by using score function and accuracy function method used in [9] gives the score value as $A = .73, B = .73, C = .84$ which gives the order$A = B > C$. So our method overcomes the shortcoming of "score function and accuracy function" method.

Example 4.2 Consider the triangular neutrosophic number given by [6]
S1= ((1.18, 1.468, 1.705); .4, .7, .5)
S2= ((1.176, 1.572, 1.801); .6, .8, .8)
S3= ((1.288, 1.592, 1.818); .6, .8, .8)
Using weighted value ambiguity the author has ordered S1>S3>S2.But we come across problems to fix the weighted value and also the ranking process is tedious. $Mag(S1) = 2.07, Mag(S2) = 1.67, Mag(S3) = 1.70$.Hence by ranking procedure we get S1>S3>S2.

Example 4.3 The three triangular neutrosophic number
A={<(1,2,3), (.5,1.5,2.5), (1.2,2.7,3.5)>}
B= {<(.5,1.5,2.5,), (.3,1.3,2.2), (.7,1.7,2.2)>}
C={<(1,3,5), (.5,1.5,2.5), (1.2,2.7,4.5)>}
taken from paper[16] are ranked by our method.

$Mag(A) = 6, Mag(B) = 4.4, Mag(C) = 7.5$ Producing a ranking order $C > A > B$ though is the same as in [15] our method is simple and time consuming one. The author has considered the

area of the trapezium for ordering. Also $Mag(-A)=-6, Mag(-B)=-4.4, Mag(-C)=-7.5$
Which results in $-B>-A>-C.$ clearly our method has consistency in ranking triangular neutrosophic number and their images.

Example 4.4 TuhinBera [10] proposed k-weighted method to rank triangular neutrosophic number. Let A={<(-11,-8,-7);.6, (-12,-8,-5);.2, (-9,-8,-6);.5>} and
B= {<(-12,-6,-4);.7, (-9,-6,-2);.4, (-11,-6,-3).3>} according to his method A>B. But The $K \in [0,1]$ which is not clear also n value is considered as any natural number.$Mag(A)-16.66, Mag(B)=-13.75$.Hence B>A.
All the above numerical examples shows that the proposed method can produce better result than the existing method.
Consider the following set of triangular neutrosophic number.
Set 1
A= ((2,4,6); .8, .7, .6)
B= ((2,4,6); .4, .6, .5)
Set 2
A= ((.528,.640,.847); .3,.8,.3)
B= ((.653,.804,.879); .4,.5,.6)
C= ((.587,.765,.881); .5,.2,.8)
Set 3
S1= ((1.18, 1.468, 1.705); .4, .7, .5)
S2= ((1.176, 1.572, 1.801); .6, .8, .8)
S3= ((1.288, 1.592, 1.818); .6, .8, .8)
Set 4
A= {< (0.37, 0.52, 0.72), (0.02, 0.06, 0.15), (0.12, 0.25, 0.42)>}
B= {< (0.19, 0.44, 0.58), (0.06, 0.12, 0.25), (0.02, 0.06, 0.18)>}
C= {< (0.44, 0.76, 0.85), (0.03, 0.1, 0.18), (0.01, 0.08, 0.15)>}
Set 5
A={<(-11,-8,-7);.6, (-12,-8,-5);.2, (-9,-8,-6);.5>}
B= {<(-12,-6,-4);.7, (-9,-6,-2);.4, (-11,-6,-3).3>}
Table 4.1 gives the comparison with the existing method.

Table 4.1: Comparative results of the existing and proposed method

Author and method	Triangular neutrosophic number	Set 1	Set 2	Set3	Set4	Set 5
Proposed method Result	A B	7.16 6.2 A>B	.888 1.230 1.186 B>C>A	2.07 1.67 1.70 A>C>B	6 4.4 7.5 C>A>B	-16.66 -13.75 B>A
Score function and accuracy function[14] Result	A B	-	-	-	.73 .73 .84 A=B>C	-

Value ambiguity weighted method[6] Result	A B	.49 .144 A>B	.0212 .237 .0198 C>B>A	 C>A>B	-	-
Value ambiguity index method[15] Result	A B	1.78 1.54 A>B	.2033 .2254 .3508 C>B>A	.485 .165 .170 A>C>B	-	-
K-weighted value function[17] K=.9,n=1 Result	A B	1.3906 .3565 A>B	.00957 .0972 .02451 B>C>A	.034168 .06847 .07373 C>B>A	.07761 .0451 .0719 A>C>B	-3.418 -3.46 A>B
Ranking method proposed in[16] Result	A B	-	-	-	.28 .21 .295 C>A >B	

5. CONCLUSION

In spite of many ranking methods ranking triangular numbers with human intuition consistency is not possible. Here drawbacks and shortcomings of the existing method are found. To overcome the shortcomings and to make the calculation simple a new ranking method is proposed. Also the new method is compared with existing method and justified for its accuracy and better result.

ACKNOWLEDGEMENT

Acknowledge only persons who have made substantive contribution to the study. Authors are responsible for obtaining return permission from persons acknowledged by name because readers may infer their endorsement of the data and conclusions.

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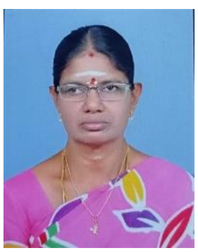
Ms.K.Radhika received the M.sc degree and B.sc degree from BharathiarUniversity, Coimbatore. She has received the M.Phil. degree from Madurai Kamaraj University,

Madurai in 2003. Presently she is a Research scholar in the Department of mathematics, Kongu Engineering College. Her Research areas includes optimization and fuzzy sets. She is currently working in Kongu Engineering College Tamil Nadu, India as an Assistant Professor since 2014.

Dr.K. Arun Prakash works as an Associate Professor in the Department of Mathematics at Kongu Engineering College, Perundurai, Erode, Tamil Nadu and has about 20 years of teaching experience. He has acted as a member of Board of studies at Kongu Engineering College and is a recognized research supervisor at the research centre of Kongu Engineering College. He has published 3 books in Engineering Mathematics and published 35 papers in reputed international journals and reviewer of Journal of Intelligent and fuzzy systems, Journal of Optimization Theory and Applications, Annals of Fuzzy Mathematics and Informatics and some other journals. He has also reviewed more than 15 articles for journals and conference proceedings. He has also received best faculty award in the year 2016.



Dr. R. Santhi M.Sc., M.Phil., Ph.D., P.G.D.C.A is presently working as an Assistant Professor of Mathematics, Nallamuthu Gounder Mahalingam College, Pollachi, Coimbatore, Tamil Nadu. She has published 56 papers in national and international journals. Her area of research is Topology, fuzzy Topology and Intuitionistic fuzzy Topology. She has 23 years of teaching experience and 19 years of research experience. She is a Life member of Indian Science Congress Association, Kerala Mathematical Association and Ramanujan Mathematical Society.