

# To My Teachers

## DECLARATION

I declare that the thesis entitled “**Topological Hyperalgebra with special emphasis on Topological Hypergroups**” has been prepared/composed by me under the supervision of **Prof.(Dr.) Manoranjan Singha**, Professor, Department of Mathematics, University of North Bengal, INDIA. No part of this thesis has been submitted for the award of any other degree, fellowship or professional qualification previously.

*Kousik Das*

Kousik Das

Department of Mathematics

University of North Bengal

P.O. North Bengal University, Raja Rammohunpur

P.S. Matigara, Dist. Darjeeling

West Bengal- 734 013

INDIA

July, 2022



## DEPARTMENT OF MATHEMATICS

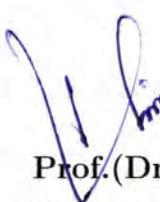
### UNIVERSITY OF NORTH BENGAL

P.O. North Bengal University, Raja Rammohunpur, Dist. Darjeeling,  
West Bengal, INDIA, PIN- 734 013

Tel. 91-353-2776383, Fax: 91-353-2776383

## CERTIFICATE

This is to certify that the thesis entitled “**Topological Hyperalgebra with special emphasis on Topological Hypergroups**” has been prepared by Kousik Das under my guidance in the Department of Mathematics, University of North Bengal, INDIA for the award of Ph.D. degree and no part of it has formed the basis for the award of any other degree, fellowship or professional qualification previously.

  
26.07.2022  
Professor  
Department of Mathematics  
University of North Bengal

Prof.(Dr.) Manoranjan Singha

Professor

Department of Mathematics

University of North Bengal

P.O. North Bengal University, Raja Rammohunpur

P.S. Matigara, Dist. Darjeeling

West Bengal- 734 013

INDIA

July, 2022

## PREFACE

They say that it is a enormous task to venture into writing a thesis. They also say that courage comes only when one knows that many stand with him. The whole work of this thesis would have never seen the light of the day without the support of many people who stood with me during the journey of this thesis and to them I would like to convey my heartfelt gratitude. First and foremost, I am immensely indebted to my guide Prof.(Dr.) Manoranjan Singha, Department of Mathematics, University of North Bengal, INDIA who planted the seed of the thought process required for the Ph.D. research work, then nourishing it, nurturing it, by channelizing my disarray ideas to the right direction and eventually guiding me to give my endeavor a final shape on paper in the form of this thesis.

I would like to thank my wife Nabanita for braving this journey with me and to stand rock-solid with me through the crests and troughs of life. Whenever doubts enveloped my thinking and I found myself trapped in the web of ideas, her persistent motivation made me believe that there is light at the end of the tunnel. I express my gratitude and obeisance from the deepest bottom of my heart to my parents, parents-in-law for their endless encouragement and commitment to shield me against the challenges of life. I am indebted to those seniors who took me under their erudite wings, names to be mentioned, specially Kapil Roy, Jagannath Chowdhury, Koushik Sarkar, my juniors Ujjal Kumar Hom, Sima Roy for their intellectual exchanges and to my friend, Olivia Bhadra and others who stood by me through thick and thin in this arduous journey. Last but certainly not the least, I bow down to Amit Kumar Biswas, my Mathematics teacher, in my school days who laid the first stone of my foundation in my formative years and keeps offering his valuable counsel time and again whenever I am in need of.









Kousik Das  
Department of Mathematics  
University of North Bengal  
INDIA  
July, 2022

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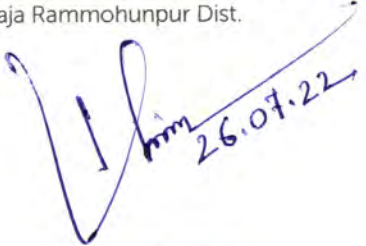
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Topological Hyperalgebra with special emphasis on Topological Hypergroups A Thesis Submitted to the UNIVERSITY OF NORTH BENGAL for the award of DOCTOR OF PHILOSOPHY in MATHEMATICS by Kousik Das Under the Supervision of Prof.(Dr.) Manoranjan Singha Department of Mathematics University of North Bengal P.O. Raja Rammohunpur Dist. Darjeeling India Pin: 734 013 July, 2022

S. Ghosal  
26/07/22.  
HEAD  
Department of Mathematics  
University of North Bengal

Kousik Das.

  
26.07.22  
Professor  
Department of Mathematics  
University of North Bengal

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## Appendix-A

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● **List of Publications:**

- (1) M. Singha, K. Das, and B. Davvaz. On topological complete hypergroups. *Filomat*, 31(16):5045–5056, 2017. (Indexed in Science Citation Index Expanded (Web of Science), Scopus (Elsevier))
- (2) M. Singha, K. Das, and B. Davvaz. Uniformities on OCP-polygroups. *J. Hyperstructures*, 7(2):104–123, 2018. (Indexed in MathSciNet, zbMATH)
- (3) M. Singha and K. Das. On topologized polygroups. *J. Tri. Math. Soc.*, 22(Dec-2020):33–42. (Indexed in MathSciNet)
- (4) M. Singha and K. Das. Topological Krasner hyperrings with special emphasis on isomorphism theorems. *Appl. Gen. Topol.*, 23(1):201–212, 2022. (Indexed in Scopus (Elsevier), ESCI (Web of Science), MathSciNet, zbMATH )
- (5) M. Singha and K. Das. A variant of Birkhoff-Kakutani theorem on topological polygroups. *Palestine J. Math.*, 11(3):598–603, 2022. (Indexed in Scopus (Elsevier), MathSciNet, zbMATH)

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## Appendix-B

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- **Papers presented in National/International Seminars/Conferences:**

- (1) K. Das, *Topological Hypergroups in the Light of Complete Parts*, Recent Advances in Mathematics and its Applications (RAMA-2020), Dept. of Pure Mathematics, University of Calcutta, February 06–07 (2020).
- (2) K. Das, *Role of Complete Parts in Topological Hypergroups*, International Conference on Mathematical Sciences and Applications, Dept. of Mathematics, University of Kalyani, February 26–28 (2020).

- **Seminars/Workshops attended:**

- (1) *3 Day Workshop on “ $\text{\LaTeX}$ ”*, Dept. of Computer Science, Cooch Behar College in collaboration with Spoken Tutorial, IIT-Bombay, August 29–31 (2016).
- (2) *International Seminar on Topology, Analysis and Algebra (ISTAA)-2017*, Dept. of Mathematics, University of North Bengal, INDIA, February 11 and 12 (2017).
- (3) *Selection Principle and Topological Game Theory*, Conducted by Prof. Ljubiša Kočinac, University of NIS, Serbia, Organized by the Dept. of Mathematics, University of North Bengal, INDIA, February 13–20 (2017).

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## Nomenclature

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$\phi$	Empty set
$\mathbb{R}$	Set of real numbers
$\mathbb{Z}$	Set of integers
$\mathbb{N}$	Set of natural numbers
$\mathbb{W}$	$\mathbb{N} \cup \{0\}$
$x \in X$	$x$ belongs to $X$
$x \notin X$	Just negation of $x \in X$
$X \cup Y$	Union of sets $X$ and $Y$
$X \cap Y$	Intersection of sets $X$ and $Y$
$X \subseteq Y$	$X$ is a subset of $Y$
$X \setminus Y$	Complement of $Y$ in $X$
$\mathcal{P}(X)$	Collection of all subsets of $X$ (power set of $X$ )
$\mathcal{P}^*(X)$	Collection of all nonempty subsets of $X$
$\mathcal{V}(x)$	Collection of all neighborhoods of $x$
$\mathcal{V}_s(x)$	Collection of all symmetric neighborhoods of $x$
$X^\circ$	Interior of $X$
$\overline{X}$	Closure of $X$