Department : Mathematics		
Academic Year : 2021-22		
Sr. No.	**Programme Code**	**Name of the Programme**
01.	309	M.Sc. (Mathematics)

Following students have carried out their Project work/ Internship/ Field Project/Industrial Training for the academic session 2021-22

Si.No.	**Name of the Students**	**Page No ……. To ……..**
1	Jitendra Kumar	3-5
2	Mamata Kaushik	6-8
3	Sunima Patel	9-11
4	Vandana Kumari	12-14
5	Shashank Nirmalkar	15-17
6	Satish Gupta	18-21
7	Anjali Saw	22-24

8	Nutan Sahu	25-27
9	Aabha Patel	28-30
10	Pankaj Yadav	31-33
11	Sourav Deep	34-36
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Signature and Seal of the Head

A Project Report on

Elliptic curve Cryptography

Department of Mathematics
GURU GHASIDAS VISHWAVIDYALAYA

Submitted by :
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M.Sc. IV Sem.(Mathematics)
Roll no. : 20406036
Enr. No. : GGV/20/05703

Supervised by :
Dr. P. P. Murthy
Associate professor
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This is to certify that JITENDRA KUMAR student of 2nd year in M.Sc. Mathematics at Department of Mathematics, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur (C.G.), 495009, has successfully completed his project on "ELLIPTIC Curve CRYPTOGRAPHY" under the guidance of Dr. P. P.Murthy.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/ Institute for the award of Degree or Diploma.

Date : .....

.....

Dr. P. P. Murthy
supervisor

Place : Bilaspur

.....14-09-22

Dr. J . P. Jaiswal
H.O.D.

Conclusion : We have described ECC which is a promising candidate for the nextgeneration public-key cryptosystem. Although ECC's security has not been completely evaluated, it is expected to come into widespread use in various fields in the future because of its compactness and thigh performance when it is hardware-implemented. It is concluded that the reliability, maturity and difficulty of a mathematical problem are very important; the more the difficulty the shorter the keys become hence overheads are eliminated. After comparing the RSA and ECC cryptosystems, the ECC has proved to involve much less overheads when compared to the RSA. The ECC has been shown to have many advantages due to its ability to provide same level of security as RSA yet using shorter keys. However, its disadvantage which may even hide its attractiveness it its lack of maturity, as mathematicians believe that enough research has not yet been done in the ECDLP. Elliptic Curves have many advantages compared to other public key cryptography algorithms. Three most popular applications of ECC, the ECDH key exchange, the EL Gamal cryptosystem and the ECDSA are tested are validated. These applications are being adopted in different application areas such as autonomous cars, smart grids, mobile devices and block chain.

A Project Report On

LITERATURE REVIEW OF FIXED POINT PROBLEMS

Under the Guidance of

Dr. P. P. MURTHY

Associate Professor, GGU, Bilaspur

Submitted

IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE
DEGREE OF
MASTER OF SCIENCE
TO

Department of Mathematics

GURU GHASIDAS VISHWAVIDHYALAYA,BILASPUR(C.G.)

Session:2020-2022

September 12, 2022

Submitted

By

MAMTA KAUSHIK

Roll no. 20406038, Enroll no. GGV/20/05707

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(2020-2022)

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To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of Degree or Diploma.

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Place: Bilaspur

12/09/2022

Dr.P.P.Murthy
(Supervisor)

13/09/2022

Dr.J.P.Jaiswal (**H.O.D**)

CONCLUSION

The problem of the fixed point is the problem of finding the solution to the equation Tx=x .It is important that the domain of T and the range of T have points in common, and in this, such points of x for which Tx=x are regarded as the fixed points of the operator T; also, the work reveals that the contraction mapping principle must be satisfied for a fixed point to exist as other basic results center on the need for the completeness of a set X , if there must be a fixed point of T in X. The work reveals that fixed point iteration method uses the concept of a fixed point in a repeated manner to compute the solution of the given equation. In all these result one consider sequence of iterates, which due to contraction condition, becomes a cauchy sequence and whose limit is a fixed point of the mapping. Fixed point theory results has various application in various areas of mathematical problems like linear equation , integral equation, differential equation.

A Project Report

On

MULTI-POINT WITH MEMORY ITERATIVE METHODS FOR NON-LINEAR EQUATIONS

Project submitted in a partial fulfilment of the requirements for the Degree of

M.Sc. in Mathematics

Under the Supervision of:

Dr. JAI PRAKASH JAISWAL
Associate Professor & Head
Department of Mathematics
Guru Ghasidas Vishwavidyalaya

Submitted by:

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M.Sc. IV SEM.(MATHEMATICS)
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ENROLL.NO.GGV/20/05718

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Signature of supervisor

19/09/2022

Signature of HOD

ABSTRACT

In this project, our main objective is to present with memory iterative methods for solving nonlinear equations. We try to convert the existing fourth-order without memory method into a with memory method. Further acceleration of convergence order is attained by means of different approximations of self-accelerating parameters. The parameters have been calculated by Hermite interpolating polynomial and applied to accelerate the order of convergence of the without memory methods. In particular, the R-order of the proposed two step with memory iterative method is increased without any additional calculations and it possesses high computational efficiency.

A Project Report

On

TWO – AND THREE- POINT WITH MEMORY METHODS FOR SOLVING NONLINEAR EQUATIONS

Project submitted in a partial fulfillment of the award of degree of

M. Sc in Mathematics

Under the supervision of:
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Submitted by:
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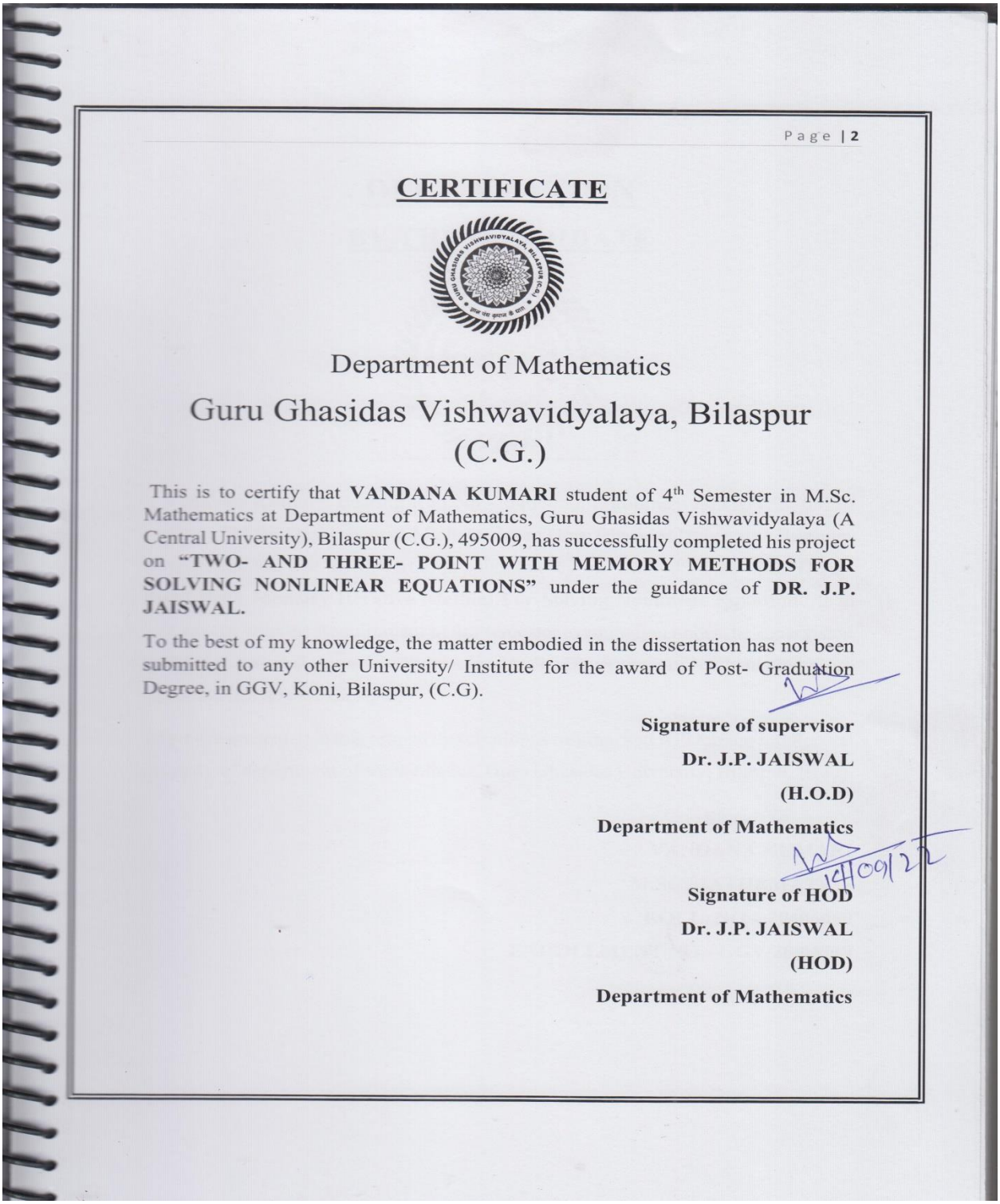

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This is to certify that **VANDANA KUMARI** student of 4th Semester in M.Sc. Mathematics at Department of Mathematics, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur (C.G.), 495009, has successfully completed his project on **"TWO- AND THREE- POINT WITH MEMORY METHODS FOR SOLVING NONLINEAR EQUATIONS"** under the guidance of **DR. J.P. JAISWAL.**

To the best of my knowledge, the matter embodied in the dissertation has not been submitted to any other University/ Institute for the award of Post- Graduation Degree, in GGV, Koni, Bilaspur, (C.G).

Signature of supervisor

Dr. J.P. JAISWAL

(H.O.D)

Department of Mathematics

14/09/22

Signature of HOD

Dr. J.P. JAISWAL

(HOD)

Department of Mathematics

ABSTRACT

Our main goal in this project is to propose two and three-point with memory methods for solving nonlinear equations in order to achieve the best computational efficiency without the need for any additional function observation. At this stage, we have improved the current fourth and eighth order without memory methods with optimal order of convergence by using different approximations of self-accelerating parameters. The parameters accelerating the order of convergence of the without memory methods were calculated using a Hermite interpolating polynomial. The proposed two and three step with memory methods R - order convergence has increased from four to five and from eight to ten, respectively. Another advantage of these methods is that the condition f'(x) in the neighborhood of the appropriate root, take imposed on Newton's method can be eliminated.

A
Project on

'STUDY OF TOPOLOGICAL PROPERTIES OF NON-TRIANGULAR METRIC SPACE'

Submitted in Partial fulfilment of the requirement of the

degree of Master of Science

By

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This is to certify that the project entitled ***'STUDY OF TOPOLOGCAL PROPERTES OF NON-TRIANGULAR METRIC SPACE'*** submitted by **SHASHANK NIRMALKAR** in the partial fulfilment for the requirements for the award of Master of Science Degree in Mathematics at Department of Mathematics, Guru Ghasidas University, Bilaspur (C.G.) 495009, INDIA is an authentic work carried out by him under my supervision and guidance.

14/05/2012

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Dr. DHANANJAY GOPAL
Associate Professor
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Abstract

The idea of non-triangular metric spaces, which was introduced by Khojasteh and Khandani in 2020 ([2]) with the intention of obtaining various fixed point result on them, is novel, and as a result, would profit from some topological study. This study expands on the work of Aniruddha Deshmukh and Dhananjay Gopal ([3]), who gave a natural definition of open sets in this context and provided the initial idea for the study of the topology of non-triangular metric spaces. I studied the topological properties of the non-triangular metric space and tried to come up with some new examples.

A

Project on

"A BRIEF STUDY ON MATHEMATICIAN JOHN CONWAY AND THE GAME OF LIFE"

Submitted in Partial fulfilment of the requirement of the degree of Master of Science

By

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Roll No.- 20406027

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GURU GHASIDAS VISHWAVIDYALAYA 2021-22

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14/09/2021

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1. ABSTRACT:- Throughout this study we shall know about the English mathematician John Horton Conway and his great contribution in the field of mathematics and further we shall know about his invention of a virtual mathematical machine that operates on a two dimensional array of square cell, which runs by a set of simple rules, called the game of life.

2. INTRODUCTION:- John Horton Conway FRS(26 December 1937 – 11 April 2020) was an English mathematician, who is famous for his study in the theory of finite groups, knot theory, number theory, combinatorial game theory and coding theory. He also made significant contribution to mathematics in the field of group theory, algebra, geometrical topology, and many branches of recreational mathematics.

He broadly known for his work on computer simulation that runs by a simple set of rules. He used von Neomann's idea of cellular automata and named his invention the game of life, which is a virtual mathematical machine that operates on two dimensional array of square cells. Each cell has two states, either alive or dead. The cell's state changes simultaneously due to the set of rules with respect to the time. A dead cell becomes alive if it has exactly three live neighbours are alive, a live cell remains alive if two or three of its neighbours are alive, if not then the cell dies.

3. ABOUT JOHN CONWAY:-

3.1 HIS EARLY LIFE:- Conway was born on 26 December 1937 in Liverpool England. His father's name was Cyril Horton Conway and his mother was Agnes Boyce, John was interested in mathematics since his childhood. According to his mother Agnes, when he was four years old, he was able to recite the power of two. John's early life was very difficult as he grew up in Britain during the second world war. Due to several bomb attacks during second world war, his hometown was one of the highly damaged area of Britain. Because of that John was sent to Bangor in North Wales. Returning home after the war very soon he demonstrated a profound fascination for mathematics and it became very clear that he had a great natural talent.

3.2 HIS EDUCATION:- John Conway had his mind set on becoming a mathematician even though he had no clear idea of what mathematics was, when he was in elementary school. When asked what he want to be when he grew up during an interview at age of eleven before starting the secondary school, he said that he would like to be a mathematician. He attended the Holt

incorporating patterns which were untraceable. Thus, the idea of a virus was created.

Cryptography:-

Stephen Wolfram also studied the idea of game of life cellular automata being able to calculate randomness in physical systems. With this, it is a method which can be utilized in cryptography.

5. CONCLUSION:- John Conway was a prominent figure in the field of mathematics. He was a natural problem solver whose boundless curiosity produced profound contribution to mathematics. "His swath was probably broader than anyone who ever lived." Said the mathematician, Neil Sloane.

He invented the idea of the Game of life, utilizing von Neumann's idea of cellular automata who wanted to create a method in which one can convert biological reproduction into a game like simulation. Now cellular automatons and computers simulation games are widely used as heuristic devices in biology, to explore implication and consequence of specific theories. Conway's Game of life has been widely used for this purpose. This game was designed to explore the evolution of ecological communities.

A

Project on

Counting in Group Theory

Submitted in Partial fulfilment of the requirement of the degree of Master of Science

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This is to certify that the Project entitled **"COUNTING PROBLEMS IN GROUP THEORY"** Submitted by **ANJALI SAW** in the partial fulfilment for the requirements for the award of Master of Science Degree in Mathematics at Department of Mathematics, Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.) 495009, INDIA is an authentic work carried out by her under my guidance.

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"Never Underestimate a Theorem Which Counts Something."

-John B. Fraleigh

INTRODUCTION

Mathematics is rich in technique and arguments. In this great variety, one of the most basic tools is counting. Yet, strangely enough, it is one of the most difficult. Of course, by counting we don't mean the creation of tables of logarithms or addition tables; rather, we mean the process of precisely accounting for all possibilities in highly complex situations. In various phase of Mathematics, we find neat counting devices which tell us exactly how many elements in some fairly broad context, satisfy certain conditions.

In this project, we shall embark on the study of the algebraic object known as group and some counting principles on it, which serves as one of the fundamental building blocks for the subject today called Abstract Algebra. From this simple description there will flow a stream of beautiful and powerful results about counting in Group Theory.

"The thing that counts is not what we know but the ability to use what we know."

– LEO L. SPEARS

Modelling the Seismic Waves in Heterogeneous Crust-Mantle Layers under Initial Stresses

A project report submitted in partial fulfillment of the requirement for the award of the degree of

MASTER OF SCIENCE

IN

MATHEMATICS

BY

Nutan Sahu

Enrollment No: GGV/20/05712
Roll No: 20406043

UNDER THE SUPERVISION OF

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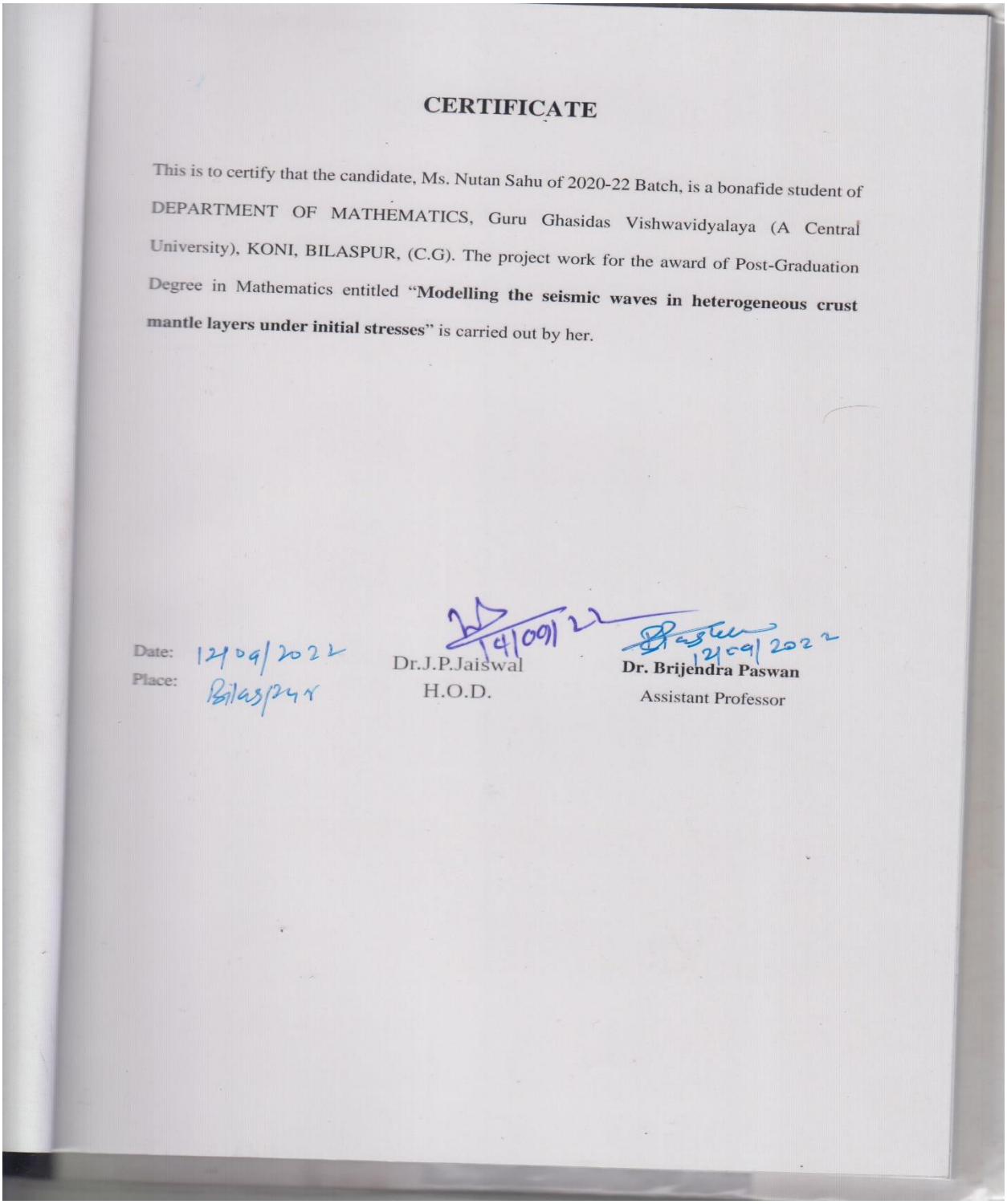

CERTIFICATE

This is to certify that the candidate, Ms. Nutan Sahu of 2020-22 Batch, is a bonafide student of DEPARTMENT OF MATHEMATICS, Guru Ghasidas Vishwavidyalaya (A Central University), KONI, BILASPUR, (C.G). The project work for the award of Post-Graduation Degree in Mathematics entitled "**Modelling the seismic waves in heterogeneous crust mantle layers under initial stresses**" is carried out by her.

Date: 12/09/2022
Place: Bilaspur

14/09/22
Dr.J.P.Jaiswal
H.O.D.

12/09/2022
Dr. Brijendra Paswan
Assistant Professor

$$\mu_{10}\frac{\partial v_1}{\partial z} = \mu_{20}\frac{\partial v_2}{\partial z}$$

$$\mu_{10}e^{ik(x-ct)}\left\{A\left[\frac{-\alpha}{2}J_\eta\left(\frac{kc}{\delta\beta_1}\right)-\frac{kc}{\beta_1}J'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right]+B\left[\frac{-\alpha}{2}Y_\eta\left(\frac{kc}{\delta\beta_1}\right)-\frac{kc}{\beta_1}Y'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right]\right\}=\mu_{20}\,Ce^{ik(x-ct)}\left[\frac{-\sigma}{2}-M\right]$$

$$A\left[\frac{\alpha}{2}J_\eta\left(\frac{kc}{\delta\beta_1}\right)+\frac{kc}{\beta_1}J'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right]+B\left[\frac{\alpha}{2}Y_\eta\left(\frac{kc}{\delta\beta_1}\right)+\frac{kc}{\beta_1}Y'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right]=\frac{\mu_{20}}{\mu_{10}}C\left[\frac{\sigma}{2}+M\right] \quad (52c)$$

Eliminating A, B and C from (52a), (52b) and (52c) we get the dispersion equation as

$$\left\{\frac{\mu_{20}}{\mu_{10}}C\left[\frac{\sigma}{2}+M\right]-\frac{\alpha^2}{4}\right\}\left\{J_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)Y_\eta\left(\frac{kc}{\delta\beta_1}\right)-Y_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)J_\eta\left(\frac{kc}{\delta\beta_1}\right)\right\}+$$

$$\left\{\frac{\mu_{20}}{\mu_{10}}\left[\frac{\sigma}{2}+M\right]\frac{kc}{\beta_1}e^{\delta h}-\frac{\alpha}{2}\frac{kc}{\beta_1}e^{\delta h}\right\}\left\{J'_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)Y_\eta\left(\frac{kc}{\delta\beta_1}\right)-Y'_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)J_\eta\left(\frac{kc}{\delta\beta_1}\right)\right\}-$$

$$\frac{\alpha kc}{2\beta_1}\left\{J_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)Y'_\eta\left(\frac{kc}{\delta\beta_1}\right)-Y_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)J'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right\}-$$

$$\frac{k^2c^2}{\beta_1^2}e^{\delta h}\left\{J'_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)Y'_\eta\left(\frac{kc}{\delta\beta_1}\right)-Y'_\eta\left(\frac{kc}{\delta\beta_1}e^{\delta h}\right)J'_\eta\left(\frac{kc}{\delta\beta_1}\right)\right\}=0 \quad (53)$$

2.6 Conclusions

An analytical approach is used to investigate the propagation of surface waves in heterogeneous media under initial stresses. In case I we obtained wave velocity relation of SH-wave in non-homogeneous initially stressed semi -infinite medium. In case II propagation of Rayleigh-Type waves in Heterogeneous medium stress, we obtain wave velocity relation under initial stress. In case III we study the propagation of love -type waves in heterogeneous layer overlying a prestressed heterogeneous half space, both under initial stresses and obtain the dispersion equation. from the relations obtained we got the following information.

i. In Case I, the phase velocity of SH-waves $c / \beta 0$ decreases monotonically with the increase of dimensionless wave number k/δ and initial stress ζ.

ii. In case II, the phase velocity of Rayleigh wave $c / \beta 0$ decreases monotonically with the increase of dimensionless wave number k/δ and initial stress ζ.

iii. The phase and damping velocities of love type waves decreases with wave number, initial stress of the upper media, and inhomogeneity of the lower media, whereas they increase with initial stress of the lower media and inhomogeneity of the upper media.

Mathematical study on the reflection and transmission phenomena of the plane waves at the interfaces of water layer sandwiched between two semi-infinite media

A project report submitted in partial fulfillment of the
requirement for the award of the degree of

MASTER OF SCIENCE

IN

MATHEMATICS

BY

Aabha Patel

Enrollment No: GGV/17/5100
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This is to certify that the candidate, Ms. Aabha Patel of 2020-22 Batch, is a bonafide student of DEPARTMENT OF MATHEMATICS, Guru Ghasidas Vishwavidyalaya (A Central University), KONI, BILASPUR, (C.G). The project work for the award of Post-Graduation Degree in Mathematics entitled "**Mathematical study on the reflection and transmission phenomena of the plane waves at the interfaces of water layer sandwiched between two semi-infinite media**" is carried out by her.

Date: 12/09/2022
Place: Bilaspur

Dr.J.P.Jaiswal
H.O.D.

12/09/2022
Dr. Brijendra Paswan
Assistant Professor

$$\left|\frac{W_4}{W_0}\right| = \left|\frac{P_4}{P_0}\right| |R'_p|^2, \quad \left|\frac{W_5}{W_0}\right| = \left|\frac{P_5}{P_0}\right| |T_{qP}|^2, \quad \left|\frac{W_6}{W_0}\right| = \left|\frac{P_6}{P_0}\right| |T_{qSV}|^2 \tag{64}$$

where,

$P_1 = d_3^{(1)} k_1 (\lambda_1 d_2^{(1)} \sin\theta_1 + (\lambda_1 + 2\mu_1) d_3^{(1)} \cos\theta_1)$,

$P_2 = d_3^{(2)} k_2 (\lambda_1 d_2^{(2)} \sin\theta_2 + (\lambda_1 + 2\mu_1) d_3^{(2)} \cos\theta_2)$,

$P_3 = d_3^{(3)} \lambda_2 k_3 (d_2^{(3)} \sin\theta_3 - d_3^{(3)} \cos\theta_3)$,

$P_4 = d_3^{(4)} \lambda_2 k_4 (d_2^{(4)} \sin\theta_4 - d_3^{(4)} \cos\theta_4)$,

$P_5 = d_3^{(5)} k_5 (C_{13} d_2^{(5)} \sin\theta_5 - C_{33} d_3^{(5)} \cos\theta_5)$,

$P_6 = d_3^{(6)} k_6 (C_{13} d_2^{(6)} \sin\theta_6 - C_{33} d_3^{(6)} \cos\theta_6)$.

2.9 Conclusions

This is systematic study of reflection and transmission of plane wave at the interferences of layered structured comprised of a water layer of finite thickness sandwiched between an upper half space constituted of ice and lower isotropic elastic half space and derived the closed form of expression of reflection and transmission coefficients of reflected and transmitted wave in terms of angle of incidence, propagation vector, displacement vector, and elastic constant of media.

Some important outcomes are as;

- Energy is conserved in the entire reflection and transmission phenomena of the considered model hence it follows the law of conservation of energy.
- The energy associated with different reflected and transmitted wave depends upon the elastic parameters of the medium, incident angle, width of layer, propagation vectors, displacement vectors and reflection/transmission coefficients of the wave.
- Reflection/transmission coefficient of reflected and transmitted wave fluctuates with different intensity with the variation of angle of incidence.
- Width of layer and elastic constant also play an important role in reflection and transmission.

This gives an analysis for the study of geological structure in the frozen (river/ocean) situation for example in Antarctica and coldest place on Earth.

Project Report on,

A note on Complex Valued Metric Spaces and Fixed Point Theorems

Department of Mathematics

GURU GHASIDAS VISHWAVIDYALAYA,
BILASPUR

Supervised by:

Dr. UMA DEVI PATEL

Assistant Professor

Department of Mathematics

Guru Ghasidas Vishwavidyalaya, Bilaspur, 495009, India

Submitted by

PANKAJ YADAV

M.Sc IV sem Mathematics

Roll no. 20406020

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This is to certify that **PANKAJ YADAV** student of 2nd year in M.Sc. Mathematics at Department of Mathematics, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur (C.G.), 495009, has successfully completed his project on **"A note on Complex Valued Metric Spaces and Fixed Point Theorems "** under the guidance of **Dr. Uma Devi Patel.**

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University/Institute for the award of Degree or Diploma.

Date: 12/09/2022

12/9/2022
Supervisor

Dr. Uma Devi Patel

Place: Bilaspur

19/09/22
H.O.D

Dr. J.P. Jaiswal

Conclusion

In 2011 A. Azam [5] develop the concept of complex valued metric space by replacing $\mathbb{R}$ by $\mathbb{C}$ (where $\mathbb{C}$ is set of complex numbers) in the definition of metric space given by M.Frechet [9]. Here d (x,y) $\in \mathbb{C}$ where d : $X \times X \to \mathbb{C}$. In this paper they extended Banach contraction Theorems in complex valued metric space and give supportive example with an application to produce a new research area in the field of fixed point theory. After that many mathematician generalized the Azam contraction in complex valued metric space and constructing example also. In 2012 Rouzkard and Imdad[6] develop the contraction in complex valued fixed point it is a genaralized contraction of Azam article. Than many mathematician like Klien - eam and Suanoom [19], Jamshaid ahmad and Satit saejung[20] on extend and improve contractions. Therefore so many Scholor are involved in this field of complex valued fixed point theory and we can see many applications of complex valued fixed point theorem put they for solving problem of Integral Equations, Differential Equations, Optimization problem, Control theory, Economics etc.

A project Report

On

F-CONTRACTION IN METRIC SPACES AND FIXEDPOINT THEOREMS

Project submitted in a partial fulfilment of the Award of Degree of

M.SC. in Mathematics

SESSION: 2020-2022

Under the Supervision of:-
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Submitted by:-
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Patel 12/09/2022

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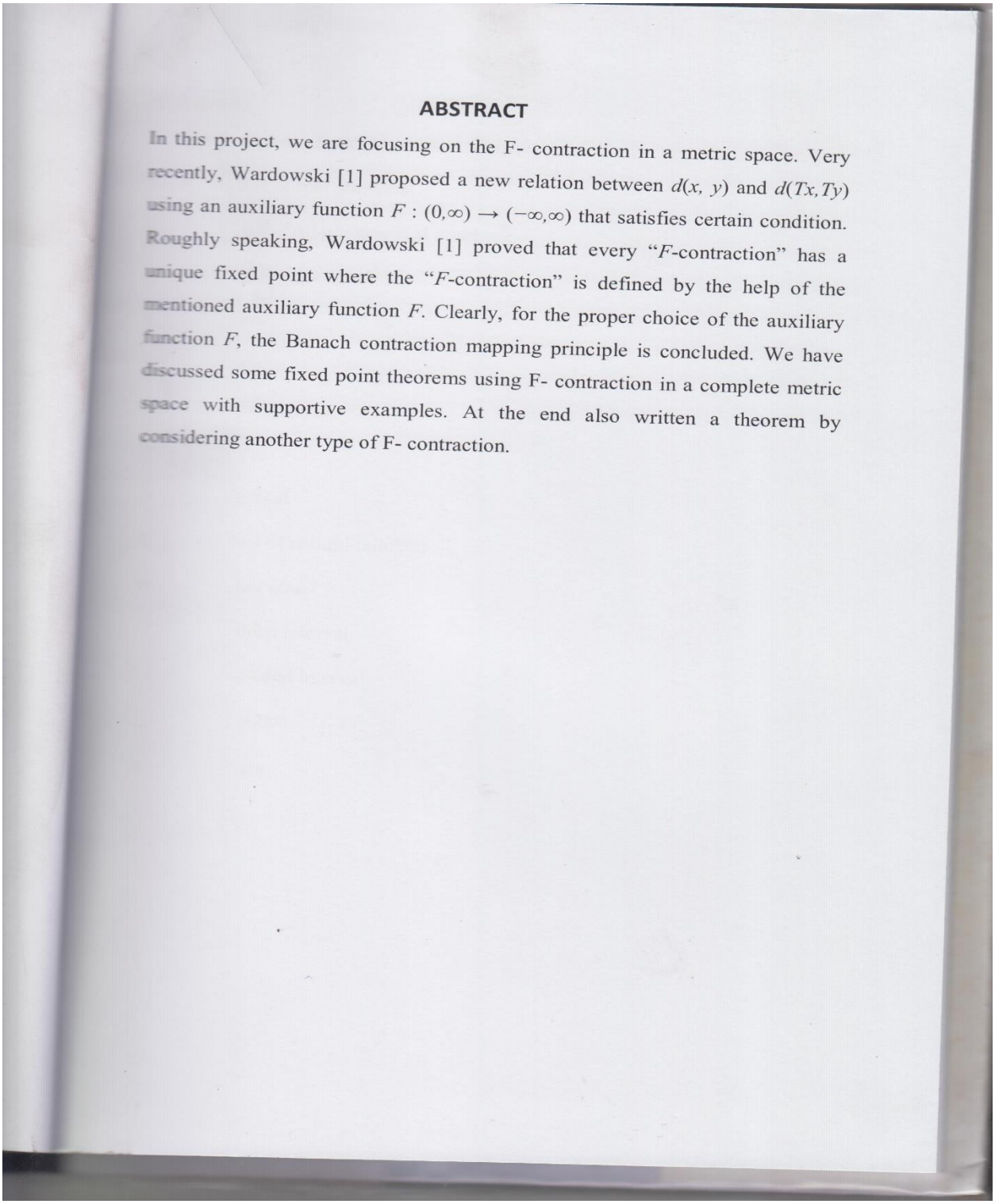

ABSTRACT

In this project, we are focusing on the F- contraction in a metric space. Very recently, Wardowski [1] proposed a new relation between $d(x, y)$ and $d(Tx, Ty)$ using an auxiliary function $F : (0,\infty) \to (-\infty,\infty)$ that satisfies certain condition. Roughly speaking, Wardowski [1] proved that every "F-contraction" has a unique fixed point where the "F-contraction" is defined by the help of the mentioned auxiliary function F. Clearly, for the proper choice of the auxiliary function F, the Banach contraction mapping principle is concluded. We have discussed some fixed point theorems using F- contraction in a complete metric space with supportive examples. At the end also written a theorem by considering another type of F- contraction.

GURU GHASIDAS VISHWAVIDYALAYA, (A CENTRAL UNIVERSITY) BILASPUR C.G.

A Project on

A Study Of Fractional Calculus

SESSION: 2021-22

COURSE: MASTER OF SCIENCE IN MATHEMATICS
DEPARTMENT OF MATHEMATICS

Submitted By: -

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CONCLUSIONS

This thesis introduced the concept of Fractional Calculus; the branch of Mathematics which explores fractional integrals and derivatives. We first gave some basic techniques and functions, such as the Gamma function, the Beta function and the Mittage-Leffler function, which were necessary to understand the rest of this paper. Thereafter we proved the construction of the Gr¨unwald-Letnikov and the Riemann Liouville method to define a differintegral. We explored examples of some frequently used functions, namely the Power function, the Exponential function and the Trigonometric functions. Next we studied Fractional Linear Differential Equations. First we had to give some basics about the Laplace transform, since we were about to use this method for solving these differential equations. Then we applied the Laplace transform to the Riemann-Liouville and Gr¨unwald-Letnikov differintegral. At last we discussed some applications of Fractional Calculus.

This thesis did not cover everything related to Fractional Calculus. There have been many more approaches to define a differintegral. For example the Caputo, Hadamard and Miller-Ross differintegrals are also frequently used. In addition there are many more methods for solving fractional linear differential equations. Some people advocate differintegrals should be implemented in standard Mathematics and replace the integer order derivatives and integrals. Although I agree to some extent with this, I don't think Fractional Calculus is necessary for ordinary Mathematics, many definitions for a differintegral exist so which one should we use in general? I also think that the formulas are pretty awkward .Though it is a very interesting subject and definitely worth researching, I believe it should be left as an 'exotic' branch of Mathematics

A Project Report
On

FRACTIONAL CALCULUS AND ITS APPLICATIONS

Project submitted for partial fulfillment of award of degree of
Master of Science in Mathematics

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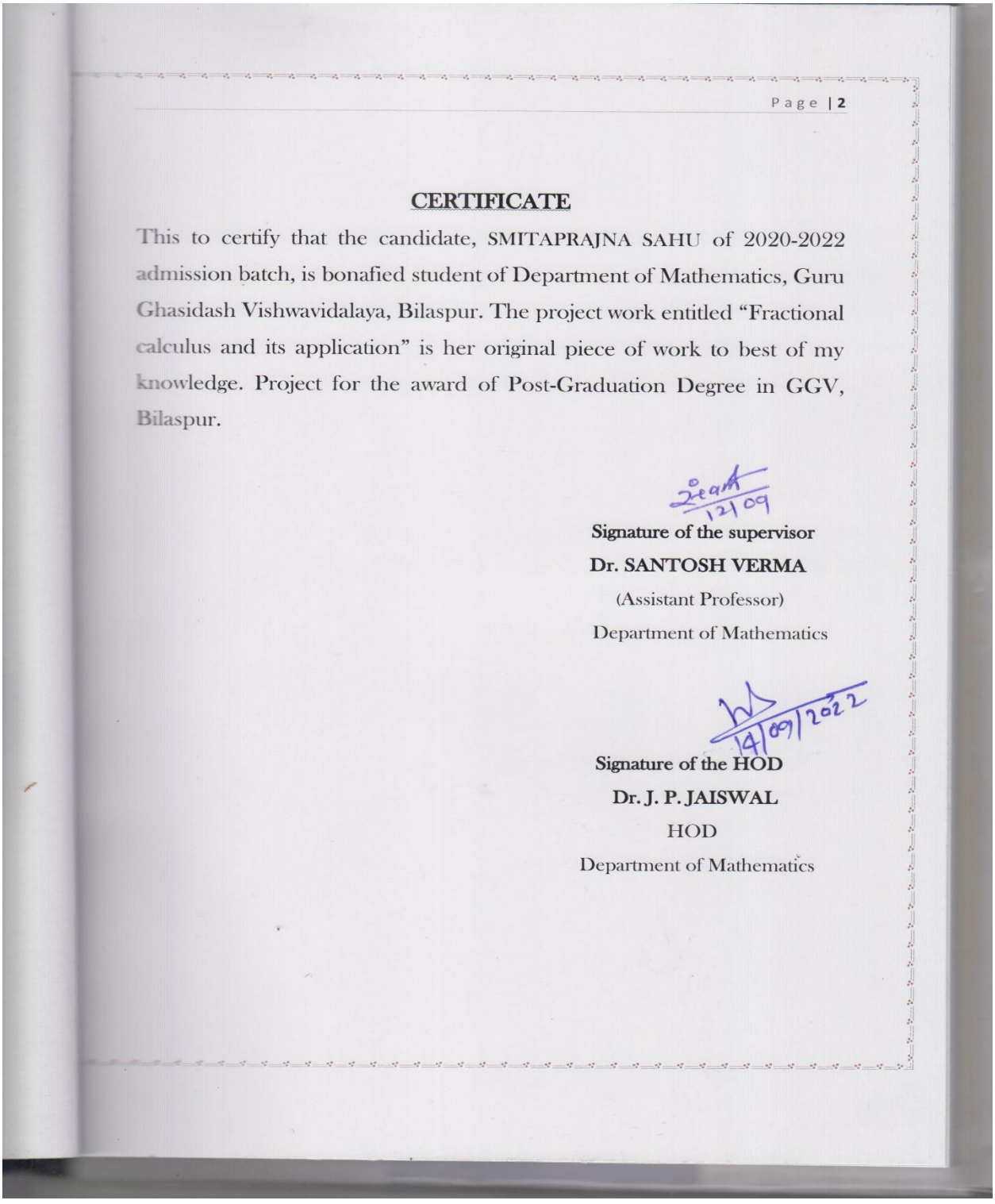

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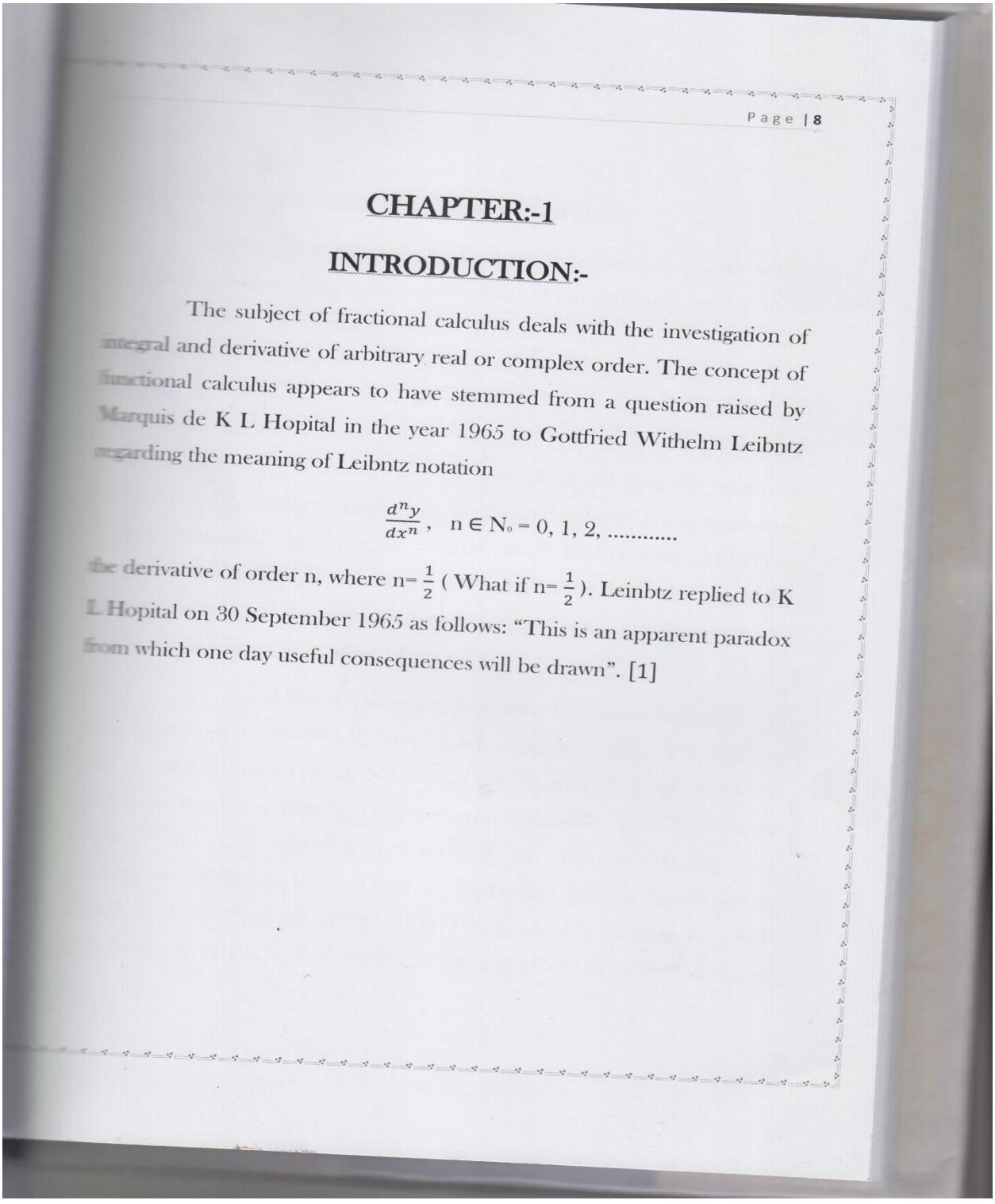

CHAPTER:-1

INTRODUCTION:-

The subject of fractional calculus deals with the investigation of integral and derivative of arbitrary real or complex order. The concept of functional calculus appears to have stemmed from a question raised by Marquis de K L Hopital in the year 1965 to Gottfried Withelm Leibntz regarding the meaning of Leibntz notation

$$\frac{d^n y}{dx^n}, \quad n \in N_0 = 0, 1, 2, \ldots\ldots\ldots$$

the derivative of order n, where $n=\frac{1}{2}$ (What if $n=\frac{1}{2}$). Leinbtz replied to K L Hopital on 30 September 1965 as follows: "This is an apparent paradox from which one day useful consequences will be drawn". [1]