

Research Activities Performed by Dr. Ranjan Kumar Jana

Research Experience: **16 years 5 months** (as on April 2020)

Research Position Held

- Research Fellowship** Selected as a **Junior Research Fellow** on a Council for Scientific and Industrial Research (**CSIR**) scheme and worked on *Large Amplitude Solitary Waves and Double Layer in Dusty and Astrophysical Plasma* at Department of Mathematics, **Visva-Bharati (A Central University)** from 19.12.2003 to 18.09.2004.
- Research Fellowship** Selected as a **Junior Research Fellow** at Atmospheric Science Division, Meteorology & Oceanography Group, **Space Applications Centre (Indian Space Research Organisation)** and worked on *Satellite data assimilation through Numerical Models for improving Weather Prediction* from 20.09.2004 to 31.01.2006.
- Doctoral Studies** Completed doctoral studies under the supervision of **Dr. A. K. Shukla**, Professor of Mathematics, AMHD, SVNIT.
Ph. D. Thesis Title: *Generalization of some Special Functions*.
- Post Doctoral Studies** Completed **post-doctoral studies** under the mentorship of **Prof. Bruce C. Berndt** at **University of Illinois at Urbana-Champaign, USA** for one year, under **Indo-US research fellowship**, awarded by **Indo-US Science and Technology Forum (IUSSTF)**, New Delhi and worked on *Bessel Function Series*.
- Research Associateship** Awarded **Research Associate ship (for University Teachers)** by **Institute of Mathematical Sciences (IMSc), Chennai** for three years (01.06.2015-31.05.2018).

Research Projects undertaken: 05

- DOS, ISRO, Govt. of India** **PI** of the project "*Simulation and Land Data Assimilation to Community Land Model for Improving Rice Crop Dynamics*" sanctioned by **DOS, ISRO, Govt. of India**, with amount **Rs. 22,20,000/- (Ongoing)** (from 03.03.2020 to till date).
- SERB, Govt. of India** **PI** of the project "*Extended Wright type Hypergeometric Functions*", sanctioned by **SERB, Govt. of India**, with amount **Rs. 15,15,360/- (Completed)** (12.08.2016-11.08.2019).
- SVNIT** **PI** of the project "*Data Assimilation methods in Numerical Weather Prediction*", sanctioned by **SVNIT** (under Institute Research Grants to the Asst. Professors), sanctioned amount **Rs. 10,28,000/- (Completed)** (14.11.2014-14.12.2016).
- DST-SERB, Govt. of India** **Co-PI** of the project "*A study on change in refractivity of the atmosphere prior to earthquake/s*", sanctioned by **DST-SERB, Govt. of India**, with amount **Rs. 14,66,200/- (Completed)** (14.06.2013-13.06.2016).

CSIR, Govt. of India Co-PI of the project "Wright type Generalized Hypergeometric Functions: Inequalities and Applications" sanctioned by CSIR, Govt. of India, sanctioned amount Rs. 90,000/-. (Completed) (01.01.2015-31.12.2017)

Research Supervision

Ph. D. Students Guidance (12)

- Completed 03
1. **Jignesh P. Chauhan:** *Some Aspects of Mittag-Leffler Function and Fractional Differential Equation Models.* (Date of notification 26.02.2018)
 2. **Bhumika V. Maheshwari:** *Some Studies on Extended Hypergeometric Functions.* (Date of notification 22.02.2019)
 3. **Rakesh L. Das:** *Production and Procurement based Inventory Models under Imprecise Environment.* (Date of notification 05.04.2019)
- Thesis Submitted 01
4. **Hiren S. Lekhadiya:** *Satellite Data Assimilation of Extreme Rainfall Events through WRF Model.*
- Ongoing PhD 08
5. **Radharaman Roy** (from December 2016) working on *Hypergeometric Functions*
 6. **Ankit Pal** (from July 2017) working on *Special Functions*
 7. **Dhawal J. Bhatt** (from November 2017) working on *Approximation Theory*
 8. **Abir Bhattacharya** (from July 2018) working on *Special Functions*
 9. **Rituparna Mondal** (from July 2019) working on *Operations Research*
 10. **Ekadashi Das**(from July 2019) working on *Operations Research*
 11. **FarhatBanu H. Patel**(from July 2019) working on *Special Functions*
 12. **Animesh Mondal**(from January 2020) working on *Supply Chain Management in Imprecise Environment*

M.Sc. Students Guidance for Master dissertation: 22

- Completed: 18
1. **Abhishek Shah:** *Equivalence between 4d-Var and Kalman Filter and Comparison with an Ensemble Kalman Filter.*
 2. **Shivani Shreya:** *An Introduction to Visual Cryptography.*
 3. **Hitesh Bansu:** *Inventory Problems with different type of Demands.*
 4. **Rakesh Das:** *Comparison of Firefly Algorithm with Particle Swarm Optimization and Genetic Algorithm and Solution of some Linear Programming Problems*

5. **Hiren Lekhadiya:** *Introduction to Different Optimization Techniques and Information Retrieval*
 6. **Heral Kevrani:** *Hotel Inventory management using Linear Programming.*
 7. **Ankit Agarwal:** *Some Study on Time series Analysis and Forecasting.*
 8. **Hinal Solanki:** *Comparison of LPP and Lingo with Genetic Algorithms for Inventory Problems*
 9. **Tejan Vadher:** *Computational Aspects of Hypergeometric Functions*
 10. **Simran S. Narang:** *Mathematical Approach to Study Bicycle Sharing System for Surat City*
 11. **Timilan Mandal:** *A Study on Geometrical Significance of Fractional Calculus*
 12. **Shweta More:** *Some study on Game Theoretic Applications*
 13. **Parth Sartanpara:** *Some Study on Project Cost Analysis as Application of PERT and CPM*
 14. **Punit Yadav:** *Some Studies on Eigen Values of Sturm-Liouville Problem*
 15. **Salim Mohamd:** **Studies on Stochastic Optimal Control Problem**
 16. **Khilan Sakariya:** *Some Heuristic Approach to Solve Travelling Salesman Problem*
 17. **Ravi Tanti:** *Mathematical Inequalities*
 18. **Hiral Brahmhat:** *Wavelet Transform in Image Processing*
- Ongoing: 04**
19. **Thekku Veetil Abhijith** working on *Game Theory*
 20. **Gowri R Chandran** working on *Cryptography*
 21. **Khobragade Vaibhav Jaydeo** working on *Mathematical Modeling*
 22. **Praveen Kumar** working on *Operations Research*

Students Guidance for Internship: 12

**Summer
Internship: 11**

1. **Hiren Lekhadiya:** *Information Retrieval* (2012).
2. **Nikhil Choksi:** *Game Theory* (2012).
3. **Divyang Gor:** *PERT and CPM* (2012).
4. **Vidhi Patel:** *Application of Transportation Model for deriving optimal supply route pattern for Textile Manufacturers in Surat* (2013).

5. **Snehal Patel:** *Introduction to Numerical Weather Prediction* (2013).
6. **Karan Patel:** *A study on Replacement Models* (2015).
7. **Hinal Solanki:** *Multi-objective Assignment Problems* (2016).
8. **Rakesh Ranjan:** *Calculus and Analytic Geometry* (2016).
9. **Nagesh Sahu:** *A study on Integral Transforms* (2017).
10. **Aash Makana:** *Methods to solve non linear equations* (2019).
11. **Vaibhav Gupta:** *Some studies on Least Squares, B-Splines and Fourier approximation* (2019).
12. **Ramkumar Radhakrishnan:** *Perturbation Technique on Eigen Value Problems* (2019).

**Winter Project:
01**

Research Topic

Plasma Physics

Plasma can be defined as an ionized gas, which contains charge particles. Dusty plasma can be considered as plasma co-existing with finite micron sized massive dusty charged particles. When non-linearity and dispersion of a medium balanced each other then only solitary waves formed in the medium. In plasma physics also solitary waves are the subject of considerable phenomena. Washimi and Taniuti (1966) first studied the propagation of solitary waves in simple plasma in the form of KdV equation. Study of double layers in dusty plasma is of great importance for the last three decades or so. It has an important role in space plasma, astrophysical plasma and laboratory plasma etc. Das (1979), Tran and Hirt (1974) and Das and Tagare (1975) studied the solitary waves in plasmas including multiple ionic species of different kind. All of them used Reductive Perturbative Technique (RPT), which is not suitable to study large amplitude solitary waves. Roychoudhury and Bhattacharya (1989) and Chatterjee and Roychoudhury (1994, 1995, 1997, 1999) studied different plasma models by non-perturbative technique. Extensive numerical studies were made to obtain the double layer solution from the analytical Sagdeevs potential.

Satellite Data Assimilation

Numerical Weather Prediction:

Numerical Weather Prediction (NWP) as well as the study of climate problems requires a complete and accurate description of the present state of the atmosphere and ocean. Unfortunately, no single component of the observing system measures the atmosphere and ocean with sufficient accuracy and completeness. Thus it is necessary to combine the information from different observing systems (Satellite, radiosonde, buoy, aircraft, radar etc) and from many different times to create a reasonably accurate estimate of the atmospheric and oceanic state. The information in the data is combined in space and time through a data assimilation system. Over the years, as the demand for atmospheric and environmental information grew, increasingly exotic and comprehensive observing systems were deployed for sampling atmospheric and oceanic parameters. In the northern hemisphere satellite data did not have a very strong impact on NWP. This lack of impact is due to the inability to properly incorporate the information from satellite observations into the data assimilation system.

The real time MM5 simulations were made assimilating local radiosonde observations into the model for providing the weather conditions over SHAR(Indian Satellite launch stations) during Cartosat-1 satellite launch by PSLV-C6. The evaluation of MM5 model for different cloud parameterization schemes had been studied.

Assimilation of Level-II MODIS temperature and moisture profiles in a Non-hydrostatic Mesoscale Model (MM5) had been conducted. Comparison was made between the experiments with and without MODIS profiles in MM5 initial condition. Comparison of initial state using NCEP analysis with the MODIS enhanced initial state clearly indicates the benefits of the assimilation of observed Mesoscale temperature and moisture fields. Different extreme rainfall events (Indian Context) have been studied by assimilating Satellite Data (main focused on INSAT-3D) in WRF Model.

Crop Prediction:

As per FAO 2015, climate change impacts on food security will be the worst in countries already suffering high levels of hunger and will worsen over time especially from mid - high latitude to low latitude or tropical countries. Food inequalities will increase, from local to global levels, because the degree of climate change and the extent of its effects on people will differ from one part of the world to another, from one community to the next and between rural and urban areas. People and communities who are vulnerable to the effects of extreme weather now will become more vulnerable in the future and less resilient to climate shocks. Extreme weather events are likely to become more frequent in the future and will increase risks and uncertainties within the global food system. The agricultural sector is strongly interlinked with other sectors and biophysical cycles (water, carbon). We have initiated to evaluate the existing form of Dynamic Generalized Vegetation Model (DGVM) of Community Land Model (CLM) in terms of its bio-geophysics and processes for major agro-ecosystems such as in rice-rice crop rotation in India and development of new crop-specific growth modules to bring out new version of DGVM suitable for Indian sub-tropics followed by its evaluation with respect to surface fluxes.

Special Functions and Integral Transform

Modern developments in theoretical and applied science depend on the knowledge of the properties of mathematical functions, from elementary trigonometric functions to the multitude special functions. These functions appear whenever natural phenomena are studied, engineering problems were formulated, and numerical simulations are performed. The effective uses of special functions require practitioners to have ready access to a reliable collection of their properties.

The study of special functions grew up with the calculus and is consequently one of the oldest, interesting and very important branches of analysis. The generalization of special functions has proved even more useful than the separate special functions themselves. It provides a connection between seemingly unrelated functions. It can provide fresh insights into the function and thus can provide properties, or proofs, which were undiscovered till now. Extensive studies were made to generalize several special functions, mainly focusing on Mittag-Leffler function, multi dimensional special polynomials (Shivleys and Sheffers) and Bessel Functions.

We have investigated several properties of extended Wright type hypergeometric functions which includes contiguous relations, differential properties, connection with other special functions, integral transforms (Beta transform, Laplace transform and Whittaker transform) and integral representation. Geometric properties including univalence, starlikeness and convexity with their existing conditions in the unit disk $|z| < 1$ of normalized form of τ -Wright type hypergeometric function also discussed. The

group theoretic method (Lie algebraic approach) has been used to derive generating functions for the hypergeometric functions.

Operations Research

Inventory Models:

The effect of substitution in the EOQ models with qualities and order quantities for stock & stock out-items have been considered. We have developed mathematical model without shortages for computing the economic order quantities where substitution effect are taken into account as well as the problem is formulated in the form of a maximization problem and solved through a gradient-based search technique- GRG (Generalised Reduced Gradient) method. The optimal order quantities and qualities of substitutable products are determined so that the total profit is maximum.

Supply Chain Management:

Sustainable humanitarian supply chain has a great impact on saving lives, decreasing human suffering and contributing to development. Organizational coordination plays an important role in it, although it is unusual to be established due to the conflicting interests and expectations. To cope with the problem and achieve the sustainability of humanitarian green supply chain, the coordination between private sector and humanitarian organization will be studied with the aid of sustainable principle regarding stakeholder approach.

The purpose of most Supply Chain Management models are to minimize the aggregate cost of the chain. In recent time the subject is getting much more attentions from researchers and firms. The cost elements are holding, transportation, back order, preservation, effect portion of environment (e.g. measure of NO₂, CO₂, fly ash etc.). The parameters and intermediate variables (demand, risk, trade credit etc.) are imprecise in reality, instead of being crisp. This impreciseness may be expressed as fuzzy number. Nowadays higher order fuzzy functions (type-2) are used, although the complete type-2 fuzzy mathematics are not available in the literature. ¹

¹Last updated on April, 2020