Estd. 1972

# Golden Jubilee Celebration

## International Conference on Mathematical Analysis And Applications

&

## 50th Annual Conference of Odisha Mathematical Society (OMS)

21st & 22nd January 2023

# ICMAA-2023

# SOUVENIR


ଗଣିତ ଓ ପ୍ରୟୋଗ ପ୍ରତିଷ୍ଠାନ

**Institute of Mathematics and Applications**

(Science & Technology Department, Govt. of Odisha)

Andharua, Bhubaneswar - 751029




# ABOUT IMA

The Institute of Mathematics and Applications (IMA) was established by the Government of Odisha in the year 1999, vide the Resolution of the Government of Odisha, Science and Technology Department letter no. 368-ST-I (SC)-159/98 dated 31st May 1999. This premier institute is well known for its unique teaching, research and training activities. The vision of IMA is to generate, disseminate, and preserve knowledge in mathematical science and related discipline and to use this knowledge for promoting welfare of the people. The aim of the institute is to strive for excellence and spread the culture of mathematical competence at all levels of the society. Its serene environment and beautiful campus atmosphere provide a perfect setting for a professionally rewarding educational experience. The students are nurtured by competent teachers and the institute's progress is monitored by a body of renowned academicians. After completing the course, the students of this institute prefer to build their career in academics and industries. Alumni of this institute are found to be absorbed in different national institute of repute like IISC, IITs, IIMs, IMSc, ISI, CMI, TIFR, IISERS, NITs, ISM, Central/State and distinguished foreign Universities including IT and Finance Sectors.



Prof. Shankar Prasad Mishra



Prof. Bamacharan Das



Dr. Ramanath Mohanty



Prof. Brajabandhoo Misra



Prof. Ghanashyam Samal



Prof. Tribikram Pati



*Golden Jubilee Celebration*

# INTERNATIONAL CONFERENCE ON 'MATHEMATICAL ANALYSIS AND APPLICATIONS' & 50th ANNUAL CONFERENCE OF ODISHA MATHEMATICAL SOCIETY (OMS)

**Date : 21.01.2023 & 22.01.2023**

## Organized by

**Institute of Mathematics and Applications**
**Andharua, Bhubaneswar - 751029**

**Prof. Ganeshi Lal**
Governor, Odisha
ପ୍ରଫେସର ଗଣେଶୀ ଲାଲ
ରାଜ୍ୟପାଳ, ଓଡ଼ିଶା

सत्यमेव जयते
Government of India

RAJ BHAVAN
BHUBANESWAR - 751 008
ରାଜଭବନ
ଭୁବନେଶ୍ୱର-୭୫୧ ୦୦୮



January 13, 2023

## MESSAGE

I am glad to know that the closing ceremony of Golden Jubilee function (50th Annual Conference of Odisha Mathematical Society) along with an International Conference on 'Mathematical Analysis and Applications' is to be held at Institute of Mathematics and Applications, Bhubaneswar on January 21-22, 2023. A souvenir is also being brought out on the occasion.

It is a matter of pride for Odisha Mathematical Society as it has reached a major milestone of 50 years of remarkable contribution to teaching and research in Mathematics through various activities. Both the conference holds immense importance and I am sure the deliberations would be enriched with the views, experiences and research ideas shared by leading researchers, research scholars and those from academics and industries.

I wish the conference and publication all success.

Ganeshi Lal

(Ganeshi Lal)

Tel. : 91-674-2536111/2536222, Fax : 91-674-2536582, E-mail : govodisha@nic.in, Website : www.rajbhavanodisha.gov.in

**NAVEEN PATNAIK**
**CHIEF MINISTER, ODISHA**

सत्यमेव जयते
Government of India

**LOKASEVA BHAVAN**
**BHUBANESWAR**



I am glad to know that the Odisha Mathematical Society is organising an international conference on "Mathematical Analysis & Applications" on the occasion of its golden jubilee celebrations during 21-22 January 2023 and bringing out a souvenir in commemoration.

Study of Mathematics is critical to our objective of developing a rational and scientific society. Therefore, Mathematical Society should prioritise its efforts to improve knowledge in mathematics at all levels of education. There is a need for concerted endeavour to attract children to the study of mathematics. I hope the conference will discuss on latest developments in mathematical studies and its applications.

I extend my warm greetings to all the members of Mathematical Society on this occasion and wish the Conference all success.

(NAVEEN PATNAIK)

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Residence : 0674-2591099, 2590299, 2590833 (Fax)
e-mail : cmo@nic.in | twitter : twitter.com/CMO_Odisha | Facebook : facebook.com/CMO.Odisha

**SHRI ASHOK CHANDRA PANDA**
MINISTER
Science & Technology, Public Enterprises,
Social Security & Empowerment of
Persons with Disability

D.O. No. 42 /M(STPESSEPD),
BHUBANESWAR
Date 13.01.2023



## Message

It gives me immense pleasure to learn that Institute of Mathematics and Applications, Bhubaneswar is hoisting International Conference on Mathematical Analysis and Applications along with 50th Annual Conference of OMS (Golden Jubilee Celebration) on 21st and 22nd January'2023.

Mathematics emerged in Indian sub-continent from 1200 BCE and important contributions were made by scholars like Ayabhata, Brahmagupta, Bhaskar-II and Varahamihir. Indian mathematicians made seminal contributions to the study of trigonometry, algebra, arithmetic and negative numbers. They gave us the concepts of "Zero". The name of Pathani Samant, prodigy of Odisha is immortal in the field of Mathematics.

Institute of Mathematics and Applications, established by Government of Odisha in 1999, has been working in the field of research and development of Mathematical studies with remarkable success.

I hope, International Conference will throw light to pave way for significant growth of mathematics and applications in our State. I welcome the delegates and participants to this land of great heritage and history.

I convey my goodwill and compliments to all concerned in this initiative and wish the Conference a grand success.

**(Ashok Chandra Panda)**

**Bhaskar Sarma, IAS**
Commissioner-cum-Secretary to Government

ଓଡ଼ିଶା ସରକାର

**Science & Technology Department**
Kharavela Bhawan, Bhubaneswar - 751001
Ph.: 0674-2536772, Fax : 0674-2393496
E-mail : secy.stech@odisha.gov.in

D.O. No. .....SS&T

Date :.....



It gives me immense pleasure and pride to know that Odisha Mathematical Society has completed 50 glorious years of its service to the State. Celebrating the 50th year in Institute of Mathematics & Applications will certainly add to the reputation of the Institute.

Practitioners in this field are not too many. However, they need encouragement and exposure. This provides and excellent forum for the spread of learning and deepening of research.

I wish their conference a grand success.

( Bhaskar Sarma )



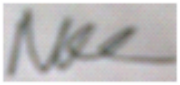
Dt.11.01.2023

**Prof. NalinKanta Chaudhury**
President
Odisha Mathematical Society(OMS)

# Message

I am very much glad that Institute of Mathematics & Applications(IMA) has come forward to take the responsibility for organizing and celebrating Golden Jubilee Conference(50 th) of Odisha Mathematical Society along with International Conference on 'Mathematical Analysis and Applications' at its campus, Andharua, Bhubaneswar-751029 on 21st and 22nd January 2023. This year is the 51st year of the foundation of OMS. The proposal of OMS for establishment of IMA was approved by the then Hon'ble Chief Minister of Odisha Sri Biju Patnaik and was germinated on the day it was inaugurated by the then Hon'ble Chief Minister of Odisha Sri Giridhar Gamang in the year 1999 by the continuous efforts of members of OMS. The Hon'ble Chief Minister of Odisha Sri Naveen Patnaik accelerated the work providing land for IMA and also he had the foundation of basic buildings constructed by TATA Company.

Today, this institute is dedicated to fulfill the aspiration of younger generation for education, teaching, training and research for the development of Society. However small it may be, this conference will meet the requirements of the participants and society.



**(Dr. NalinKanta Chaudhury)**



**Prof. Jasobanta Jena**
Director, Institute of Mathematics and Applications

# Message

On behalf of the Institute of Mathematics and Applications (IMA) family, I am thankful to the Executive Body Members of the Odisha Mathematical Society (OMS) for entrusting IMA for organizing International Conference on Mathematical Analysis and Applications and 50th Annual Conference of Odisha Mathematical Society (GOLDEN JUBILLE CELEBRATION).

I am grateful to the Invited Speakers and the Delegates from reputed Institutes and Universities of the country and from abroad for their participation in the conference. I am confident that the Conference will provide an excellent opportunity for all via meaningful interactions and exchange of ideas for future courses of actions in promotion of research in Mathematics and its Applications.

I extend my best wishes to the members of the Organizing Committee, Staff and Students of IMA, who are trying their best to make the visit and stay of our guests at

(Jasobanta Jena)



**Dr. Sudhakar Sahoo**
Institute of Mathematics and Applications,
Andharua, Bhubaneswar, Odisha, 751029

# Message

It gives me immense pleasure to announce that the Golden Jubilee Celebration of Odisha Mathematical Society (OMS) along with an International Conference on Mathematical Analysis and Applications (ICMAA) is going to be held in the campus of Institute of Mathematics and Applications (IMA), Bhubaneswar, during 21-22 January, 2023. I believe that this conference will bring researchers, research scholars and experts from academics and industries on a common platform to discuss the cutting-edge research in Mathematical Analysis and Applications as well.

Many distinguished Mathematicians and renowned Scientists across the country and from abroad will grace the occasion by delivering their talks. I am thankful to all of them for their kind concurrence to become a part of this conference.

I am equally elated that a souvenir will be published containing the rich research abstracts and ideas of academicians and scholars to commemorate the occasion. It will definitely provide a scope to learn more about the recent and relevant research, theories and practices in the area of Mathematics and Applications. I am very much gratified to all the participants for their willing involvement in the conference.

I am honored to thank Prof. Ganeshi Lal, Hon'ble Governor, Odisha for his praiseworthy words towards the 50 years of remarkable contributions in teaching and research activities of Odisha Mathematical Society. I am also honored to thank Shri Naveen Patnaik, Hon'ble Chief Minister, Odisha for his warm wishes towards the success of the event, narrating the significance of studying Mathematics and our objective of developing a rational and scientific society. I am privileged to thank Shri Ashok Chandra Panda, Hon'ble Minister, Science and Technology, Odisha for his encouraging message towards the contributions of Indian Mathematicians in the field of Mathematics and whole hearted support to IMA. I am grateful to Shri Bhaskar Jyoti Sarma, IAS, Commissioner-cum-Secretary to Government, Science & Technology Department, Govt. of Odisha for his words of encouragement, support and wishes for success. I am very much thankful to Prof. Nalin Kanta Chaudhury, President, OMS, for admiring the commendable contributions of IMA to fulfill the aspiration of younger generation for education, teaching, training and research for the development of Society. I am specially obliged to Prof. Jasobanta Jena, Director, IMA for his active involvement since inception. In addition to our hard work, it's his necessary logistics support and constant guidance that has made the event possible.

Lastly, I would like to take this opportunity to thank all members of the E[illegible]

Sudhakar Sahoo.

**Sudhakar Sahoo**
Organising Secretary

# ORGANIZING COMMITTEE

**Chief Patron**

**Shri Ashok Chandra Panda**
Hon'ble Cabinet Minister, Science & Technology
Govt. of Odisha.

**Patron**

**Shri Bhaskar Jyoti Sharma, IAS**
Commissioner-cum-Secretary to Government, Science & Technology Department, Govt. of Odisha.

**Organizing Chairman**

**Prof. Jasobanta Jena**
Director, Institute of Mathematics and Applications
Bhubaneswar.

**Organizing Secretary**

**Dr. Sudhakar Sahoo**
Institute of Mathematics and Applications, Bhubaneswar.

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Dr. Pinakadhar Baliarsingh
Dr. Siddharth Kanungo
Sri Indra Bate
Dr. (Mrs.) Anasuya Nath
Dr. Prayag Prasad Mishra
Prof. Nilamber Biswal
Prof. Bibekananda Jena
Prof. Smruti Ranjan Sahoo
Prof. Ajay Kumar Singh
Prof. Jyoti Ranjan Nayak
Dr. Chittaranjan Mallick

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**Vice Chancellor**, Utkal University: Member.

**Principal Secretary to Government,** Finance Department, Govt. of Odisha or Nominee: Member.

**Commissioner-cum-Secretary to Government**, Science & Technology Department: Member.

**Chairman or his Nominee**, National Board for Higher Mathematics, DAE, Govt. of India: Member.

**Senior most Professor of Mathematics**, Utkal University, Bhubaneswar: Member.

**Senior most Professor of Mathematics**, Sambalpur University: Member.

**Senior most Professor of Mathematics**, Berhampur University: Member.

**Director,** Institute of Physics, Bhubaneswar: Member.

**President**, OMS: Member.

**Prof. R. Balasubramanian**, IMSc, Chennai: Member.

**Prof. Gadadhar Mishra**, Chairman, Dept. of Mathematics, IISC, Bangalore: Member.

**Director, IMA,** Bhubaneswar: Member Secretary: Member.

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Prof. (Dr.) T. Sahoo, IIT, Kharagpur
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Prof. (Dr.) R. Patra, Berhampur University
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| Sl. No | Duty assigned | Chairman | Members | Assistants |
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| 2 | Refreshment and Entertainment, Stage and Seating for Inauguration, Valedictory Function, | Dr. Pinakadhar Baliarsingh | 1) Prof .N. Biswal, 2) Dr.(Mrs) A. Nath<br>3) Prof. J.R. Nayak, 4) Prof. A.K. Singh,<br>5) Mr. P.K. Sahoo, 6) Mrs. S. Panda,<br>7) Mr. D.K. Mishra | Mr. N. Biswal<br>Mr. P.K. Mandhata<br>Mr. S. Behera<br>Mess Manager, IMA |
| 3 | Resource Generation, Advertisement and Message collection, Souvenir Design, Publication, Schedule/Slot arrangement, Reporter/record keeper for each paper presentation hall and lecture hall etc. | Dr. Sudhakar Sahoo | 1) Dr.T.Panigrahi, 2) Dr. C. Mallick<br>3) Dr. S. Acharya 4) Mr. A. Ghosh,<br>5) Mr. S. Sahoo, 6) Mr. P.K Sahoo,<br>7) Mr. M. Hota | Mr. K.B. Samal<br>Academic attendant |
| 4 | Technical Program, Database creation, Web design , Information broad casting, Technical Session arrangement for parallel presentations, Video coverage, Digital Infrastructure arrangement etc. | Mr. Indra Bate | 1) Prof. S.R. Sahoo,<br>2) Prof. J.R. Nayak,<br>3) Mr. M. Hota, 4) Mr. S. Sahoo | Mr. N. Biswal<br>Mr. S. Behera |
| 5 | Registration-cum-Reception, Certificate & Memento Design and Distribution, Pre-conference KIT (Souvenir, abstract, pad, pen), Help Desk, Arrangement for OMS Book exhibition, Flex Design etc | Mr. Indra Bate | 1) Prof. N. Biswal, 2) Prof. B. Jena<br>3) Dr. M. Das, 4) Miss E. Pattanayak<br>5) D.K. Mishra, 6) Mr. P.K. Sahoo<br>7) Mrs. S. Panda | Mr. K.B. Samal<br>Mr. S. Behera |
| 6 | Accommodation , Transportation, Hospitality etc | Dr. Pinakadhar Baliarsingh | 1) Dr. P.P. Mishra, 2) Dr. S. Kapoor,<br>3) Mr. I. Bate, 4) Mr. D.K. Mishra,<br>5) Mrs S. Panda, 6) Mrs. S. Chakraborty | Mr. N. Biswal<br>Mr. D. Sahoo<br>Mess Manager, IMA |

| STUDENT VOLUNTEERS IMA | | | | |
|---|---|---|---|---|
| **ANCHORING** | **Hall Management** | **Registration & Help Desk** | **Sound & Music** | **Camera** |
| Aniket (Intro.) | Soumeek (T. Pati Hall) | Satabdi | Biswajit (T. Pati Hall) | Piyush (T. Pati Hall) |
| Manisha (Intro.) | Pralaya (T. Pati Hall) | Ipsita | Kaushik (T. Pati Hall) | Satyajit (T. Pati Hall) |
| Bibhu (T. Pati Hall) | Pananga (T. Pati Hall) | Bibhu | Aakash (T. Pati Hall) | Madhav (Hall-1) |
| Sneha (T. Pati Hall) | Omkar (T. Pati Hall) | Rudra | Rohan (Hall 1) | Shilajit (Hall 1) |
| Deepshikha (Hall-1) | Debashish (Hall-1) | Sai | Gourish (Hall-1) | |
| Safia (T. Pati Hall) | Suprateek (Hall-1) | Aliva | | |
| Sangram (Hall-1) | Rudrajit (Hall-1) | Pritiprava | | |
| | Tathagat (Hall-3) | | | |
| | Tanush (Hall-3) | | | |
| | Jeetesh (Hall-3) | | | |
| | Divesh (Lab) | | | |
| | Aakashdeep (Lab) | | | |
| **Web-Maintenance** | **Accommodation, Hospitality & Transportation** | **Welcome (Inaugural & Valedictory)** | **Certificate Writing** | **Decoration & Seating** |
| Gourish | Tathagat | Manisha | Manisha | **Inside** |
| Purushottam | Avik | Swayamsnigdha | Niharika | Hasan |
| Madhav | Satabdi | Aliva | Rudra | Aliva |
| | Rakesh | Niharika | Satabdi | Piyush |
| | Aliva | Arunjyoti | | Swayamsnigdha |
| | Subrat | Priyam | | **Outside** |
| | Navya | Shreejita | | Uditanshu |
| | Sabitri | Satabdi | | Sambit |
| | Ananta | | | Shifa |
| | Maharshi | | | Navya |
| | Jeeresh | | | Manisha |
| | Swayamsnigdha | | | Digvijay |
| | Sambit | | | Sangram |

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**ORISSA MATHEMATICAL SOCIETY(OMS)**
Regd No.7203/202 of 1973-74

# Annual Report for 2022-2023

**INTERNATIONAL CONFERENCE ON 'MATHEMATICAL ANALYSIS AND APPLICATIONS'**
**&**
**50thANNUAL CONFERENCE OF ODISHA MATHEMATICAL SOCIETY**
**at**
**INSTITUTE OF MATHEMATICS AND APPLICATIONS, ANDHARUA, BHUBANESWAR, ODISHA, INDIA -751029**
**(Golden Jubilee Celebration of for the 50th Annual Conference of OMS)**

**21-22,January-2023**

**Dr. Sabyasachi Pani**
**General Secretary, OMS**

Respected Chief Guest: Sri Ashok Chandra Panda, Hon'ble Cabinet Minister of Science and Technology, Public Enterprises, Social Security & Empowerment of Persons with Disability, Govt. Of Odisha.

Esteemed Guest of Honour: Sri Bhaskar Sharma, IAS; Commissioner cum Secretary to Govt., Science and Technology Dept., Govt.of Odisha.

Esteemed Guest of Honour: Prof. Gokulananda Das, Ex VC Utkal University,

Esteemed President of Odisha Mathematical Society: Prof. Nalin Kanta Chaudhury

Esteemed Director, Institute of Mathematics and Applications: Prof. Jashobant Jena

Esteemed Organizing Secretary of the Conference: Dr. Sudhakar Sahoo.

My revered teachers, Esteemed delegates, invitees, dignitaries, printing & electronics media personnel, security and police personnel, members of Organising Committee and Advisory Committee, members of Odisha Mathematical Society (OMS); faculties and staff members of Mathematics Department, Utkal University, other supporting organisations who have helped

directly or indirectly for the success of this programme, students, ladies and gentlemen;

At the outset, I congratulate and welcome all of you for your kind presence and sparing your valuable time in this auspicious occasion of the Golden Jubilee Celebration on the occasion of 50th Annual Conference of OMS. This International Conference and the program is to encourage the students and teachers for their progress in research and academic pursuits for a better cause of the society.

I thank, the authority of IMA for inviting Odisha Mathematical Society to host the Golden Jubilee Celebration of for the occasion of 50th Annual Conference of OMS with the International Conference on 'Mathematical Analysis and Applications.'

Sir, Odisha Mathematical Society (OMS) came into existence on the auspicious day of Ganesh Chaturthi, 11thSeptember 1972. This was germinated out of the minds of eminent mathematicians; Late Prof. Ramanath Mohanty, Late Prof. Bama Charan Das, Late Prof. Brajabandhoo Misra, Late Prof. Shankar Prasad Mishra, Prof. Siba Prasad Mishra, Professor Tribikram Pati, Prof. Gokulananda Das, Prof. Ram Narayan Mohapatra, Prof. Ram Shankar Rath and others. OMS is a registered society having Regd No.7203/202 of 1973-1974 with its Head Quarters at P. G. Department of Mathematics, Utkal University, Vani Vihar, Bhubaneswar-751004.

**Aims and objectives of OMS:**

(i) To promote and inculcate research in Mathematics;
(ii) To render suggestions for curriculum reforms in Mathematics from school level to university level;
(iii) To organize annual conferences and symposia;
(iv) To publish journal periodically on research and teaching of mathematics;
(v) To publish a bilingual periodical in Oriya and English language to popularize the subject;
(vi) To encourage and discover talents in mathematics and award prizes and certificates;
(vii) To felicitate persons having outstanding contributions for research and teaching in mathematics;

The 1st Annual Conference of OMS was held on 20-21 January 1973 at P. G. Department of Mathematics, Utkal University, Vani-Vihar, Bhubaneswar. Prof. Ramanath Mohanty (EX-Vice-chancellor of Utkal University) was the President,

Prof. Shankar Prasad Mishra was the General Secretary, Prof. Ghanashyam Samal was the vice-president, Prof. Ram Shankar Rath was the Treasurer. The Golden Jubilee Celebration on the occasion of 50th Annual Conference of OMS is hosted at its Manas Putra IMA.

Odisha Mathematical Society (OMS) is a registered body for lovers of mathematics. Any person having interest in mathematics can become a member of OMS paying membership fee. There are ~820 life members as on 21. 01. 2023. Post COVID-19 inertia affected the programs.
However the following programmes/activities are taken by OMS:

| SL No | Event with Description |
|---|---|
| 1. | **Strengthening Institute of Mathematics and Applications (IMA):** Now IMA has its Regular Director, and running with 01 Associate Professor and 3 Assistant Professor. The Institute of Mathematics and its applications is achieving its objective and purpose of expanding Research and Academy in good pace. IMA will maintain its academic excellence by recruiting best faculties initiating theme-based research activities. With UGC norm, fellowship will be provided to newly recruited research scholar as sanctioned by Govt. of Odisha. |
| 2. | OMS is actively involved in the developments of the matters related to Mathematics: Like<br>1. Strengthening Mathematics Departments of Colleges and Universities of Odisha:<br>2. Strengthening schools with mathematics teachers up to Higher Secondary Level in Odisha:<br>3. Conducting Mathematics Olympiad Training Programme with IMA |
| 4. | Release of Printing Materials by Chief Guest<br>(i) Release of conference Souvenir<br>(ii) Release of book: Abhinav Ganita Bichitra (to popularize mathematics )<br>(iii) Release of Journal of OMS Vol. 41<br>(iv) Release of book: Contribution of Hindu mathematicians to world culture(Vol-II) written by Prof. Bhagaban Patra. |
| 5. | **Prof. Bama Charan Das prize for best Graduate** in +3/B.Sc /B.A Mathematics (Honours) (instituted by **Mrs. Punnyaprava Das W/O late Prof. B. C. Das**): **Miss Rajalaxmi Biswal** is the winner of this award for 2022. She passed B.Sc. with Mathematics, from S.C.S Autonomous College, Puri in the academic session 2021-22 under Utkal University. She is continuing Post |

| | |
|---|---|
| | Graduation in Mathematics at Department of Mathematics, Ravenshaw University, Cuttack. |
| 6. | The following eminent teachers will be felicitated<br>(i) Sri Ashok Pradhan, Retired from Satyabadi High School , Puri in 2005<br>(ii) Prof. Arabinda Das, Retired from Ekamra College, Bhubaneswar in 2002<br>(ii) Prof. P. K. Satpathy, Retired from S.C.S. College, Puri in 2006 |
| 7. | **We have 19 number of Invited Talks.**<br>**The Keynote Speakers:**<br>1. Dr. Bigyani Das, USA (online)<br>2. Prof. Gadadhar Misra, Dept. of Mathematics, Indian Institute of Science, Bangalore<br>3. Prof. A K Pani, BITS, Pilani-Goa campus<br>4. Prof. Arindama Singh, IIT Madras<br>8. Prof. Ranjan Kumar Mohanty, South Asian University, New Delhi |
| 9. | **Invited Lectures**<br>1. Prof. A K B Chand , IIT Madras (Chennai)<br>2. Prof. T Sahoo , IIT Kharagpur<br>3. Prof. C Nahak , IIT Kharagpur<br>4. Prof. R K Behera, Dept. of Computational and Data Science, IISC Bangalore<br>5. Prof. Swadesh K Sahoo, IIT Indore<br>6. Prof. Manoranjan Mishra, IIT Ropar<br>7. Dr. Epsilon Das, USA<br>8. Prof. Prasant Kumar Ray, Sambalpur University<br>9. Prof. Parasar Mohanty, IIT Kanpur |
| 10. | **Memorial Lectures:**<br>There will be four memorial lectures in the name of following eminent mathematicians<br>(i) Prof. Bama Charan Das memorial lecture by Prof G .Das. Ex VC Utkal University<br>(ii) Prof. Ramanath Mohanty memorial lecture by Prof. Ram N Mohapatra University of Central Florida, Orlando, USA<br>(iii) Prof. Shankar Prasad Mishra memorial lecture by Prof Prof.G. D. Veerana Gowda, TIFR Centre for Applicable Mathematics, Bangalore<br>(iv) Prof. Mina Ketan Das memorial lecture by Prof. M N Mishra, Ex-Prof., Sambalpur University |
| 11. | **More than 85 abstracts have been received for Presentation.** |

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|---|---|
| | **Prizes/Awards for paper presentation:**<br>1. **Professor Ghanashyam Samal best paper presentation award** (for UG/PG/M.Phil/M.Tech students) instituted by Professor Purna Chandra Das, Ex-Professor of Mathematics, IIT Kanpur<br>2. **Professor Ghanshyam Samal best paper presentation award** (for Ph.D/Research Scholar) instituted by Dr. Hadibandhu Pattanayak in the memory of his father late Sri Kamapal Pattanayak.<br>3. **Professor Tribikram Pati best presentation award** (for post Doctoral Students /faculties below 35 years of age) instituted by Professor Gopal Krishna Panda of NIT Rourkela in the memory of his father Late Satyananda Panda. |
| 12. | **Programme to Popularise Mathematics:**<br>(i) Publication of quarterly magazine Abhinav Ganita Bichitra (bilingual in English and Odia) for Popularization of Mathematics having ISSN : 2231-4067<br>(ii) Publication of Mathematics Research Journal since 1981 named as "Journal of Odisha Mathematical Society " (JOMS) having ISSN: 0975 – 2323.<br>(iii) Training to students for Mathematics Olympiad Examinations to search talents for Indian National Mathematics Olympiad (INMO), International Mathematics Olympiad (IMO): The Mathematical Olympiad Programme in India is organized by the Homi Bhabha Centre for Science Education (HBCSE) on behalf of the National Board for Higher Mathematics (NBHM) of the Department of Atomic Energy (DAE), Government of India. Apart from the International Mathematical Olympiad (IMO), in which India has been participating since 1989, it has also started participating in two more international Olympiad events: the European Girls' Mathematical Olympiad (EGMO) and Asia Pacific Mathematics Olympiad (APMO).<br>The following programs are taken by OMS and IMA.<br>JMO (Junior Mathematics Olympiad) Examination (for vi,vii,viii students), PRMO (Pre Regional Mathematics Olympiad) Examination(for viii, ix, x, xi, xii students).This PRMO is introduced in 2018. Class XII students are included.<br>RMO (Regional Mathematics Olympiad) Examination (for viii, ix,x,xi,xii students), INMO training camp.<br>SMO (Senior Mathematics Olympiad) Examination (for 2nd and 3rd year of BA/B.Sc/ +3 (Sc/Arts)/B.Sc of NISER with mathematics as a core subject /B.Tech students of IIT, NIT , Engineering Colleges and Universities of Odisha ) to guide for M.Tech/P.G studies. |

1. **Support for hosting the International Conference along with 50th OMS Conference:**

Members of OMS are very much thankful to the organisations/Publishers for encouraging us to conduct such programme by their support.
Especially I on behalf of the OMS thanks the Director, IMA Prof. Jasobant Jena for his whole hearted in time support to hold the Conference.

2. **The General Body meeting of OMS:**
   The general body meeting of OMS is held to discuss the affairs of OMS. The annual income and expenditure statements are presented. Election is held for office Bearers of OMS.
3. **Message for next Conference:**
   The two days programme of the conference will be closed by valedictory function giving new message for the future programme of OMS.

   Once again, I thank you all for your kind cooperation.

   Bande Utkal Janani

   Jai Hind

# Inaugural Programme

## Date: 21st January 2023

10.00 AM : Invited / Distinguished Guests get seated

10.05 AM : Lighting of Lamp with Chanting of Shloka

10.10 AM : Flower Bouquet to dignitaries on the dais

10.15 AM : Opening Song

10.20 AM : Welcome address by Director, IMA

10.25 AM : Annual Report by General Secretary of OMS

10.30 AM : Release of Souvenir

10.35 AM : Release of Books, Magazines and Journals by OMS

11.00 AM : Awards and Felicitation to Teachers & Students

11.05 AM : Address by the Guest of Honour, Prof. G. Das
(Ex-VC. Utkal University, Vani Vihar, Bhubaneswar)

11.15 AM : Address by the Guest of Honour, Sh. Bhaskar Jyoti Sarma
(Commissioner-Cum Secretary, S & T Dept.)

11.25 AM : Address by the Chief Guest, Sh. Ashok. Chandra Panda
(Hon'ble Minister, Science & Technology)

11.35 AM : Address by President of OMS

11.45 AM to 11.50 AM : Vote of Thanks by the
Organizing Secretary of Conference

International Conference on "Mathematical Analysis and Applications"
&
50th Annual Conference of Odisha Mathematical Society
(Golden Jubilee Celebration)

January 21-22, 2023

INSTITUTE OF MATHEMATICS AND APPLICATIONS
BHUBANESWAR
**Details of Technical Programme / Sessions**
**21st January 2023**

| Sl No | Time | T.Pati Hall<br>Name of Rapporteurs:<br>(1) Prof. Prayag Prasad Mishra<br>(2) Prof. Chittaranjan Mallick | Hall No-1<br>Name of Rapporteurs:<br>(3) Prof. Bibekananda Jena<br>(4) Prof. Smruti Ranjan Sahoo |
|---|---|---|---|
| 1 | 7.00 AM – 9.00 AM | Registration & Breakfast<br>(Corridor in front of T. Pati Hall) | |
| 2 | 9.00 - 9:30 | | Invited Talk (Online):<br>Speaker: Dr. Bigyani Das,<br>IMSG, Rockville MD 20852, USA<br><br>Title: Application of Mathematical Modeling in Sciences<br><br>Video call link:<br>https://meet.google.com/bmx-ndqu-vjr<br>Or dial: (US) +1 203-397-6785<br>PIN: 585 232 092#<br><br>Chairperson: Prof. G. D. Veerappa Gowda |
| 3 | 10:00 -11:50 | Inaugural Programme<br>Venue- T.Pati Hall | |
| 4 | 11:50-12:00 | Tea Break | Tea Break |
| 5 | 12:00-12:45 | Talk: Prof. Shankar Prasad Mishra Memorial Lecture<br><br>Speaker: Prof. G.D.Veerappa Gowda , TIFR Centre for Applicable Mathematics, Bangalore, India<br><br>Title: Well balanced higher order Godunov type numerical methods for a model of granular flow<br><br>Chairperson: Prof. B. P. Acharya | |

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|---|---|---|---|
| 6 | 12.45-1:15 | Invited Talk:<br>Speaker: Prof. Arindama Singh, Department of Mathematics, Indian Institute of Technology, Madras, India<br><br>Title: True-pairs of real linear operators - an intrinsic proof<br><br>Chairperson: Prof. S. Pattanayak | Invited Talk:<br>Speaker: Prof. Trilochan Sahoo, Department of Ocean Engg and Naval Architecture, Indian Institute of Technology, Kharagpur, India<br><br>Title: Mathematical challenges in the blocking dynamics of flexural gravity waves - an overview<br>Chairperson: Prof. S Padhy |
| 7 | 1:15-2:00 | Lunch Break | Lunch Break |
| 8 | 2:00 - 2:45 | Talk: Prof.Ramanath Mohanty Memorial Lecture<br>Speaker: Prof. Ram N. Mohapatra, Department of Mathematics, University of Central Florida, Orlando, USA<br><br>Title: Solving Stochastic Variational Inequalities with Mirror-Proximal Algorithm and Derivative-Free Descent Methods with Applications in Machine Learning<br><br>Chairperson: Prof. G. Das | |
| 9 | 2:45-3:15 | Invited Talk:<br>Speaker: Prof. Amiya Kumar Pani, Department of Mathematics, Birla Institute of Technology & Science, Philani-Goa Campus, India<br><br>Title: Through Eyes of Feedback Control: How does External Stimulus Influence Research in Applied Mathematics<br>Chairperson: Prof. G C Dash | Invited Talk:<br>Speaker: Dr. Ratikanta Behera, Department of Computational and Data Sciences, Indian Institute of Science, Bangalore, India<br><br>Title: Tensor Computations for Data Science<br><br>Chairperson: Prof. A Singh |
| 10 | 3:15 - 3:45 | Invited Talk:<br>Speaker: Prof. Gadadhar Misra, Department of Mathematics, Indian Institute of Science (IISc.) Bangalore, India<br><br>Title: Homogeneous operators | Invited Talk:<br>Speaker: Prof. Swadesh K. Sahoo, Department of Mathematics, Indian Institute of Technology, Indore, India<br><br>Title: Area of regions and unsolved issues in analytical function theory |
| | | Chairperson: Prof. S Nanda | Chairperson: Prof. C Nahak |
| | 3:45-4:15 | Invited Talk:<br>Speaker: Prof. Parasar Mohanty, Department of Mathematics, Indian Institute of Technology, Kanpur, India<br><br>Title: Weighted Inequality: Recent Developments<br>Chairperson: Prof. P K Das | Invited Talk:<br>Speaker: Prof. Chandal Nahak, Department of Mathematics, Indian Institute of Technology, Kharagpur, India<br>Title: Best Approximation and Optimization<br><br>Chairperson: Prof. S P Mohanty |
| 11 | 4:15 - 4:30 | Tea Break | Tea Break |
| 12 | 4:30 - 6:30 | Paper Presentation<br><br>Judges :<br>Prof.S P Mohanty<br>Prof.M K Mahanti | Paper Presentation<br><br>Judges:<br>Prof. H B Pattanyak<br>Prof. P K Das |
| 13 | 6:30 - 8:45 | Cultural Programme<br>Venue: In front of Administrative Block | Cultural Programme<br>Venue: In front of Administrative Block |
| 14 | 8:45 - 9:30 | Dinner | |

International Conference on "Mathematical Analysis and Applications"
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January 21-22, 2023

INSTITUTE OF MATHEMATICS AND APPLICATIONS
BHUBANESWAR

**Details of Technical Programme / Sessions**

**22nd January 2023**

| Sl No | Time | T.Pati Hall<br>Name of Rapporteurs:<br>(1) Prof. Prayag Prasad Mishra<br>(2) Prof. Chittaranjan Mallick | Hall No-1<br>Name of Rapporteurs:<br>(3) Prof. Bibekananda Jena<br>(4) Prof. Smruti Ranjan Sahoo |
|---|---|---|---|
| 1 | 7.30 AM – | Registration & Breakfast | |
| | 8.30 AM | (Corridor in front of T. Pati Hall) | |
| 2 | 8.30 - 10:00 | Paper Presentation<br><br>Judges :<br>Prof.S P Mohanty<br>Prof.M K Mahanti | Paper Presentation<br><br>Judges:<br>Prof. H B Pattanyak<br>Prof. P K Das |
| 3 | 10:00 - 10:45 | Talk: Prof. Bama Charan Das Memorial Lecture<br>Speaker: Prof. Gokulananda Das, Ex-VC, Utkal University, Bhubaneswar<br>Title: Language<br>Chairperson: Prof. M N Mishra | |
| 4 | 10:45-10:50 | Tea Break | Tea Break |
| 5 | 10:50-11:20 | Invited Talk:<br>Speaker: Prof. Ranjan K. Mohanty, Department of Mathematics, South Asian University, New Delhi, India<br><br>Title: Unconditionally Stable Operator Splitting Method for 2D Telegraph Model Equation with Unequal Mesh Size Discretization<br><br>Chairperson: Prof. A K Ojha | Invited Talk:<br>Speaker: Prof. Prasanta Kumar Ray, Department of Mathematics, Sambalpur University, Burla, India<br><br>Title: Binary and Higher Order Recurrent Sequences: An Overview<br><br>Chairperson: Prof. A Singh |
| 6 | 11:20-11:50 | Invited Talk:<br>Speaker: Prof. A.K.B. Chand, Department of Mathematics, Indian Institute of Technology, Madras, India<br><br>Title: Fractal Interpolation Functions for Noisy Data Sets<br><br>Chairperson: Prof. T Sahoo | Invited Talk:<br>Speaker: Dr. Epsilon Das, WrkSpot, 11307, Michelle Street, Cerritos, California, USA,90703<br><br>Title: Computer and Employment Opportunity<br><br>Chairperson: Prof. C K Mohapatra |

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|---|---|---|---|
| 7 | 11:50-12:35 | Talk: Prof. Minaketan Das Memorial Lecture<br>Speaker: Prof. Mahendra N. Mishra, Former Professor Emeritus, Institute of Mathematics and Applications, Bhubaneswar<br><br>Title: The origin of Stochastic Differential Equations and their applications | |
| | | Chairperson: Prof. T Biswal | |
| 8 | 12:35-1:05 | Invited Talk:<br>Speaker: Prof. Manoranjan Mishra, Department of Mathematics, Indian Institute of Technology, Ropar, India<br><br>Title: Modeling of Hydrodynamic Instability in a layered channel flow with chemical reaction<br><br>Chairperson: Prof. A K B Chand | Paper Presentation<br><br>Judges:<br>Prof. M K Mahanti<br>Prof. P K Das<br>Prof. S P Mohanty<br>Prof. H B Pattanayak |
| 9 | 1:05-2:00 | Lunch Break | Lunch Break |
| 10 | 2:00-3:30 | Paper Presentation<br><br>Judges:<br>Prof. M K Mahanti<br>Prof. P K Das<br>Prof. S P Mohanty<br>Prof. H B Pattanayak | Symposium on Syllabus of School/UG/PG courses<br>Chairman: Prof. S Padhy |
| 11 | 3:30-4:30 | General Body Meeting of OMS | |
| 12 | 4:30-5:30 | Valedictory function, Prize distribution for best paper presentation | |
| 13 | 5:30-6:00 | Refreshment | |

# Articles

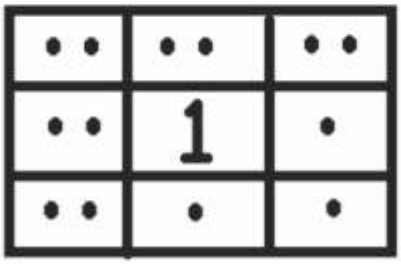
# ଭାରତୀୟ ଗାଣିତିକ ସଂସ୍କୃତିର ଇତିହାସ

ରାମଶଙ୍କର ରଥ

ଯେ କୌଣସି ବିଷୟରେ ଇତିହାସ ଲେଖିଲାବେଳେ ତଥ୍ୟଗୁଡ଼ିକର ଗ୍ରହଣୀୟ ତାକୁ ଲେଖକର ସ୍ୱକୀୟ ରୁଚି ବା ପ୍ରକୃତି ପ୍ରଭାବିତ କରିବା ସ୍ୱାଭାବିକ। ସପ୍ତଦଶ ଶତାବ୍ଦୀର ଦାର୍ଶନିକ ବାରୁଚ ସ୍ପିନୋଜା ପରାମର୍ଶ ଦେଇ କହିଛନ୍ତି ଦ୍ୱେଷ, ଘୃଣା , ଅନୁଶୋଚନାକୁ ମନରୁ ପୋଛି ନିର୍ମଳ ଓ ନିଷ୍ପକ୍ଷ ମନରେ ତଥ୍ୟଗୁଡିକ ଉପସ୍ଥାପନ କରିବାକୁ ହେବ। ପାଶ୍ଚାତ୍ୟ ସଭ୍ୟତା ପ୍ରତି ଅନୁରକ୍ତ ଆଧୁନିକ ଭାରତୀୟ ଛାତ୍ରମାନେ ବିଶ୍ୱାସ କରିବାକୁ ପ୍ରସ୍ତୁତ ନୁହନ୍ତି ଯେ ଦଶମିକ ସଂଖ୍ୟା ପଦ୍ଧତି ଓ ଶୂନ ଭଳି ମୌଳିକ ଗଣିତର ଧାରଣା ଗୁଡିକ ଭାରତରୁ ହିଁ ଆରବ ଦେଶଦେଇ ପାଶ୍ଚାତ୍ୟ ଦେଶକୁ ଯାଇଥିଲା। ତେବେ କେବେ ଓ କେଉଁ ଭାରତୀୟ ଗଣିତଜ୍ଞ ଏ ଗୁଡିକ ଆବିଷ୍କାର କରିଥିଲେ ତାହାର ସଠିକ ନିର୍ଣ୍ଣୟ ଏ ଯାଏଁ କରାଯାଇ ପାରିନାହିଁ। ଖୁବ୍ ସମ୍ଭବ ଖ୍ରୀ.ପୂ 100 ରୁ ଦଶମିକ ପଦ୍ଧତିର ପ୍ରଚଳନ ଆରମ୍ଭ ହୋଇଥିଲା। ବୈଦିକ ଶାସ୍ତ୍ର ଓ ରାମାୟଣ, ମହାଭାରତର ଯୁଦ୍ଧର ବର୍ଣ୍ଣନାରେ ସୈନ୍ୟ ସାମନ୍ତ, ହସ୍ତୀ, ଅଶ୍ୱ, ରଥଙ୍କ ସମ୍ପର୍କରେ ପରାର୍ଦ୍ଧ, ଅର୍ବୁଦ, ଖର୍ବ, ନିଖର୍ବ ଭଳି ବଡବଡ ସଂଖ୍ୟାର ଉଲ୍ଲେଖ ଥିବାରୁ ଅତି ପ୍ରାଚୀନ ଯୁଗରୁ ଭାରତୀୟମାନଙ୍କର ଏହି ସଂଖ୍ୟାଜ୍ଞାନ ଥିବା ପ୍ରମାଣିତ ଅଟେ। ଚିତ୍ର ଓ ସଙ୍କେତ ଦ୍ୱାରା ହିନ୍ଦୁମାନେ ଏହି ସଂଖ୍ୟାଜ୍ଞାନ ମାଧ୍ୟମରେ ପାଟୀଗଣିତକୁ ଆଗେଇ ନେବା ବିଷୟରେ G.B Halstead ତାଙ୍କର 'On the Foundation of the technique of Arithmetic' (Chicago, 1912) ପୁସ୍ତକରେ ଲେଖିଛନ୍ତି 'The importance of the zero mark can never be exaggerated'. This gives to airy nothing not merely a local habitation and a name, a picture, a symbol but a helpful power; it is the characteristic of the Hindu race whence it sprang..... . No single mathematical creation has been more potent for the general ongo of intelligence and power.'

ସିନ୍ଧୁ ଉପତ୍ୟକାରେ ଆବିଷ୍କୃତ ଖ୍ରୀ.ପୂ 3000 ରୁ 2500ର ହରପ୍ପା ସଂସ୍କୃତି ଉନ୍ନତ ମାନର ଥିଲା। ଇଟାଗୁଡିକର ସାୟିତ୍ୱ ପାଇଁ ଆବଶ୍ୟକ ଦୈର୍ଘ୍ୟ, ପ୍ରସ୍ଥ ଓ ବେଧର ଅନୁପାତରୁ କାରିଗରମାନଙ୍କର ଗଭୀର ଜ୍ୟାମିତି ଜ୍ଞାନର ସୂଚନା ମିଳେ । ସେହି ସଂସ୍କୃତିର ଅବକ୍ଷୟର ଅନେକ ଶହ ବର୍ଷ ପରେ ବୈଦିକ ଯୁଗ ଆରମ୍ଭ ହୋଇଥିଲେ ବି ସେ ଯୁଗର ଯଜ୍ଞବେଦୀର ଇଟାରୁ ହରପ୍ପା ଯୁଗର ଜ୍ଞାନ କୌଶଳ ପ୍ରୟୋଗ କରାଯାଇଥିବା କଥା ଲୌଗାକ୍ଷି, ମାନବ, ବାରାହ, ବୈଧାୟନ, ଭାଧୂଲା, ଆପସ୍ତମ୍ବ, ହିରଣ୍ୟକେଶି, କାତ୍ୟାୟନ ଓ ମୈତ୍ରାୟନ ଶୀର୍ଷକ ନଅଟି ଶୁଲ୍ବସୂତ୍ରରୁ ସୂଚିତ ହୁଏ। ଏ ଗୁଡିକର ଭାଷାରୁ ଜଣାଯାଏ ପାଣିନୀଙ୍କ ଦ୍ୱାରା ଆଠଶହ ବର୍ଷ ତଳେ ଏ ଗୁଡିକ ରଚିତ ହୋଇଥିଲେ। ସେତେବେଳକୁ 3, 4, 5 ଅନୁପାତରେ ସମକୋଣୀ ତ୍ରିଭୁଜର ବାହୁଗୁଡିକ ଅଙ୍କିତ ହେବା ଜ୍ଞାନ ପୃଥିବୀର ଅଧିକାଂଶ ସଭ୍ୟଦେଶର ଥିଲା। କିନ୍ତୁ ଶତପଥ ବ୍ରାହ୍ମଣରେ ବିଭିନ୍ନ ଲକ୍ଷ୍ୟ ସାଧନ ପାଇଁ ଭିନ୍ନ ଭିନ୍ନ ଅନୁପାତର ଯଥା 36, 15, 39, ଓ 5, 12, 13 ବାହୁ ବିଶିଷ୍ଟ ଯଜ୍ଞବେଦୀ ନିର୍ମାଣର ପରାମର୍ଶ ଦିଆଯାଇ କୁହାଯାଇଛି ଯେ $15\sqrt{2}, 36\sqrt{2}, 39\sqrt{2}$ ଏକକର ବାହୁ ଟି ନିର୍ମାଣ ପୂର୍ବକ ଯଜ୍ଞ ବେଦୀରେ ଅଶ୍ୱମେଧ ଯଜ୍ଞ ଓ $5\sqrt{3}, 12\sqrt{3}, 13\sqrt{3}$ ହେଲେ ସୌତ୍ରାମଣି ଯଜ୍ଞ ଅନୁଷ୍ଠିତ ହୋଇଥାନ୍ତି। ଏଥିରୁ ଅନୁମାନ ହେବା ସ୍ୱାଭାବିକ ଯେ ପିଥାଗୋରସୀୟ ସମୀକରଣ $x^2 + y^2 = z^2$ ର ପରିମେୟ ଓ ଅପରିମେୟ ସମାଧାନ ଶୁଲ୍ବ ଜ୍ୟାମିତିକାରମାନଙ୍କୁ ଜଣାଥିଲା। ବୋଧାୟନ, ଆପସ୍ତମ୍ବ ଓ କାତ୍ୟାୟନ ଶୁଲ୍ବ ସୂତ୍ରରେ $\sqrt{2}$ ର ଆସନ୍ନମାନ (approximate value)

ନିରୂପଣର ସୂତ୍ରଟିଏ ଦିଆଯାଇଛି। ଗ୍ରୀକ ଗଣିତଜ୍ଞମାନଙ୍କ ବହୁପୂର୍ବରୁ ବୈଦିକ ଯୁଗରେ ଭାରତରେ ଏହି ଜ୍ଞାନର ଉପଲବ୍ଧି ଭାରତୀୟ ଗଣିତର ଶ୍ରେଷ୍ଠତା ସପକ୍ଷରେ ଏକ ନିଶ୍ଚିତ ପ୍ରମାଣ ଅଟେ। ନିମ୍ନର ଚିତ୍ରଟି ମାଧ୍ୟମରେ ବୋଧାୟନ ଶୁଲ୍ବସୂତ୍ର ଜ୍ୟାମିତିରୁ ଉତ୍ପନ୍ନ ଏକ ପାଟୀ ଗାଣିତିକ ଅଭେଦ $1+3+5+\cdots+(2n-1) = n^2$ ର ପ୍ରମାଣ କୌଶଳର ସୂଚନା ମିଳେ।




ସୂଚନା: 1 ଲେଖାଯାଇଥିବା କ୍ଷୁଦ୍ର ବର୍ଗକ୍ଷେତ୍ରଟିକୁ ଶୂନ୍ୟ ସ୍ତରର ବର୍ଗକ୍ଷେତ୍ର ମନେକର। ଏହାକୁ ଭିତ୍ତି କରି ପ୍ରଥମ ସ୍ତରର ବୃହତ୍ତର ବର୍ଗକ୍ଷେତ୍ରଟି [•] ସୂଚିତ ତିନୋଟି ବର୍ଗକ୍ଷେତ୍ର ସାହାଯ୍ୟରେ ନିର୍ମିତ ହୋଇଛି। ଦ୍ୱିତୀୟ ସ୍ତରରେ ବୃହତ୍ତର ବର୍ଗକ୍ଷେତ୍ର ର ନିର୍ମାଣ [••] ସୂଚିତ ଆଉ ପଞ୍ଚୋଟି ବର୍ଗକ୍ଷେତ୍ର ସାହାଯ୍ୟରେ କରାଯାଇଛି। ଠିକ୍ ସେହିପରି ତୃତୀୟ ସ୍ତରର ବୃହତ୍ତର ବର୍ଗକ୍ଷେତ୍ରଟିର ନିର୍ମାଣ ପାଇଁ 7 ଟି [•••] ସୂଚିତ ବର୍ଗକ୍ଷେତ୍ର ଆବଶ୍ୟକ ହେବ।

ଏଥିରୁ ନିମ୍ନ ପାଟୀ ଗାଣିତିକ ଅଭେଦ ସୂତ୍ର ଗୁଡିକ ମିଳିଥାନ୍ତି ଯଥା $1+3=2^2$, $1+3+5=3^2$ $1+3+5+7=4^2$ । ଏହାର ପରବର୍ତ୍ତୀ ଅଭେଦ ସୂତ୍ର ଗୁଡିକ n ଯାଏଁ ଲେଖିଲେ $1+3+5+\ldots+(2n-1)=n^2$ ଅର୍ଥାତ ପ୍ରଥମ n ଟି ଅଯୁଗ୍ମ ସଂଖ୍ୟା ର ଯୋଗଫଳ $= n^2$ ସୂତ୍ରଟି ମିଳେ।

ଭାରତରେ ଜୈନ ଓ ବୌଦ୍ଧ ଧର୍ମର ହିନ୍ଦୁ ସଂସ୍କୃତିରୁ ଭିନ୍ନ ସଂସ୍କୃତି ରହିଛି। ହିନ୍ଦୁ ପୌରଣିକ ସାହିତ୍ୟରେ ମହାବୀର ଜୈନଙ୍କ ପୂର୍ବରୁ ଋଷଭ, ଭରତ ଭଳି ତୀର୍ଥଙ୍କର ରହିଥିବାର ଉଲ୍ଲେଖ ଅଛି। ସେମାନଙ୍କ ଦ୍ୱାରା ଶୁଲ୍ବ ଗଣିତରୁ ପ୍ରାଚୀନତର ଗାଣିତିକ ଅବଦାନ ଥିଲେ ବି ସେହି ମୌଳିକ କୃତି ଗୁଡିକ ଏବେ ଲୁପ୍ତ, କେବଳ ସେଗୁଡିକର ଭାଷ୍ୟ ବ ଟୀକା ମିଳୁଛି। ଖ୍ରୀ.ଅ 150 ର ଜୈନ ଗଣିତଜ୍ଞ ଉମାଶ୍ୱତୀଙ୍କର ପାଞ୍ଚେ ତିନିଶହ ବର୍ଷ ପରେ ଜନ୍ମିତ ପ୍ରସିଦ୍ଧ ହିନ୍ଦୁ ଗଣିତଜ୍ଞ ଆର୍ଯ୍ୟଭଟ୍ଟ ତାଙ୍କ ଦ୍ୱାରା ସ୍ଥାପିତ କୁସୁମପୁର ଗଣିତ ସ୍କୁଲ ର ହିଁ ଛାତ୍ର ଥିଲେ। ଉମାଶ୍ୱତୀଙ୍କ ରଚିତ 'ତତ୍ତ୍ୱାର୍ଥାଧିଗମ ସୂତ୍ରଭାଷାରେ' (ପାଇ) $\pi$ ଓ $\sqrt{10}$ ର ଯେଉଁ ଆସନ୍ନମାନର ଉଲ୍ଲେଖ ରହିଛି ତାହାକୁ , ଖ୍ରୀ. ପୂ 500 ରୁ ଖ୍ରୀ. ଅ 1500-2000 ବର୍ଷ ଯାଏଁ ଗଣିତଜ୍ଞମାନେ ମାନି ନେଇଥିଲେ। ଖ୍ରୀ.ପୂ 300 ରେ ରଚିତ 'ସ୍ଥାନାଙ୍ଗ ସୂତ୍ର ' ନାମକ ଜୈନ ଗଣିତ ଗ୍ରନ୍ଥରେ ପରିକର୍ମ , ବ୍ୟବହାର, ରଜ୍ଜୁ , ରାଶି, କଳାସବର୍ଣ୍ଣ , ୟାବତ୍ –ତାବତ୍, ବର୍ଗ, ଘନ, ବର୍ଗ-ବର୍ଗ ଓ ବିକଳ୍ପ ଶୀର୍ଷକ ଦଶଟି ଅଧ୍ୟାୟରେ ବିସ୍ତୃତ ଗାଣିତିକ ଚର୍ଚ୍ଚା କରାଯାଇଛି। 'ପରିକର୍ମରେ ମିଶାଣ, ଫେଡାଣ, ଗୁଣନ, ହରଣ ଓ ବ୍ୟବହାର'ରେ ସେମାନଙ୍କର ପ୍ରୟୋଗ ପ୍ରଣାଳୀ ବୁଝାଇ ଦିଆଯାଇଛି। 'କଳାସବର୍ଣ୍ଣ ' ଭଗ୍ନାଂଶକୁ, 'ରଜ୍ଜୁ' ଜ୍ୟାମିତିକୁ, 'ରାଶି' ବସ୍ତୁ ଗୁଡିକର ମାପିବା ପ୍ରଣାଳୀକୁ ବୁଝାଇଛି। 'ୟାବତ୍ –ତାବତ୍' ରେ x,y ଭଳି ଅଜ୍ଞାତ ରାଶିର ବ୍ୟବହାର ଅର୍ଥାତ ବୀଜଗଣିତର ଓ 'ବିକଳ୍ପ'ରେ ଆଧୁନିକ ପର୍ମ୍ୟୁଟେସନ-କମ୍ବିନେସନ ପ୍ରକ୍ରିୟାର ଉଲ୍ଲେଖ ରହିଛି। ଏହି ପ୍ରକ୍ରିୟାର ବ୍ୟବହାର ଖ୍ରୀ.ପୂ ଷଷ୍ଠ ଶତାବ୍ଦୀର ସୁଶ୍ରୁତ ସଂହିତା ରୁ ସ୍ପଷ୍ଟ ଏହି କାରଣରୁ ହୁଏ ଯେ ଗୋଟିଏ ସ୍ଥାନରେ ଉଲ୍ଲେଖ ରହିଛି ଷଡ୍ ରସକୁ ନେଇ ତେଷଠି ଭିନ୍ନ ପ୍ରକାର ସ୍ୱାଦର ଖାଦ୍ୟ ପ୍ରସ୍ତୁତି ସମ୍ଭବ ଅଟେ। ପ୍ରକୃତରେ ଦେଖାଯାଏ $6_{C_1}+6_{C_2}+6_{C_3}+6_{C_4}+6_{C_5}+6_{C_6}=63$ । ଖ୍ରୀ.ପୂ ତୃତୀୟ କିମ୍ବା ଚତୁର୍ଥ ଶତାବ୍ଦୀର ପିଙ୍ଗଳାଚାର୍ଜ୍ୟଙ୍କ ରଚିତ 'ଛାନ୍ଦ-ସୂତ୍ର' ର ସାତଟି ଅଧ୍ୟାୟରେ ସେ ଅନେକ ଗାଣିତିକ ପ୍ରକ୍ରିୟା ଯେପରିକି ଦଶମିକ ପଦ୍ଧତିର ସଂଖ୍ୟା କୁ ଦ୍ୱିକ ପଦ୍ଧତିରେ ଲେଖିବା ଓ ପର୍ମ୍ୟୁଟେସନ-କମ୍ବିନେସନର ବ୍ୟବହାର ଇତ୍ୟାଦି ଦର୍ଶାଇଛନ୍ତି।

ଖ୍ରୀ.ଅ ପ୍ରଥମରୁ ଦଶମ ଶତାବ୍ଦୀ କୁ ଭାରତୀୟ ଗଣିତର କ୍ଲାସିକଲ ଯୁଗ ବୋଲି ନାମିତ କରାଯାଇପାରେ କାରଣ ଏହି ସମୟ ଖଣ୍ଡରେ ଖ୍ରୀ.ଅ 476 ରେ ଆର୍ଯ୍ୟଭଟ୍ଟ, ଖ୍ରୀ.ଅ 505 ରେ ବରାହମିହିର, ଖ୍ରୀ.ଅ 598 ବ୍ରହ୍ମଗୁପ୍ତ, ଖ୍ରୀ.ଅ 815 ରେ ମହାବୀର, ଖ୍ରୀ.ଅ 750 ରେ ଶ୍ରୀଧର ଓ ଖ୍ରୀ.ଅ 1115 ରେ ଭାସ୍କରାଚାର୍ଯ୍ୟ (ଦ୍ୱିତୀୟ) ଙ୍କର ଜନ୍ମ ହୋଇଥିଲା। ଯେଉଁମାନେ ଗଣିତକୁ ନିଜର ବଳିଷ୍ଠ ଅବଦାନ ଦ୍ୱାରା ସମୃଦ୍ଧି କରି ଯାଇଥିଲେ।

23 ବର୍ଷ ବୟସରେ ରଚିତ ପ୍ରସିଦ୍ଧ ଗ୍ରନ୍ଥ 'ଆର୍ଯ୍ୟଭଟ୍ଟୀୟ' ର ମାତ୍ର ତେତିଶିଟି ଶ୍ଲୋକରେ ଆର୍ଯ୍ୟଭଟ୍ଟ ପିଥାଗୋରସ ଉପପାଦ୍ୟ, ବର୍ଗମୂଳ, ଘନମୂଳ, ପାଟୀଗାଣିତିକ ଓ ଜ୍ୟାମିତିକ ପ୍ରଗତି, ଦ୍ୱିଘାତୀ ସମୀକରଣ ଓ ଏକଘାତୀ ଅନିରୁପେୟ ସମୀକରଣର ସମାଧାନ ଆଦି ପ୍ରସଙ୍ଗର ଚର୍ଚ୍ଚା କରିଥିଲେ। ଅନ୍ୟ କେତେକ ଗଣିତଜ୍ଞ ଆଗରୁ ଚର୍ଚ୍ଚା କରିଥିଲେ ବି $\pi$ ର ଆସାନ୍ନମନ ନିରୂପଣ, ସାଇନଟେବୁଲର ପ୍ରସ୍ତୁତି କୁଟଟକ ପ୍ରଣାଳୀରେ ଅନିରୁପେୟ ସମୀକରଣର ସମାଧାନରେ ତାଙ୍କର ମୌଳିକ ବିଚାର ପ୍ରତିଫଳିତ ହୋଇଥିଲା। ବରାହମିହିର ତାଙ୍କର ଜ୍ୟୋତିର୍ଗାଣିତିକ 'ପଞ୍ଚସିଦ୍ଧାନ୍ତିକା' ଗ୍ରନ୍ଥରେ ପୌଲିଶ, ରୋମକ, ବଶିଷ୍ଠ, ସୌର ଓ ବ୍ରାହ୍ମ ଶୀର୍ଷକ ପାଞ୍ଚଟି ସୌରନୀତିକୁ ଜ୍ୟୋତିର୍ଗଣିତର ନିର୍ଭୁଲ ଗଣନା ପ୍ରଣାଳୀ ରୂପେ ପ୍ରତିପାଦିତ କରିଥିଲେ। ବୃହଜ୍ଜାତକ ଓ ବୃହତ୍ ସଂହିତା ନାମକ ଅନ୍ୟ ଦୁଇଟି ପ୍ରସିଦ୍ଧ ଗ୍ରନ୍ଥ ବି ସେ ରଚନା କରିଥିଲେ ।

ବିଷୁବ ରେଖାରେ ସୂର୍ଯ୍ୟଙ୍କର ଅବସ୍ଥାନ ସମୟରେ ପୃଥିବୀର ନିଜ ଅକ୍ଷ ଚାରିପାଖେ ଗତି କେତେ ମନ୍ଥର ହୋଇଥାଏ ତାହା ନିର୍ଣ୍ଣୟ କରି ସେଥିପାଇଁ ଲଗ୍ନ ନିରୂପଣରେ ତ୍ରୁଟି ସଂଶୋଧନ କରିବା ପ୍ରାଣାଳୀ ବି ସେ ଦର୍ଶାଇଥିଲେ। ଆଧୁନିକ ପାକିସ୍ଥାନର ସିନ୍ଧୁ ପ୍ରଦେଶରେ ଷଷ୍ଠ ଶତାବ୍ଦୀର ଶେଷରେ ଜନ୍ମିତ ବ୍ରହ୍ମଗୁପ୍ତଙ୍କର ରଚିତ ବ୍ରହ୍ମସ୍ଫୁଟ ସିଦ୍ଧାନ୍ତ'କୁ ମୌଳିକ ତତ୍ତ୍ୱ ଦୃଷ୍ଟିରୁ ଶ୍ରେଷ୍ଠତମ ଗଣିତ ଗ୍ରନ୍ଥର ମର୍ଯ୍ୟାଦା ଦିଆଯାଏ । ସେପରି ଖ୍ରୀ.ଅ 860 ରେ ପୃଥୁଦକ ସ୍ୱାମୀଙ୍କ ରଚିତ ଏହାର ଟୀକାଟିକୁ ମଧ୍ୟ ଅନ୍ୟାନ୍ୟ ଟୀକା ଅପେକ୍ଷା ଅଧିକ ମହତ୍ତ୍ୱ ଦିଆଯାଏ। ଭାରତୀୟ ଜ୍ୟୋତିଃ ଶାସ୍ତ୍ରର ଖ୍ୟାତି ଆରବ ଦେଶକୁ ବ୍ୟାପିବା ପରେ ସେଠାର ଶାସକ ଖଲିଫ ଆବ୍‌ଦା ସିଦ୍—ଅଲ୍ –ମନସୁର୍ (ବାଗ୍ ଦାଦ ନଗରୀର ପ୍ରତିଷ୍ଠାତା) ଅଲ୍ ପଞ୍ଜରୀଙ୍କ ଦ୍ୱାରା ଏହି ଗ୍ରନ୍ଥକୁ ଆରବୀ ଭାଷାରେ ହିନ୍ଦ-ସିନ୍ଦ (କିମ୍ବା ସିନ୍ଦ- ହିନ୍ଦ) ନାମରେ ଅନୁବାଦ କରାଇଥିଲେ। ଖ୍ରୀ.ଅ 815 ରେ ଜନ୍ମିତ ମହାବୀର ଜୈନ କର୍ଣ୍ଣାଟକର ଶାସକ ଅମୋଘବର୍ଷ ନୃପତୁଙ୍ଗଙ୍କ ରାଜତ୍ୱ ବେଳେ ଖ୍ରୀ.ଅ 850 ରେ 'ଗଣିତ ସାର ସଂଗ୍ରହ' ରଚନା କରିଥିଲେ। ଭାସ୍କରାଚାର୍ଯ୍ୟଙ୍କ ରଚିତ 'ସିଦ୍ଧାନ୍ତ ଶିରୋମଣି ' ରେ ଲୀଳାବତୀ , ବୀଜଗଣିତ, ଗ୍ରହଗଣିତ ଓ ଗୋଳାଧ୍ୟାୟ ଶୀର୍ଷକ ଚାରୋଟି ଅଧ୍ୟାୟ ପଦ୍ୟକାରରେ ରହିଛି। ବୋଧଗମ୍ୟ ଶୈଳୀରେ ଠିକଣା କ୍ରମରେ ସମସ୍ତ ଗଣିତଜ୍ଞାନ ଏଥିରେ ଦିଆଯାଇଥିବାରୁ ଏହାକୁ ତତକାଳୀନ ଛାତ୍ରଙ୍କର ପାଠ୍ୟବହିର ମାନ୍ୟତା ମିଳିଥିଲା, ତେଣୁ ଭାସ୍କର(ଦ୍ୱିତୀୟ) ଙ୍କୁ ଆଚାର୍ଯ୍ୟ ଭାବେ ସମ୍ବୋଧିତ କରାଗଲା। ଲୀଳାବତୀ ଅଧ୍ୟାୟଟିରେ ପାଟୀଗଣିତ, ଜ୍ୟାମିତି, ଦ୍ୱିଘାତୀ ସମୀକରଣ, ପର୍ମ୍ୟୁଟେସନ,କମ୍ବିନେସନ ଓ କୁଟଟକ ପ୍ରାଣାଳୀ ଦିଆଯାଇଥିଲାବେଳେ ବୀଜଗଣିତ ଅଧ୍ୟାୟରେ ତ୍ରିଘାତୀ ଓ ଚତୁର୍ଘାତୀ ସମୀକରଣ ଗୁଡିକର ସମାଧନ ପ୍ରଣାଳୀ ସହିତ ଲିମିଟିଙ୍ଗ ପ୍ରକ୍ରିୟାରେ ଅନନ୍ତ ଶ୍ରେଣୀର ଯୋଗଫଳ ନିର୍ଣ୍ଣୟର କୌଶଳ ବର୍ଣ୍ଣିତ ଥିଲା। ଗୋଟିଏ ଦିବସର ଅବଧିକୁ ଅସଂଖ୍ୟ କ୍ଷୁଦ୍ରାଂଶରେ ବିଭକ୍ତ କରି ଯେ କୌଣସି ଦୁଇଟି ସନ୍ନିହିତ ଅଂଶ ଶେଷରେ କୌଣସି ଗ୍ରହର ନିରୀକ୍ଷିତ ଅବସ୍ଥାନ ଓ ଗ୍ରହଟିର ତତକାଳୀନ ଗତିବେଗ ନିରୂପଣକୁ ଆଧାର କରି ସେ ଅବକଳ କାଇକୁଲସର ଭିତ୍ତିଭୂମି ପ୍ରତିଷ୍ଠା କରିଥିଲେ। ତାଙ୍କର ଏହି ଇନଫିନିଟେସିମଲ ପ୍ରକ୍ରିୟାର ଧାରଣାକୁ ମଧ୍ୟଯୁଗୀୟ କେରଳ ସ୍କୁଲର ଗଣିତଜ୍ଞମାନେ ମାର୍ଜିତ ଓ ବିକଶିତ କରି କଳନ ଗଣିତ (calculus ) ଆବିଷ୍କାରର ପଥ ପରିଷ୍କାର କରି ଦେଇଥିଲେ।

ଭାସ୍କରାଚାର୍ଯ୍ୟଙ୍କ ପରବର୍ତ୍ତୀ ଦେଢଶହ ବର୍ଷ ଭାରତର ଗାଣିତିକ କ୍ଷେତ୍ର ଶୁଷ୍କ ଓ ଅନୁର୍ବର ଅବସ୍ଥାରେ ପଡିଥିଲା କହିଲେ ଚଳେ । ଚତୁର୍ଦ୍ଦଶ ଓ ପଞ୍ଚଦଶ ଶତାବ୍ଦୀରେ କେରଳ ଗଣିତ ସ୍କୁଲର ଗଣିତଜ୍ଞମାନେ ତାହାକୁ ପୁଣି ଉର୍ବର କରି ତାହାର ଉତ୍ପାଦିକା ଶକ୍ତି ଫେରାଇ ଆଣିଥିଲେ। ଖ୍ରୀ.ଅ 1340-1425 ରେ କେରଳର ସଙ୍ଗମ ଗ୍ରାମରେ ଜନ୍ମିତ ମାଧବ ସେହି ସ୍କୁଲର ସଂସ୍ଥାପନ କରିବା ଦ୍ୱାରା ସେଥିରୁ ଯେଉଁ ଗଣିତଜ୍ଞମାନେ ସୃଷ୍ଟି ହେଲେ ସେମାନଙ୍କ ମଧ୍ୟରେ ପ୍ରମୁଖ ଥିଲେ ନୀଳକଣ୍ଠ ସୋମୟାଜି, ପରମେଶ୍ୱର , ଦାମୋଦର, ଜ୍ୟେଷ୍ଠଦେବ ଇତ୍ୟାଦି। ମାଧବଙ୍କ ଗ୍ରନ୍ଥଗୁଡିକ ମୁଖ୍ୟତଃ ଜ୍ୟୋତିର୍ଗଣନା ବିଷୟକ ହେଲେ ବି ଗାଣିତିକ ଏନାଲିସିସର ପ୍ରବର୍ତ୍ତକ ଭାବେ ତାଙ୍କୁ ସମ୍ମାନ ଦିଆଯାଏ। ଇନଫିନିଟ ସିରିଜ, କଳନ ଗଣିତ, ତ୍ରିକୋଣମିତି, ଜ୍ୟାମିତି ଓ ବୀଜଗଣିତ କ୍ଷେତ୍ରରେ ବି ତାଙ୍କର ଉଲ୍ଲେଖନୀୟ ଅବଦାନ ରହିଛି। ଏହି ସ୍କୁଲର ଗଣିତଜ୍ଞମାନେ $\tan^{-1} x, \sin x, \cos x$ ଇତ୍ୟାଦିକୁ ପାୱାର ସିରିଜରେ ପ୍ରସାରଣ କରିବା ଜ୍ଞାନ ହାସଲ କରିଥିଲେ ଓ ଇନଫିନିଟ ସିରିଜର ଅଭିସରଣ ପ୍ରକ୍ରିୟା ବିଷୟରେ ସେମାନଙ୍କର ସ୍ପଷ୍ଟ ଧାରଣା ଥିଲା। ୟୁରୋପୀୟ ଗଣିତଜ୍ଞମାନେ ଏ ସମସ୍ତ ବିଷୟରେ ପ୍ରାୟ ଦୁଇ ଶହ ବର୍ଷ ପରେ ଚର୍ଚ୍ଚା ଆରମ୍ଭ କରିଥିଲେ, ଏକଥା ଭୁଲି ଆମେ ସେମାନଙ୍କୁ ଏହାର ଶ୍ରେୟ ଦେଉଛେ ଏହା ପଛରେ ଭାରତୀୟମାନଙ୍କ ଉଦାରତା ନା ହୀନମାନ୍ୟତା ରହିଛି ତାହା ବିଚାର କରିବାର କଥା ।

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ଟେଲି:୨୫୪୨୭୦୮

# ପଚଶ ପାହାଚ

ଗୋକୁଳାନନ୍ଦ ଦାସ

ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ସୁବର୍ଣ୍ଣ ଜୟନ୍ତୀ ଅଧିବେଶନ ଉପଲକ୍ଷେ ।

ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ସୁବର୍ଣ୍ଣ ଜୟନ୍ତୀ ଅଧିବେଶନ ଅନୁଷ୍ଠିତ ହେବାକୁ ଯାଉଛି ଜାନୁଆରୀ ୨୧-୨୨, ୨୦୨୩ ତାରିଖରେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଓ ପ୍ରୟୋଗ, ଅନ୍ଧାରୁଆ, ଭୁବନେଶ୍ୱର ଠାରେ ।

ଗଣିତ ସଂସଦ ନିର୍ମାଣ ସଂପର୍କରେ ଏକ ଅକୁହା କଥା ମୁଁ ପ୍ରକାଶ କରିବାକୁ ଯାଉଛି । ସେତେବେଳେ ମୁଁ ସମ୍ବଲପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟରେ ଥାଏ । ପ୍ରଫେସର ଶିବପ୍ରସାଦ ମିଶ୍ର ରିଜିଓନାଲ ଇଂଜିନିୟରିଙ୍ଗ କଲେଜ, ରାଉରକେଲାରେ ଥାଆନ୍ତି ଓ ବାରମ୍ବାର ସମ୍ବଲପୁର ଆସନ୍ତି ସମ୍ବଲପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟର ସିଣ୍ଡିକେଟ୍ ମିଟିଂରେ ଯୋଗ ଦେବାକୁ । ସେତେବେଳକୁ ଡକ୍ଟର ରାମ ନାରାୟଣ ମହାପାତ୍ର ସମ୍ବଲପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟରେ ଅଧ୍ୟାପକ ଥାଆନ୍ତି । ଆମେ ତିନିଜଣ ମାସରେ ଥରେ ନିଶ୍ଚିତ ଭେଟ ହେଉ ଓ ବିଭିନ୍ନ ଆଲୋଚନା ମାଧ୍ୟମରେ ଓଡ଼ିଶା ଗଣିତ ସଂସଦ ଗଠନ କରିବା ପ୍ରସଙ୍ଗ ଆସେ । ପ୍ରଫେସର ଶିବ ପ୍ରସାଦ ମିଶ୍ର ଦାୟିତ୍ୱ ନେଲେ ଏ ପ୍ରସ୍ତାବକୁ ଓଡ଼ିଶାର ସମସ୍ତ ଗଣିତ ଅଧ୍ୟାପକମାନଙ୍କୁ ଜଣାଇବାକୁ । ଠିକ୍ ଏହି ସମୟରେ ଉତ୍କଳ ବିଶ୍ୱବିଦ୍ୟାଳୟ ଗଣିତ ବିଭାଗର ପ୍ରଫେସର ଶଙ୍କର ପ୍ରସାଦ ମିଶ୍ର ଓଡ଼ିଶା ଗଣିତ ସଂସଦ ଗଠନ ବିଷୟରେ ଓଡ଼ିଶାର ସମସ୍ତ ଗଣିତ ଅଧ୍ୟାପକମାନଙ୍କୁ ଜଣାଇଦେଲେ । ଏ ସଂବାଦରେ ଆମେ ସମସ୍ତେ ଖୁସି ହେଲୁ ଓ ଏହି ଆନ୍ଦୋଳନରେ ଆମେ ସମସ୍ତେ ଝାସ ଦେଲୁ । ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ପ୍ରଥମ ଅଧିବେଶନ ହେଲା ଉତ୍କଳ ବିଶ୍ୱବିଦ୍ୟାଳୟର ଗଣିତ ବିଭାଗରେ । ଏହି ଅଧିବେଶନ ଉପଲକ୍ଷେ ମୁଁ Souvenir ପାଇଁ ଏକ ସନ୍ଧର୍ଭ ଲେଖିଲି । ଏହି ସନ୍ଦର୍ଭର କାମ ଥିଲା-

ଏହି ସନ୍ଦର୍ଭରେ ମୁଁ ଆହ୍ୱାନ ଦେଇଥିଲି ଯେ ଆମର ଗଣିତ ପାଠ୍ୟକ୍ରମ ଏତେ ପଛୁଆ ଯେ ଆମେ ଏହାକୁ ଯୁଗୋପଯୋଗୀ ନ କଲେ ଭବିଷ୍ୟତ ବଂଶଧରମାନେ ଆମକୁ କ୍ଷମା ଦେବେ ନାହିଁ ।

ଏହି ଅଧିବେଶନରେ ମୁଁ ମଧ୍ୟ କହିଥିଲି- "A case against Euclid" ଏହି ଭାଷଣରେ ମୁଁ ଦର୍ଶାଇଥିଲି ଯେ ଇଉକ୍ଲିଡ଼ "ବିନ୍ଦୁ"ର ସଂଜ୍ଞା ପ୍ରକରଣ କରି କିପରି ବୃତ୍ତୀୟ ଦୋଷ (fallacy of circle) ରେ ପିଡ଼ିତ ହୋଇଛନ୍ତି, ତାହା କିପରି ଦୂରୀକରଣ କରାହେବ ଓ ଜ୍ୟାମିତି ପାଠ୍ୟକ୍ରମ କିପରି ତ୍ରୁଟିମୁକ୍ତ ହେବ ।

ପ୍ରଫେସର ତ୍ରିବିକ୍ରମ ପତି ଯେତେବେଳେ ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ସଭାପତି ଥିଲେ, ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଓ ପ୍ରୟୋଗ ପ୍ରତିଷ୍ଠା ପାଇଁ ସେ ବାରମ୍ବାର ଓଡ଼ିଶା ସରକାରଙ୍କ ସହିତ ଆଲୋଚନା କରିଥିଲେ ଯାହା ଫଳରେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଜନ୍ମ ସମ୍ଭବ ହେଲା । ସେତେବେଳେ ବିଜୁପଟ୍ଟନାଏକ ଓଡ଼ିଶାର ମୁଖ୍ୟମନ୍ତ୍ରୀ, ପ୍ୟାରୀମୋହନ ମହାପାତ୍ର ତାଙ୍କର ବ୍ୟକ୍ତିଗତ ସଚିବ, ଅଭୟ ରଥ ଶିକ୍ଷା ବିଭାଗ ସେକ୍ରେଟାରୀ ଓ ସୁବାସ ପାଣି ବିଜ୍ଞାନ ଓ କାରୀଗରୀ ବିଦ୍ୟା ବିଭାଗର ସେକ୍ରେଟାରୀ । ସରକାରଙ୍କର ଏହି ପ୍ରତିନିଧିମାନଙ୍କ ସହିତ ଆଲୋଚନାରେ ଯୋଗ ଦେଇଥିଲୁ । ଆମେ : ମୁଁ, ପ୍ରଫେସର ଶିବ ପ୍ରସାଦ ମିଶ୍ର ଓ ପ୍ରଫେସର ତ୍ରିବିକ୍ରମ ପତି । ଏହି ଆଲୋଚନାରେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଗଠନର ସିଦ୍ଧାନ୍ତ ହେଲା ଓ ଏହା ବିଜ୍ଞାନ ଓ କାରୀଗରୀ ବିଦ୍ୟା ବିଭାଗ ଅଧିନରେ କାମ କରିବ ।

ସେହି ସମୟରେ ବାଣୀବିହାରରେ ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ଅଧିବେଶନ ହେବାର ଥାଏ । ବିଜୁବାବୁ ଏହାକୁ ଉଦ୍‌ଘାଟନ କରିବାକୁ ସମ୍ମତି ଦେଇଥିଲେ । ମୁଁ "ଗଣିତରାଣୀ" କବିତା ଲେଖିଥିଲି ସେହି ଅଧିବେଶନରେ ପ୍ରାରମ୍ଭିକ ସଂଗୀତ ହିସାବରେ ପରିବେଷଣ କରିବାକୁ । କିନ୍ତୁ ଦୁଃଖର ବିଷୟ ମୁନିସିପାଲିଟି ନିର୍ବାଚନ ଥିବାରୁ ବିଜୁବାବୁ ଆଉ ମିଟିଂକୁ ଆସି ପାରିଲେ ନାହିଁ ଓ ଗଣିତ ପ୍ରତିଷ୍ଠାନ କଥା କହି ପାରିଲେ ନାହିଁ ।

ବିଜୁବାବୁଙ୍କ ପରେ ଜାନକୀବାବୁ ମୁଖ୍ୟମନ୍ତ୍ରୀ ହୋଇ ଆସିଲେ ଓ ଫାଇଲ୍‌ରେ ଲେଖିଦେଲେ ଯେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ବର୍ତ୍ତମାନ ପାଇଁ ସ୍ଥଗିତ ରହୁ । ଜାନକୀବାବୁଙ୍କ ପରେ ମୁଖ୍ୟମନ୍ତ୍ରୀ ହେଲେ ଗିରିଧର ଗମାଙ୍ଗ ଓ ସେହି ସମୟରେ ଗଣିତ ପ୍ରତିଷ୍ଠାନର ଜନ୍ମ ହେଲା ୧୯୯୯ ମସିହାରେ । ଏଥିପାଇଁ ଏକ ଛୋଟ ସମାରୋହ ହୋଇଥିଲା ପ୍ଲାନେଟାରିୟମ ପରିସରରେ ।

ଗଣିତ ପ୍ରତିଷ୍ଠାନର ଡାଇରେକ୍ଟର କିଏ ହେବ ? ସେତେବେଳେ ମୁଁ ଉତ୍କଳ ବିଶ୍ୱବିଦ୍ୟାଳୟରକୁଳପତି । କୌଣସି କାରଣରୁ ମୁଁ ସେକ୍ରେଟାରିଏଟ ଯାଇଥିଲି ମୁଖ୍ୟ ଶାସନ ସଚିବ ସୁଧାଂଶୁ ମିଶ୍ରଙ୍କୁ ଭେଟିବାକୁ । ସେ ମୋତେ ଦେଖି ସାଙ୍ଗେ ସାଙ୍ଗେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଫାଇଲ ମଗାଇଲେ ଓ ଗଣିତ ପ୍ରତିଷ୍ଠାନର ଡ଼ାଇରେକ୍ଟର କିଏ ହେବ ସେ ପ୍ରସଙ୍ଗ ଉଠାଇଲେ । ମୁଁ ସ୍ୱାଧୀନର ନାମ କହିଲି ଓ ସଙ୍ଗେ ସଙ୍ଗେ ରାଜି ହୋଇ ଓ ଏ କଥା ଫାଇଲରେ ଲିପିବଦ୍ଧ କରି ଫାଇଲ୍ ଫେରାଇଦେଲେ । ସ୍ୱାଧୀନ ସେତେବେଳେ ସମ୍ବଲପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟରେ ପ୍ରଫେସର ।

ସ୍ୱାଧୀନ ଗଣିତ ପ୍ରତିଷ୍ଠାନର ଡ଼ାଇରେକ୍ଟର ପଦବୀରେ ଯୋଗ ଦେବା ବେଳକୁ ଶ୍ରୀଯୁକ୍ତ ନବୀନ ପଟ୍ଟନାୟକ ଓଡ଼ିଶାର ମୁଖ୍ୟମନ୍ତ୍ରୀ ।

ଗଣିତ ପ୍ରତିଷ୍ଠାନ ପ୍ରତିଷ୍ଠା ହେବାର କିଛି ବର୍ଷ ପରେ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ଉପରେ କଳାବାଦଲ ଢାଙ୍କି ହୋଇଗଲା । କେତେ ଜଣ ଚେଷ୍ଟା କଲେ ଏହାକୁ Indian Statistical Institute (ISI) କଲିକତାକୁ ହସ୍ତାନ୍ତର କରିଦେବାକୁ । ଏହାର ତୀବ୍ର ବିରୋଧ ହେଲା; ଗଣିତ ସଂସଦ ଅଧିବେଶନରେ ମଧ୍ୟ । ଫଳରେ କଳାବାଦଲ ଭାସିଗଲା । ବର୍ତ୍ତମାନ ଗଣିତ ପ୍ରତିଷ୍ଠାନ ସଗର୍ବରେ ଅନ୍ଧାରୁଆରେ ଓଡ଼ିଶା ଗଣିତ ସଂସଦର ସୁବର୍ଣ୍ଣ ଜୟନ୍ତୀ ପାଳନ କରିବାକୁ ଯାଉଛି ଆସନ୍ତା ଜନୁଆରୀ ୨୧-୨୨, ୨୦୨୩ ମସିହାରେ ।

ସ୍ୱାଗତମ୍, ଅଭିନନ୍ଦନ ।

# Principle of Duality

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"Mathematics is the most beautiful and the most powerful creation of the human spirit", said Stefan Banach, Polish mathematician. "Mathematics allows for no hypocrisy and no vagueness", said Stendhal, a French writer of 19th century. Patience is created by solving mathematics. Patience is the foundation for achieving any goal. A discipline and civilized society is developed using mathematics. Mathematics makes every subject and society beautiful.

Ramakrishna Paramhamsa said, Protect the plant from the herd of goats by fencing around the orchard for the growth of the plant. After the growth of the plant, the herd of goats will take rest under the tree and live happily taking the branches of the tree.

In the same way, preserve the outcome of basic research in mathematics to be used as per our requirement to live happily.

The principle of duality is an important concept that appears in mathematics, physics, engineering, statistics, managerial decision-making and many other different places & contexts. Some simple illustrative examples are given only.

A finite man has infinite thoughts. A mortal man has immortality. . How high a person may be ! defects are there. Virtues and vices coexist within man. (finite, infinite), (mortal, immortal), (defect, non-defect) and (virtues, vices) are some dualities. These show that duality exists within a person. Peace and war, love and hate, up and down, black and white, dark and light, truth and false, join and meet, AND andOR , 0 and 1 are also duals.

In the United States, all passenger cars have the driver's seat at the left front. The following traffic regulations are observed :

Cars always travel on the right side of a street.
On a multilane divided highway, left lanes are passing lanes.
Cars may make right turns at a red light.

However, since all passenger cars in England ( same rule in India also)have the driver's seat at the right front, the following traffic regulations are observed:

Cars always travel on the left side of a street.
On a multilane divided highway, right lanes are passing lanes.
Cars may make left turns at a red light.

It is noted how the concepts of left and right can be interchanged in these two situations so that meaningful traffic rules in the United States become meaningful traffic rules in England, and conversely. These concepts of left and right are dual concepts.

There is a Chinese fiction called "Flowers in the Mirror". The original title is "Ching Hua Yuan". It was written by Li Ju-Chen (1763-1830). An English translation by Lin Tai-Yi was published by the University of California Press, 1965. In this fiction, there was a country called The Land of Gentlemen. The following conversation is a typical example of the behavior of its people.

Customer : I want to buy this vase. It is most beautiful.
Storekeeper : The vase does not really look that good. Please note that there are some defects in the paint job.
Customer : You would not call these defects ,would you ? The vase is a perfect piece of art work. How much do you want for it ?
Storekeeper : Usually, I will sell a vase like this for $10 . Since you have been a good customer of ours for many years, I will sell it for$15 .

Customer :$15 is too low. I cannot allow myself to take advantage of you. How about $20.
Storekeeper : I would be making a good profit at $15 .Since you insist, let us agree on $16.
Customer : My wife will complain that I do not pay enough for things I buy. However, I am willing to buy the vase at $18.

The author has described it taking the stuck of the situation of an indiscipline and disorder society at that time of crime and murder to reform the mind of the people. Many concepts in business bargaining in The Land of Gentlemen are opposite to those we are more accustomed to. The pairs of concepts of high and low prices, profitable and non-profitable business transactions, good and bad quality of work are some examples of pairs of dual concepts in the subject. In electrical engineering, the concepts of voltage and current, resistance and conductance, inductance and capacitance are dual concepts. In graph theory, the concepts of circuit and cut-set, tree and co-tree , maximizing and minimizing in Operation Research problems are dual concepts. In analysis we face dual spaces. The duality principle solves the problem easily. In De Morgan's Laws and LP problem duals are given below

**De Morgan's laws :** For any $a$ and $b$ in a Boolean algebra

$\overline{a \vee b} = \bar{a} \wedge \bar{b}$ (1) and $\overline{a \wedge b} = \bar{a} \vee \bar{b}$ (2)

we say

(2) $\overline{a \wedge b} = \bar{a} \vee \bar{b}$ follows from (1) by the principle of duality. i.e (2) is the dual of (1) .

(1) $\overline{a \vee b} = \bar{a} \wedge \bar{b}$ follows from (2) by the principle of duality. i.e (1) is the dual of (2) .

In Linear Programming(LP) Problem dual can be expressed from the primal as follows

| **Primal** | **Dual** |
|---|---|
| $Max\ z_x = \sum_{j=1}^{n} c_j x_j$ | $Min\ z_y = \sum_{i=1}^{m} b_i y_i$ |
| Subject to the constraints | Subject to the constraints |
| $\sum_{j=1}^{n} a_{ij} x_j \le b_i ; i = 1,2,\ldots,m$ | $\sum_{i=1}^{m} a_{ji} y_i \le c_j ; j = 1,2,\ldots,n$ |
| $a_{ij} = a_{ji}$ | |
| and $x_j \ge 0$ ; j = 1,2,…, n | and $y_i \ge 0$ ; i = 1,2,…, m |
| | Here $b_i$ ; $a_{ji}$ ; $c_j$ ; i=1,2,…m ; j=1,2,…n are taken from Primal problem |

Reference : Elements of Discrete Mathematics; C. L. Liu , second edition, Mc Graw Hill Publication

# ଚାରିର ମହତ୍ତ୍ୱ

ପ୍ର. ଡଃ. ସ୍ମୃତି ମହାନ୍ତି

ଚାରି, ପ୍ରଥମ ଯୌଗିକ ସଂଖ୍ୟା
ମିଶାଣ, ଗୁଣନ ଦୁଇ ଦୁଇରେ,
ଚାରି ଦଳରେ କେତେଯେ ଖେଳ
ଭାରି ମଜା ହୁଏ ଲୁଡୁ ପାଲିରେ (୧)

ବ୍ରହ୍ମାଙ୍କର ଚାରି ମସ୍ତକ
ମୁଖରୁ ନିଃସୃତ ଚାରୋଟି ବେଦ,
ଋଗ୍, ସାମ୍, ଯଜୁର୍, ଅଥର୍ବ
ହିନ୍ଦୁ ଧର୍ମର ଅମୂଲ୍ୟ ସମ୍ପଦ (୨)

ଜୀବନକୁ ଆମେ ବିବାଜିତ କରି
ପାଇଛୁ ପରା ଚାରି ଅବସ୍ଥା,
ଶୈଶବ, କିଶୋର, ଯୁବକ, ବୃଦ୍ଧ
ସେହି ଅନୁସାରେ କରୁ ବ୍ୟବସ୍ଥା (୩)

ଜୀବନ ଗତିର ଚାରି ସୋପାନ
ବ୍ରହ୍ମଚର୍ଯ୍ୟ, ଗ୍ରାହସ୍ଥ୍ୟ, ବାନପ୍ରସ୍ଥ, ସନ୍ୟାସ,
ସୋପାନ ଭିତ୍ତିକ କାର୍ଯ୍ୟକ୍ରମ କଲେ
ପ୍ରସ୍ଫୁଟିତ ହେବ ହର୍ଷ ଉଲ୍ଲାସ (୪)

ଶିକ୍ଷା, ସୁରକ୍ଷା ଦେଉଥା'ନ୍ତି ସଦା
ପିତା, ମାତ, ଗୁରୁ, ଈଶ୍ୱର,
ଏଇ ଚାରିଜଣ ଥା'ନ୍ତି ଚାରି ପାର୍ଶ୍ୱେ
ତାଙ୍କ ପାଦତଳେ କରୁ ଜୁହାର (୫)

ଶରୀର ତତ୍ତ୍ୱରେ ଚାରୋଟି ସତ୍ତା
ଶରୀର, ହୃଦୟ, ମନ, ଚେତନ,
ଚାରିଗୋଟି ମୁଖ୍ୟ ଧର୍ମଗ୍ରନ୍ଥ ଆମ
ରାମାୟଣ, ମହାଭାରତ, ଉପନିଷଦ, ପୁରାଣ (୬)

ଚାରୋଟି ମହାନ ବିଶ୍ୱବାଣୀ ଅଛି
ସଭିଙ୍କର ନିତ୍ୟ ଅପରିହାର୍ଯ୍ୟ,
'ଓମ୍ ଶାନ୍ତି', 'ବସୁଧୈବ କୁଟୁମ୍ବକମ୍'
'ସର୍ବେ ଭବନ୍ତୁ ସୁଖିନଃ', 'ଅହିଂସା ପରମଧର୍ମ' (୭)

ଚାରୋଟି ଦିଗର ବ୍ୟବହାର ଆମ
ପୁର୍ବ, ପଶ୍ଚିମ, ଉତ୍ତର, ଦକ୍ଷିଣ,
ସତ୍ୟ, ତ୍ରେତୟା, ଦ୍ୱାପର, କଳି
ଏ ଚାରି ଯୁଗ ସୃଷ୍ଟି ଚକ୍ରର (୮)

ପଦାର୍ଥର ଚାରି ମୌଳିକ ବଳ
ମାଧ୍ୟାକର୍ଷଣ, ବିଦ୍ୟୁତଚୁମ୍ବକୀୟ,
ଆଉ ଦୁର୍ବଳ, ସବଳ ଦୁଇ ପରମାଣୁ ବଳ
ବିଜ୍ଞାନର ପରା ଆମେ ପୂଜକ (୯)

# ଗଣିତର ଜୟଗାନ

ଡ. ହାଡିବନ୍ଧୁ ପଟ୍ଟନାୟକ

ସର୍ବ ଶାସ୍ତ୍ର ମଧ୍ୟେ ଗଣିତ ସାଧନ
ପାଇଛି ସ୍ଥାନ ଉର୍ଦ୍ଧ୍ୱରେ
ଅଭ୍ୟାସ ସାହସ ଶ୍ରଦ୍ଧା, ଧୈର୍ଯ୍ୟ, ବୁଦ୍ଧି
ଅଧ୍ୟବସାୟ ବଳରେ ।
କୁଟିଳ ଜଟିଳ ଯେତେଜ ସମସ୍ୟା
ଉପୁଜେ ଏହି ସଂସାରେ
ସମାଧାନ ସବୁ ହୁଅଇ ସମ୍ଭବ
ଗଣିତ ବିଦ୍ୟା ବଳରେ ।
ଭାରତୀୟ ଗଣିତଜ୍ଞଙ୍କ କୃତିରେ
ପୂର୍ଣ୍ଣ ପଣିତ ଭଣ୍ଡାର
ବୈଦିକ ଗଣିତ ଆର୍ଯ୍ୟଭଟ୍ଟ ଶୂନ
ବିଶ୍ୱେ ପାଇଛି ଆଦର ।
ଆର୍ଯ୍ୟଭଟ୍ଟ ବ୍ରହ୍ମଗୁପ୍ତ ଶତାନନ୍ଦ
ଶଙ୍କରାଚର୍ଯ୍ୟ ମାଧବ
ଭାସ୍କର, ଶ୍ରୀଧର ବରାହ ମିହିର
ରାମାନୁଜନ ପଲ୍ଲବ ।
ଭାରତ ମାତାର ସୁଯୋଗ୍ୟ ସନ୍ତାନ
ବିଶ୍ୱେ ହୁଅନ୍ତି ବନ୍ଦିତ
ଶୂନ୍ୟରୁ ପୂର୍ଣ୍ଣତା ନିର୍ମୋହ ଦିବ୍ୟତା
ସତ୍ୟ ମୋକ୍ଷ ବିମଣ୍ଡିତ ।
ଗଣିତ ସଂଗୀତ ସଂସ୍କୃତ ଶାସ୍ତ୍ରରେ
ସର୍ବଦା ଥାଉ ଆଦର
ଏ ତିନି ବିଦ୍ୟାକୁ କରିଣ ସାଧନ
ଜୀବନକୁ ଧନ୍ୟକର ।

ଗଣିତ ପାଠଟି ମାତୃ ଗର୍ଭୁଜାତ
ଶ୍ମଶାନ ଯାଏ ଜାଗ୍ରତ
ଗଣିତ ବିଦ୍ୟାର ମୂଲ୍ୟବାଦ ଦାନ
ଏହାକୁ କରେ ଶାଣିତ ।
ମିଥ୍ୟା, ମୁଦ୍ରା, ମଦ ମୋହ ମାତ୍ସର୍ଯ୍ୟରୁ
ଗଣିତ ରୁହେ ଦୂରରେ
ସତ୍ୟ ଧର୍ମ ପ୍ରେମ ଶାନ୍ତି ଓ ଅହିଂସା
ଉପଲବ୍ଧ ଗଣିତରେ ।
ପାଞ୍ଚରୁ ପନ୍ଦର ଶତାବ୍ଦି ଅଟଇ
ଗଣିତ ସୁବର୍ଣ୍ଣ ଯୁଗ
ଅଜ୍ଞାତିତ ଭାବେ ଗଣିତ ତତ୍ତ୍ୱକୁ
ବାଣ୍ଟିଲେ ନକରି ଭୋଗ ।
ଥାଇ ଧନ ଜ୍ଞାନ ନାହିଁ ସେ ସାଧନ
ଗଣିତର ତତ୍ତ୍ୱଜ୍ଞାନ
ଗଣିତେ ଉତ୍କର୍ଷ ହେଉ ନାହିଁ ଆଉ
ଯେଣୁ ନାହିଁ ପ୍ରୋତ୍ସାହନ ।
ପୃଥିବୀର ପ୍ରତି କୋଣେ ଅନୁକୋଣେ
ଗଣିତର ଜୟଗାନ
ଗଣିତ ତତ୍ତ୍ୱର ବିନା ପ୍ରୟୋଗରେ
ସମସ୍ତ ବିଦ୍ୟା ଶ୍ରୀହୀନ ।
ଯେ ଦେଶ ଦେଇଛି ଗଣିତ ଶାସ୍ତ୍ରକୁ
ଯେତିକି ଅଗ୍ରାଧିକାର ।
ସେହି ଦେଶ ଅଟେ ସେତିକି ଉନ୍ନତ
ସମୃଦ୍ଧ ଓ ଆଗୁସାର ।

# Memorial Talks

## MEMORIAL LECTURE

### Well balanced higher order Godunov type numerical methods for a model of granular flow.

**Veerappa Gowda**

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**Abstract**

We propose and analyze second order finite volume Godunov type methods based on discontinuous flux for a $2 \times 2$ system of non-linear partial differential equations proposed by Hadeler and Kuttler to model the dynamics of growing sand piles generated by a vertical source on a flat bounded rectangular table. The scheme is made well-balanced by modifying the flux function locally by including source term as a part of the convection term. Numerical experiments are presented to illustrate the efficiency of the second order scheme for both open table and partially open table problem by comparing with first order scheme. This is a joint work with Aekta Aggarwal and Sudarshan Kumar.

### Solving Stochastic Variational Inequalities with Mirror-Proximal Algorithm and Derivative-Free Descent Methods with Applications in Machine Learning

**O. Chadli and Ram N. Mohapatra**

Department of Mathematics, University of Central Florida, Orlando, Florida, USA.

**Abstract**

In this talk, we present a novel method for solving a monotone class of Stochastic Variational Inequalities. In our approach, we propose an algorithm combining the mirror-proxmethod and a free-derivative descent method through a compatible regularized D-gap function corresponding to the standard optimality criteria in the aforementioned problem. Our algorithmdoes not require prior knowledge about smoothness/ nonsmoothness and the noise properties ofthe problem. Optimal error bounds are obtained and an application to an overlapped group lassoproblem is provided.

## The origin of Stochastic Differential Equations and their applications

**Mahendra Nath Mishra**

The origin of the Brownian motion and subsequent studies by Bachelier, Eienstein and Wiener have been discussed. Since this phenomena does not explain the physical motion, Paul Langevin tried to describe the physical motion by a Stochastic Differential Equation. Later Stochastic Differential Equation was developed in a new setting by $K$. Itô and now-a-days it has applications in various branches of Science and Technology.

## Language

**Prof. Gokulananda Das**

Ex-VC, Utkal University, Bhubaneswar

# Invited Talks

## Invited Talks

### Homogeneous operators

**Prof. Gadadhar Misra,**

Department of Mathematics, Indian Institute of Science (IISc.) Bangalore, India

Homogeneous operators are bounded linear operators with the property: g(T) isunitarily equivalent to T for all bi-holomorphic (Mobius) maps of the unit disc. It thenfollows that the spectrum of the operator T can only be either the closed unit disc or the unit circle. We will discuss a template for finding homogeneous operators anddiscuss some of the properties of operators in this class.

### Best Approximation and Optimization

**Prof. Chandal Nahak**
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India-721302
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**Abstract**

For some time, the approximation and optimization theories have developedindependently in parallel. In 1960's, it was observed that optimization, i.e., theproblem of extremization (min or max) of a function contains approximations asa special case. Indeed, the approximation is the minimization or maximizationof a particular function on a normed linear space $(X, ||.||)$, namely, the function

$$f(x) = ||x_0 - x_k||, x \in X.$$

This talk discusses the bridge and relationship between the said problems.

### Unconditionally Stable Operator Splitting Method for 2D Telegraph Model Equation with Unequal Mesh Size Discretization

**R.K. Mohanty**

Department of Applied Mathematics,South Asian University
Akbar Bhawan, Chanakyapuri, New Delhi -110021, India

**Abstract**

An unconditionally stable operator splitting method of order (2,4) is proposed for 2D Telegraph model equation with unequal mesh size discretization. We use two-parameter mesh ratios and discuss a new 3-level compact implicit method of order (2,4) for the solution of 2D nonlinear hyperbolic partial differential equations. The numerical approximation at

first time level is concisely discussed. Various benchmark problems are solved to confirm the usefulness of the proposed discretization.

## Modeling of Hydrodynamic Instability in a layered Channelflow with chemical reaction

**Manoranjan Mishra**
Department of Mathematics,Indian Institute of Technology Ropar, Rupnagar, Punjab, 140001, India.

### Abstract

Hydrodynamic instabilities in a viscously stratified flow has gained significant attention in the scientificcommunity for its applications in industries andenvironments. Viscous fingering(VF) instability occurswhen a less viscous fluid tries to push a more viscous one in the porous media or Hele-Shaw cell, where theflow equations are known as Darcy's law. Far from Darcy's flow regime, i.e., in a pressure-driven flowgoverned by the Navier-Stokes equations, we show that a vertical viscosity stratification at alocalizedregion caused by a chemical reaction of A+ B→C type yields an inconspicuous shear layer. A chemo-hydrodynamic Kelvin–Helmholtz instability or cat-eye-shaped morphology develops at one reaction front,while the other front diffuses steadily over time. The governing equationsbecome a set of coupled non-linear PDEs of convection-diffusion-reaction type, which are solved using a diffuse interface finite volumemethod with WENO. Depending upon the product's viscosity, K-H billows occur at either A-C or C-Breaction front. Further, the onset times of Instability () that are found through direct numerical simulationsfor various governing non-dimensional parameters such as the mobility ratio (), Damköholer number (),Péclet number (), and Reynolds number () will be presented.

## Area of regions and unsolved issues in analytical function theory

**Swadesh Kumar Sahoo**
Indian Institute of Technology Indore
swadesh.sahoo@iiti.ac.in

### Abstract

We will consider one-one (univalent) analytic functions in the unit disk $|z| < 1$ having Taylor's series expansion of the form

$$f(z) = z + a_2 z^2 + a_3 z^3 + \cdots, |z| < 1.$$

One of the most well-known issues relates to the category of analytic functions

f on |z| < 1 with finite Dirichlet integrals Δ(1, f), where

$$\Delta(r,f) = \iint_{|z|<r} \left|\frac{\partial(u,v)}{\partial(x,y)}\right| dx\,dy = \iint_{|z|<r} |f'(z)|^2\,dx\,dy \quad (0 < r \leq 1)$$

$$(z = x + iy, f = u + iv)$$

represents the area of the image domain f(|z| < r). When f ranges across

any traditional analytic functions having geaometric features, we estimate areas

of type Δ(r, z/f). This includes a conjecture of Yamashita from 1990 that M.

Obradovi´c, S. Ponnusamy, and K.-J. Wirths solved in 2013.

The famous Bieberbach conjecture, which was presented in 1916 and solved

by de Branges after 68 years, states that if $f(z) = z + a_2z^2 + a_3z^3 + \cdots$ is analytic and one-one in |z| < 1, then $|a_n| \leq$ n for all n ≥ 2.

We will wrap off the discussion with some relevant open problems.

## True-pairs of real linear operators - an intrinsic proof

**Arindama Singh**
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https://home.iitm.ac.in/asingh

**Abstract**

A linear operator on a finite dimensional nonzero real vector space may not have an eigenvalue. However, corresponding to each such operator $T$, there exists a pair of real numbers $(\alpha,\beta)$ and a nonzero vector $v$ such that $[(T-\alpha I)^2+\beta^2 I](v)=0$. This can be proved by using the Fundamental theorem of algebra, Cayley-Hamilton theorem, and/or complexification. We construct an inductive proof of this fact, where we do not use even the complex numbers. From this we deduce that a polynomial with real coefficients can be written as a product of linear factors and quadratic factors with negative discriminant. It thus gives a proof of the latter fact about polynomials with real coefficients, which does not use complex numbers, thereby solving an open problem raised earlier.

## Fractal Interpolation Functions for Noisy Data Sets

**A. K. B. Chand, Mohit Kumar, Neelesh S Upadhye**
Department of Mathematics, IIT Madras.
Email: chand@iitm.ac.in

**Abstract**

Fractal interpolation is a modern technique to capture non-linearity associated with variousscientific experiments and natural phenomena. Linear fractal interpolation functions (FIFs) arethe simplest functions to capture such non-linearity associated with any data

generatingfunction. The explicit form of linear FIF is derived at an arbitrary point in the domain. In thiswork, we estimate probability distributions of linear FIFs for data sets with Gaussian, Cauchy,Students-t and stable noises. We also provide some statistical properties and real lifeapplications of these linear fractal functions. Further, we provide the extension of the presentsetting to the recurrent FIFs.

## Through Eyes of Feedback Control: How does External Stimulus Influence Research in Applied Mathematics

**Amiya KumarPani**

Department of Mathematics, BITS-Pilani, K.K.Birla Goa Campus,
Zuarinagar,Goa
Email: amiyap@goa.bits-pilani.ac.in

### Abstract

Starting with Engineering way of looking at stabilization of Viscous Burger's equation through feedback control laws, I plan to explain what kind of Mathematical questions involving both theoretical and computational issues throw by such problems. While explaining the possible answers, my objective is to highlight `How do such answers help the user community?The second part of the talk deals with objective of Computational PDEs, and it examines some numerical experiments using a proposed finite element algorithm. In order provide some mathematical justifications as to why numbers crunched by the said algorithm make sense, we discuss some global stabilization results for the viscous Burgers equation, say, around constant steady state solution using nonlinear Neumann boundary feedback laws. The feedback laws are derived using classical approach of finding Lyapunov functional. Then, using conforming finite element, a priori error estimates for the state variable as well as for feedback control laws are established, which in turn repose faith on the numbers crunched by the proposed algorithm. This talk is concluded with some related problems.

## Mathematical challenges in the blocking dynamics of flexural gravity waves - an overview

**Trilochan Sahoo**

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### Abstract

The area of wave-structure interaction is a major branch of fluid mechanics and assumes significant importance due to its wide range of applications in Marine Technology and Arctic Engineering in the context of global warming. This interdisciplinary branch embodies the basic equations of fluid mechanics, structural mechanics, and concepts of wave propagation. In the last two decades, there is a wide interest to understand wave interaction with floating and submerged flexible structures which are used for various activities in the marine environment. There is a parallel interest in analyzing wave interaction with large floating ice sheets, which are also modelled as very large floating structures and are of significant importance in the ice-covered ocean in the polar region. In many situations, these structures

are considered to be flexible, and hydroelastic analysis is made to analyze several hydrodynamic characteristics of these structures. In the hydroelastic analysis of floating structures, the physical issues give rise to boundary value problems or initial boundary value problems that are not of the classical Sturm-Liouville type and are connected to the Laplace or Helmholtz equation satisfying certain higher-order boundary conditions at one or more of the boundaries. In addition to having higher-order boundary conditions, there can be a change in the material properties of the medium, which gives rise to singularities at interface boundaries. In the recent decade, the study on flexural gravity wave blocking has taken on a particular relevance due to the occurrence of multiple propagating waves within the limits of blocking frequencies and coalescence of the propagating wave modes at blocking and saddle points. In the context of the present talk, an overview of the generalization of various canonical mathematical techniques for dealing with wave-structure interaction problems from the perspective of blocking dynamics will be discussed via a class of physically plausible issues emerging in maritime technology and polar engineering.

## Weighted Inequality: Recent developments

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### Abstract

Weighted inequality for singular integral says a singularintegral is limited by a constant times a weighted integral. The weight inthis case is a non-negative function that changes the integral.Muckenhoupt weights are a type of weight function that is used to studyweighted inequalities for singular integrals. Basically, the weightfunction does not grow too quickly ortoo slowly in any area. In recentyears, one of the most important areas of research has been to describethe sharp weighted bounds for singular integral operators and to study howthe bounds depend on the properties of the space and the weight function.In this overview talk, Iwill try to give a taste of it.

# Binary and Higher Order Recurrent Sequences: An Overview

**Prof. Prasanta Kumar Ray**

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**Abstract**

A linear recurrent sequence is an infinite sequence of numbers whose $n$-th term can be obtained by the linear combination of its previous $k$ terms. This $k$ (not depending on $n$) is called the order of the recurrent sequence. For $k = 2$, it is called a binary recurrent sequence and for more than 2 these sequences are called higher order recurrent sequences. There are many results available in the literature involving binary recurrent sequences like Fibonacci, Lucas, Pell, Balancing sequences etc., and ternary recurrent sequences like Padovan, Perrin, Narayana Cow's sequences etc..

To study the intersection of two sequences or to write the terms of one sequence by the arithmetic expressions of other sequence draw attention of many researchers in recent past While searching Fermat numbers in Narayana Cow's sequence, it is shown that the only Fermat number is it's fifth term 3 . In the authors showed that repdigits that can be expressed as difference of two Fibonacci numbers are $11, 33, 55, 88$ and 555 and for Lucas numbers they are $11, 22$ and 44. Further, it is also observed that, the $11^{th}$ and $20^{th}$ terms of the Perrin sequence and the $14^{th}$ and $17^{th}$ terms of the Narayana Cow's sequence are expressible as sum of two repdigits Many results on Diophantine properties of recurrent sequences have been proved with the use of refined tools like Matveev's Theorem, LLL Algorithm, Baker Davenport's reduction Methods etc.. Special attention is given on how to represent the terms of a recurrent sequence as concatenations of terms of other sequences

Researchers are also focused on finding various multiplicative relations among the recurrent sequences having many terms all with small prime factors. A vector $v = (v_1, v_2, \cdots, v_n) \in \mathbb{C}^n$, is multiplicatively dependent if either one of the $v_i$'s equal to zero or there exist integers $k_1, k_2, \cdots, k_n$ not all zero satisfying the multiplicative relation

$$\prod_{i=1}^{n} v_i^{k_i} = 1.$$

Otherwise, $v$ is called multiplicatively independent. Using the idea of multiplicative relations, Wirsing and Schinzel proved that, some partition numbers $p(n)$ have large prime factors. Luca et. al. used it to give an explicit lower bound on the number of irregular primes $p \leqslant x$. These results attract many researchers to investigate the multiplicative relations in different recurrent sequences. For example, Carmichael showed that after $12^{th}$ number of terms, all the terms of the Fibonacci sequence have a primitive divisor. This means any two Fibonacci numbers with indices grater than equal to 13 are multiplicatively independent.Some researchers are also searching multiplicative dependent $k$-tuples with coordinates involving different recurrent sequences.

## Tensor Computations for Data Science

**Dr. Ratikanta Behera**
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Indian Institute of Science, Bangalore, India.

**Abstract**

In the era of BIG data, artificial intelligence, and machine learning, we are faced with the need to process multiway (tensor-shaped) data. These data are mostly in the three or higher-order dimensions, whose orders of magnitude can reach billions. Huge volumes of multidimensional data are a great challenge for processing and analysing; the matrix representation of data analysis is not enough to represent all the information content of the multiway data in different fields. In this talk, we will discuss a closed multiplication operation between tensors with the concept of transpose, inverse, and identity of a tensor. Then we will discuss a colour image deblurring problem and the solution to the Poisson problem in a tensor-structure domain.

## Application of Mathematical Modeling in Sciences.

**Dr Bigyani Das**
Dayton, Maryland

**Abstract**

In this talk, general application of mathematical modeling in sciences will be presented. Specifically, the application in biomedical engineering and remote sensing will be discussed. All of the natural sciences are governed by specific laws that can be described by mathematical formulation. In biomedical engineering, the Navier-Stokes equation of fluid dynamics is applied to model the blood flow phenomena. The aggregation and disaggregation of red blood cells are governed by constitutional formulation which are used to analyze the non-Newtonian nature of blood flow in microvessels. In remote sensing, the raw data obtained by the sensors in satellites are being analyzed through mathematical modeling to be converted into Sensor Data Records (SDR) and Environmental Data Records (EDR). A few examples from biomedical and remote sensing applications will be presented.

## Computer and Employment Opportunity

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**Paper ID: ICMAA_1**

## Use of Cryptography in Ancient Indian Astronomical Texts

**Sudhira Panda**
Satananda Institute Astronomy, Tulashichaura, Puri-12

**Abstract**

Use of Criptology is very old. Leon Battista Albertic is known as the father of cryptography in western world. He has introduced cryptic language and set cryptic words to send important massages in around 1467 CE.

However it is quite exciting to know that India has used cryptography in astronomy since the period of Aryabhata in early 5th century. These are mostly to hide the numbers by symbolic words while calculating celestial phenomenon. There were different forms of cryptic language like (i) Katapayadi

System, (ii) BhutaSankhySytem and Kerala bayalish etc.

In this presentation I shall explain the method generating numbers in all three system and rules and regulation of its use.

**Paper ID: ICMAA_2**

## Existence of Solutions for a Class of Hemivariational-Like Inequalities

**K. Mahalik, C. Nahak**
Department of Mathematics, Indian Institute of Technology Kharagpur, India

**Abstract**

We establish the existence results for a new class of mixed hemivariational-like inequality problems with nonlinear terms in reflexive Banach spaces, which contain variational and hemivariational inequalities as special cases. We derive the existence results of solutions for both bounded and unbounded aspects of the constrained set. The new results are formulated in terms of various topological tools. Several theoretical applications of the main results have also been discussed.

**Paper ID: ICMAA_3**

## Discussing the Higher-Order Nonlinearity of a Boolean Bent Function class(Constructed via Niho power functions)

**Kezia Saini and Manish Garg**
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**Abstract**

Boolean functions possessing high "$r^{th}$-order nonlinearity" plays a significant role while analysing the design and security of symmetric cryptosystems (such as stream ciphers and block ciphers), since the Boolean functions having high $r^{th}$-order nonlinearity are capable of providing high security to the corresponding systems in which it is used, against several known attacks like best affine approximation attacks, linear cryptanalytic attacks etc. Also,

this property is vital in the field of coding theory, since the maximal value of the $r^{th}$-order nonlinearities of all Boolean functions on n-variables equals the covering radius of the Reed-Muller code RM(r, n) of length $2^n$ and order r.

In this article, we present a lower bound on the $\left(\frac{m}{2}\right)^{th}$-order nonlinearity of a Bent Boolean function class of the form $g(x) = Tr_1(a_1 x^{d_1} + a_2 x^{d_2})$ where $a_1, a_2 \in F_{2^n}$, $n = 2m$ and $d_1, d_2$ are Niho exponents, which were constructed by the authors Dobbertin et al. (H. Dobbertin, G. Leander, A. Canteaut, C. Carlet, P. Felke, and P. Gaborit, Construction of bent functions via Niho power functions, Journal of Combinatorial Theory, Series A, Vol. 113, pp. 779-798 (2006)).Further, for particular values of n, the computed lower bound is being compared with the lower bounds on the second-order and third-order nonlinearities of other different classes of Boolean functions obtained by the authors Gode et al. and Singh, which proves our bound to be better.

**Paper ID: ICMAA_4**

## Singular surface in real two-phase flow

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### ABSTRACT

The behavior of singular surface for pressure gradient in real two-phase flows is carried out. The effects of parameters contained in the system under consideration on amplitude of singular surface and on its critical time of breaking are also investigated in detail.

**Paper ID: ICMAA_5**

## Some families Of (k, d) Graceful Graphs Formed by AssociatingSeveral Isomorphic Copies of a Path

**Debdas Mishra[1], Govinda Mohanty[2], Subarna Bhattacharjee[*3]**
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Keywords: (k, d)-graceful Labeling, caterpillar, hairy cycle, spraying pipe, spraying flowers, inverse labeling.
AMS classification: 05C78

### Abstract

A graph G with q edges is said to be a (k, d) graceful graph if there is an injective mapping fof V (G) into {0, 1, .., k+ (q−1)d} for some positive integers k and d such that the mappingg of E(G) ⟶ into {k, k + d, k + 2d, . . . , k + (q − 1)d} defined by g(a, b) = |f(a) − f(b)|for any (a, b) ∈ E(G), is surjective. This labeling scheme was introduced by Acharya andHegde in 1990. A (1, 1) graceful labeling is known as graceful labeling, the most popularlabeling scheme which was however introduced by Rosa in 1966. A (k, 1) graceful labelling is known as k - graceful labeling which was introduced earlier than (k, d) graceful labelling independently and concurrently by Slater and Maheo and Thuillier both in 1982. Bu etal. in 1994 established that $K_{m,n}$ is (k, d)-graceful for all k and d and $K_n$ is (k, d)-gracefulif and only if k = d. Mohanty et al. in their papers published in 2021 and 2022 gave(k, d) graceful labeling to some families of graphs such as cater pillars, cyclic caterpillars,firecrackers, cyclic firecrackers, graphs formed by associating several paths with a cycle ora path and developed some new techniques such as inverse labeling and component movingtransformation for constructing (k, d) graphs from a given (k, d) graceful graph. For detailson the development involving (k, d) graceful labeling of graphs one may refer to the latestsurvey on Graph Labeling Problems and their Applications published in Electronic Journalof Combincatorics in 2020.

Here we introduce a new family of graphs known as spraying flowers defined below. Consider the graph $P_n \cup K_{1,m}$obtained by attaching one leaf of $P_n$ to m leaves. A rooted tree inwhich the root is attached to the leaves of finite number of isomorphic copies of the graph$P_n \cup K_{1,m}$ is called a spraying flower. Here we denote the spraying flower from r isomorphiccopies of $P_n \cup K_{1,m}$by $r - P_n \cup K_{1,m}$. The spraying flower $r - P_n \cup K_{1,1}$ is called a sprayingpipe.

In this paper we give (k, d)- graceful labeling to some new classes of graphs, namelyspraying pipes, spraying flowers, joining of several caterpillars with central paths havingequal length along a path, caterpillar, cycle, and hairy cycle with some conditions on k and d.Ring learning with errorbased Signal Leakage attack resilience Authenticated Key Exchange

**Paper ID: ICMAA_6**

## An approach based on fractional-order Lagrange polynomials for the numerical approximation of fractional order non-linear Volterra-Fredholm integro-differential equations

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**Abstract**

In this work we discussed and analyzed a numerical technique based on fractional-order Lagrange polynomials to solve a class of fractional-order non-linear Volterra-Fredholm integro-differential equations. The fractional derivative has been considered of Caputo type. The existence and uniqueness of the continuous solution have been discussed for the given

problem. In this approach, first using the Laplace transform, fractional-order Lagrange polynomials operational matrices of fractional integration have been derived. Then using these operational matrices, the continuous problem has been reduced into a system of algebraic equations. The error analysis also has been carried out and an upper error bound estimate for the approximate solution has been given in L2-norm. It is also shown that as the number of fractional-order Lagrange polynomials increases, the approximation error approaches to zero rapidly. Further, some numerical examples are discussed to verify the accuracy and efficiency of the proposed numerical technique and to validate our theoretical findings.

**Paper ID: ICMAA_7**

## Multiplicative dependent pairs in the sequence ofPadovan numbers

**Mitashree Behera**

(A joint work with **P. K. Ray**)

### Abstract

Let n be a positive integer and$v = v_1, v_2, v_3, \dots v_n \in C^n$, where C is the set of complexnumbers. We say that v is multiplicatively dependent if either one of the vi's equalto zero or there exist integers $k_1, k_2, k_3, \dots k_n$ not all zero satisfying the multiplicativerelation

$$\prod_{i=1}^{n} v_i^{k_i} = 1$$

Otherwise, $v$ is called multiplicatively independent.

The Padovan sequence is the sequence A000931 in the OEIS (On-Line Encyclopediaof Integer Sequences) satisfying the ternary recurrence relation

$$P_n = P_{n-2} + P_{n-3}$$

for n > 3, with initial conditions$P_0 = P_1 = P_2 = 1$. In this note, we investigate allpairs of multiplicative dependent vectors whose coordinates are Padovan numbers andcome up with the following result.

All pairs of Padovan numbers are multiplicative independent except the pairs$\{(P_4, P_3), (P_6, P_3), (P_{11}, P_3), (P_6, P_4), (P_{11}, P_4), (P_9, P_5), (P_{11}, P_6), (P_{15}, P_6), (P_{15}, P_8)\}$and the trivial solutions $\{(n, m) \mid m + 1 \leq n, 0 \leq m \leq 2\}$.

To get this result we solve the Diophantine equation $(P_n)^x = (P_n)^y$. After manipulatingthe Binet formulas of Padovan sequence we come out with non-zeroes linear forms inlogarithms and there upper bounds. For lower bounds, the celebrated Baker's theoremdue to Matveev is used. The upper bounds obtain for the variables m and n via Baker'stheorem are too large to allow computing. So, we use LLL algorithm and a result fromcontinued fraction to reduce the bounds. Finally, using Mathematica we calculate allthe possible values of m and n which satisfy the mentioned Diophantine equation.

**Paper ID: ICMAA_8**

# On the Diophantine equation $B_{n_1} + B_{n_2} = 2^{a_1} + 2^{a_2} + 2^{a_3}$

**Kisan Bhoi**
(A joint work with **P. K. Ray**)

**Abstract**

Balancing sequence {Bn}n≥1 is originated from a simple Diophantine equation 1 + 2 +. . .+(n−1) = (n+1)+(n+2)+· · ·+(n+r) introduced by Behera and Panda [1]. Here,r is called a balancer corresponding to a balancing number n. The balancing sequencesatisfies the binary recurrence $B_{n+1} = 6B_n - B_{n-1}, n \geq 1$ with seeds $B_0 = 0$ and $B_1 = 1$.Binet's formula for $\{B_n\}_{n\geq 1}$ is given by$B_n = \frac{\alpha^n - \beta^n}{4\sqrt{2}}$ where $\alpha = 3+\sqrt{8}$ $and$ $\beta = 3-\sqrt{8}$are the zeros of the characteristic polynomial $f(x) = x^2 - 6x + 1$. Diophantine equations involving powers and binary recurrence sequences have been extensively studied bymany researchers in recent past. For example, Bravo and Luca [2] found all solutionsof the equation $F_n + F_m = 2^a$, where $F_n$ is the n-th Fibonacci number. Later, Bravo andBravo [3] extended this work and found all positive integer solutions of the Diophantineequation $F_n + F_m + F_l = 2^a$. In [5], S¸iar and Keskin solved the same type equation,instead of taking sum, they considered the difference of two Fibonacci numbers andfound solutions to the equation $F_n + F_m = 2^a$. Chim and Ziegler [4] considered the equations$F_{n_1} + F_{n_2} = 2^{a_1} + 2^{a_2} + 2^{a_3}$and $F_{m_1} + F_{m_2} + F_{m_3} = 2^{t_1} + 2^{t_2}$and provedthat $\max\{n_1, n_2, a_1, a_2, a_3\} \leq 18$ and $\max\{m_1, m_2, m_3, t_1, t_2\} \leq 16$, respectively. Inthis presentation, we look at the Diophantine equation

$$B_{n_1} + B_{n_2} = 2^{a_1} + 2^{a_2} + 2^{a_3}, \qquad (0.1)$$

where $B_n$ is the n-th balancing number with $n_1 \geq n_2 \geq 0$ and $a_1 \geq a_2 \geq a_3 \geq 0$ and try to find all its solutions. We prove that all nonnegative integer solutions$(n_1, n_2, a_1, a_2, a_3)$ of the equation (0.1) are given by$(n_1, n_2, a_1, a_2, a_3) \in$ {(2, 0, 1, 1, 1),(2, 0, 2, 0, 0),(2, 1, 2, 1, 0),(2, 2, 2, 2, 2),
(2,2, 3, 1, 1),(3, 0, 5, 1, 0),(3, 1, 4, 4, 2),(3, 1, 5, 1, 1),(3, 2, 5, 3, 0),(3,3,6,2,1).

We use lower bounds for linear forms in logarithms and a version of Baker-Davenportreduction method as main tools to solve the problem.

**Paper ID: ICMAA_9**

## Higher order Hybrid Finite Difference Scheme for Singularly Perturbed Problem with InteriorLayer

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**Abstract**

This work deals with the numerical study of a singularly perturbed parabolic problem with an interior turning point considered in a rectangular domain in the x-t plane with Dirichlet boundary conditions. The solution to this class of problems possesses an interior layer at the location of the turning point. We first establish the stronger bounds for the regular and singular components and their derivatives by decomposing the solution into a regular and singular component. The approximate numerical solution is determined by using the fitted mesh finite difference scheme, which consists of a hybrid finite difference operator on a non-uniform Shishkin mesh in the space direction and a backward implicit Euler scheme on uniform mesh in time variable. The scheme converges ε-uniformly in both the direction with respect to the singular perturbation parameter. Then the accuracy of the resultant scheme is enhanced using the Richardson extrapolation scheme in the temporal direction and shown that the extrapolated scheme is almost second order convergent in both space-time variables. Two numerical examples are considered to illustrate the effectiveness and accuracy of the discussed finite difference methods.
Keywords: Singularly perturbed problems; Interior tuning point; Internal Layer; Implicit Euler scheme; Finite difference scheme; piece-wise uniform mesh; Richardson extrapolation scheme; Uniform convergence

**Paper ID: ICMAA_10**

## Theoretical study of the HCV/HIV co-infection model with optimal control

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**Abstract**

In this study, we look at the burden of HIV/HCV viremia and the efficacy of treatment in reducing the severity of HIV/HCV co-infection patterns. We have computed the basic reproduction number and the stability of the disease-free equilibrium of the model. The numerical results suggest that the HIV viral load impacts the severity of the HCV infection impressively. The efficacy of treatment has also been found to influence the natural progression of HCV in HIV/HCV co-infection. Significant research has recently been conducted to develop antiviral therapy strategies to control HCV infection. Disease-free equilibrium and endemic equilibrium are two equilibrium states in the absence of drugs
Keyword: HIV/HCV, Hepatocyte cells, Proliferation, Basic reproduction number, Optimal control system.

**Paper ID: ICMAA_11**

## Determining critical community size for recurrent epidemics

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**Abstract**

In large communities, persistence of recurrent epidemics for longduration is affected by random variability and their eventual eradication is
too critical. In small communities, a threshold, Critical Community Size(CCS), helps to convey predictions regarding the expected time ofextinction of recurrent epidemic unless reintroduced from outside. Wepresent a four dimensional deterministic model of HIV/AIDS epidemicintroducing the role of contact tracing in HIV partner notification. With theaid of Nåsell's approach , CCS and time of extinction for HIV/AIDSepidemic are computed from the stochastic version of the model. Themodel is adjusted using the data of HIV/AIDS cases of India for the last 30years. The computation of CCS approach is independent of number ofvariables and thus it may be fitted for any recurrent infectious diseasemodel with complex dynamics or of higher dimension.

**Paper ID: ICMAA_12**

## A fractional order epidemic model on antiviral effects of 2-DG during SARS-CoV-2 infection: A control based study

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**Abstract**

To interpret the natural phenomena associated to nonlocality,fractional order differential equations are used as an excellent tool. Significantcomplex behaviors like memory of disease patterns, profile of geneticvariation etc. of a disease system could be calibrated in a proficient mannerthrough fractional order derivatives making it more realistic than itsinteger order counterpart. In this study, a fractional order differentialequations model is developed in micro level to gain perceptions regardingthe effects of host immunological memory in dynamics of SARS-CoV-2infection. Optimal control of SARS-CoV-2 infection with the help of anantiviral drug viz. 2-DG has been exemplified. The fractional order optimalcontrol is enable to employ proper administration of the drug minimizingits systematic cost and generates better therapeutic measures. Numericalsimulations based on real data advantages to visualize the dynamicaleffects of the immunological memory and optimal control inputs in theepidemic system.

**Paper ID: ICMAA_13**

## On Means of Aging Intensity function

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### Abstract

Researchers engaged in reliability theory and survival analysis are quite conversant with failure rate (FR). In recent years, aging intensity function (AI) and their properties are studied. We propose some new aging classes based on monotonicity of different means of AI function. Moreover, some characterizations of distributions based on these functions are established. Examples of some probability distributions are framed to have a deeper insight of the spread of proposed aging classes. Applications of aging functions in real lifetime and simulated data are also illustrated.

**Paper ID: ICMAA_14**

## Obsessive Compulsive Disorder Detection using Hyper-Parameters Optimized NeuralNetwork

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Sambalpur, Odisha. India

### Abstract

Obsessive-compulsive disorder (OCD) is a mental illness characterized by recurrent anxiousfeelings or sensations (obsessions) or the desire to repeat a behavior (compulsions). Thesepeople are oblivious to the fact that they have OCD and are attempting to avoid treatmenteven if visible behavioral symptoms are there. In such case laboratory detection of OCD canplay an important role in medical science. Recent studies suggest that OCD is genetic and hasa different pattern of oxidative stress. This research work aims at classifying the oxidativestress biomarkers of an individual into one class among three classes: healthy individuals(HI), genetically affected individuals (GAI), and OCD-affected individuals (OAI). Anartificial neural network-based approach has been proposed for classifying the three classesfromOxidative Stress Biomarkers. Several classification accuracy indicators are consideredto validate and compare the approach's effectiveness with popular approaches. Experimentalresults and comparative analysis indicate that the proposed approach outperforms comparedto the classical classification approaches with an accuracy of 86 ± 1%.

**Paper ID: ICMAA_15**

# AN OPTIMAL ORDERING POLICY FOR A DETERIORATING ITEM WITH VARYING TIME-DEPENDENT CUBIC DEMAND, TWO-PARAMETER WEIBULL DISTRIBUTION DETERIORATION AND CONDITION OF DELAY IN PAYMENT

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**Abstract**

In this paper, an EOQ (Economic Order Quantity) model is developed for a deteriorating item havingtime-dependent demand when delay in payment is permissible. The deterioration rate is assumed to betwo-parameter Weibull distribution deterioration and the time varying demand rate is taken to be aquadratic function of time. Mathematical models are also derived under two different circumstances, i.e.Case I: The credit period is less than or equal to the cycle time for settling the account and Case II: Thecredit period is greater than the cycle time for settling the account. The results are illustrated with severalnumerical examples. Justification for considering a time-dependent cubic demand and permissible delayin payment are discussed.

**Paper ID: ICMAA_16**

## An Analytical Study of Computational Methods for Obsessive Compulsive DisorderDetection using Oxidative Stress Biomarkers

**Kabita Patel, Ajaya Kumar Tripathy**
Dept. of Computer Science, Gangadhar Meher University, Sambalpur, Odisha. India

**Abstract**

Obsessive-Compulsive Disorder (OCD) is a long-lasting mental sickness described byunwanted thinking and the impulse to carry out frequent tasks. It has progressed from anessentially incurable, persistent psychological condition very controllable condition duringthe last three decades. Findings indicate that accurate identification of the problem is essentialfor prompt treatment and enhancement of the patient's general standard of lifestyle. Severalcomputational approaches related to OCD have been found in the literature. This articleprovides a taxonomy of computational methods designed for different aspects of OCD andprovides some distinguished approaches as an example. These approaches mostly focus onOCD detection, OCD treatment response analysis, and OCD severity detection by analyzingdifferent biomarkers, such as neuroimaging and oxidative stress biomarkers. This studyhighlights the research gaps in analyzing different biomarkers in concern with OCD.

**Paper ID: ICMAA_17**

## Some results on E-proximinality in Banach spaces

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**Abstract**

The notion of proximinality ensures the collection of best approximationsfrom a point to a set. While discussing various concepts of proximinality, E-proximinality has come into our interest. The "nearest minima" norm of anelement in a Banach space is known as E-proximinality. It is a stronger notion than that of proximinality but weaker than that of the ball and strongproximinality. E-proximinality may thereby confirm a range of applications inoptimisation, control theory, etc. We discuss a variety of E-proximinality resultsin this paper and provide an example of why E-proximinality does not implystrong proximinality.

**Paper ID: ICMAA_18**

## Quasiperiodic shrimp induced torus bubbling transition to chaos and multistability in a delayed discrete predator-prey system

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**Abstract**

In this presentation we will discuss on the discovery of quasiperiodic shrimp-shaped structures
in bi-parameter space of nonlinear dynamical system. We consider the logistic Lotka-Volterra predator-prey system with delayed harvesting of the prey. The system is first discretized using
the Euler discretization technique. Conditions for stability of the fixed points and existence of Neimark-Sacker bifurcation are derived analytically. A detailed investigation of the effort-delayparameter space of the discrete system is carried out based on the Lyapunov exponents andperiodicity of the system. We show the existence of both periodic and quasiperiodic shrimps incertain parameter spaces. We also reveal that the quasiperiodic shrimp induces torus-bubblingtransition to chaos and multi-stability between different quasiperiodic and chaos dynamics. Incertain parameter spaces, the quasiperiodic shrimps are connected along a spiral loop with aShil'nikov-like quasiperiodic homoclinic connection at the hub of the spiral.

**Paper ID: ICMAA_19**

## GRAVES TRIAD IN PROJECTIVE PLANE

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be University, Bhubaneswar.
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**Abstract**

In this paper a group of three triangles are taken in aprojective plane. The vertices of one triangle are lying on theside of another triangle. The same will occur also for othertriangles in a cyclic order.

**Paper ID: ICMAA_20**

## Effect of vaccination for COVID-19 : a Fractional-Order Compartmental Model

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**Abstract**

During the past several years, the deadly COVID-19 pandemic has dramatically affected the world; thedeath toll exceeds 4.8 million across the world according to current statistics. Mathematical modeling isone of the critical tools being used to fight against this deadly infectious disease. It has been observedthat the transmission of COVID-19 follows a fading memory process. We have used the fractional orderdifferential operator to identify this kind of disease transmission, considering both fear effects andvaccination in our proposed mathematical model. Our COVID-19 disease model was analyzed byconsidering the Caputo fractional operator. A brief description of this operator and a mathematicalanalysis of the proposed model involving this operator are presented. In addition, a numericalsimulation of the proposed model is presented along with the resulting analytical findings. We showthat fear effects play a pivotal role in reducing infections in the population as well as inencouraging thevaccination campaign. Furthermore, decreasing the fractional-order parameter α value minimizes thenumber of infected individuals. The analysis presented here reveals that the system switches its stabilityfor the critical value of the basic reproduction number R0=1.

**Paper ID: ICMAA_21**

## Prediction of Air Quality using Supervised Machine Intelligent Models

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**Dr.Chittaranjan Mallick,**
Dept. of Basic Science (Mathematics), Parala Maharaja Engineering College, Berhampur, Odisha, India

**Abstract:**

Due to rise of air pollution in the environment, the air quality index (AQI) may changes from good to hazardous. Regular monitoring of AQI is strongly needed for an area nowadays for environment safety. The AQI is mainly categorized into good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous groups. Accurate prediction of such group is needed for taking safety actions in emergency. So, artificial intelligence (AI) is a technology that can be used for solving the problem of classification and prediction more accurately. For this, machine learning models can be used for prediction of the category of air quality. There are many supervised machine intelligent models that can be used for prediction such as Neural Network, Support Vector Machine, k-Nearest Neighbor, Decision Tree, Random Forest, Naive Bayes, etc. For implementation of this, the models need to be trained using standard dataset and also these should be tested for analysis of better accuracy. The model that shows maximum accuracy is selected for such categorization of air quality.

**Paper ID: ICMAA_22**

## An Algorithm to Solve Bi-level Linear Fractional Programming Problem with Trapezoidal FuzzyParameters

**Sujit Maharana and Suvasis Nayak***
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KIIT Deemed to be University, Bhubaneswar, 751024, Odisha, India,,
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**Abstract**

This paper presents a solution algorithm of a bi-level linearfuzzy fractional programming problem consisting of all its constants andcoefficients expressed as trapezoidal fuzzy numbers. The bi-level fuzzyoptimization is equivalently transformed into bi-level interval valued formusing fuzzy α- and β-cuts respectively in the objective functions and constraints. Subsequently, it generates a bi-level bi-objective linear fractionalprogramming problem. Variable transformation method is implementedto construct linear fuzzy membership functions for the objective functions present at both upper and lower level. Fuzzy goal programmingeliminating over deviations from the aspiration level of fuzzy member-ship functions along with a proposed modified linearization process offractional functions are together used to determine the compromise solution of the problem. To illustrate the proposed method and justifyits feasibility, an existing numerical problem is solved and the resultsobtained are comparatively analyzed.

**Paper ID: ICMAA_23**

## Insight into free convection of an unsteady flow of kerosene conveying copper nanoparticles subject to thermal radiation

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satyaranjan_mshr@yahoo.co.in*

**Abstract**

The present article deals with the analysis of enhanced heat transportphenomenon due to the interaction of radiative heat and heat absorption in the time-dependent flow of nanofluid past a semi-infinite flat plate embedding within a permeablemedium. The inclusion of magnetic field also strengthening the profiles. Because of todaysneed in several industries as well as in biological fluids like the radio therapy, peristalticflow of blood pumping, drug delivery system, etc. the application of nanofluid is vital.Therefore, the implementation of the thermal radiation and heat absorption plays animportant role. For the better enhancement, Cu nanoparticle is considered to dispersed in thekerosene-based liquid. The transformation of the

dimensional governing equations needsvarious non-dimensional quantities as well as variables and further, perturbation techniqueis deployed with the suitable choice of perturbation parameter. These transformed equationsare handled by analytically and the variation of the characterizing parameters are illustratedgraphically for the different values setting their range as per the earlier cited in literatures.However, the rate coefficients for the different profiles with their numerically simulatedresults are displayed in tabular form. Further, the important outcomes are; thinning in thevelocity bounding surface thickness is obtained for the augmentation in the resistive force ofmagnetic field within a permeable medium further, nanoparticle concentration and themagnetic parameter enhances the shear rate coefficient.

**Paper ID: ICMAA_24**

## Effect of vaccination for COVID-19 : a Fractional-Order Compartmental Model

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Department of Mathematics, K.L.S. College, Magadh University, Nawada 805110, Bihar, India
anchaterji@gmail.com

**Abstract**

During the past several years, the deadly COVID-19 pandemic has dramatically affected the world; thedeath toll exceeds 4.8 million across the world according to current statistics. Mathematical modeling isone of the critical tools being used to fight against this deadly infectious disease. It has been observedthat the transmission of COVID-19 follows a fading memory process. We have used the fractional orderdifferential operator to identify this kind of disease transmission, considering both fear effects andvaccination in our proposed mathematical model. Our COVID-19 disease model was analyzed byconsidering the Caputo fractional operator. A brief description of this operator and a mathematicalanalysis of the proposed model involving this operator are presented. In addition, a numericalsimulation of the proposed model is presented along with the resulting analytical findings. We showthat fear effects play a pivotal role in reducing infections in the population as well as in encouraging thevaccination campaign. Furthermore, decreasing the fractional-order parameter $\alpha$ value minimizes thenumber of infected individuals. The analysis presented here reveals that the system switches its stabilityfor the critical value of the basic reproduction number $R0=1$.

**Paper ID: ICMAA_25**

## Novel wave solutions of the full nonlinearity form of the Fokas-Lenellmodel

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**Abstract**

The newly derived solitary wave solutions of the full nonlinearity form of theFokas-Lenells model are examined in this study. To derive the novel solutions,an effective method is considered namely, the sigmoid function method. Afterapplying the proposed method to the model, it results in distinct wave solutionswhich include bright, dark, anti-kink and singular soliton solutions. The mostsignificant effects of the suggested method can be seen in the displayed propertiesof the retrieved solutions at general order of nonlinearity. This shows the efficacyand fruitfulness of the proposed method.

**Paper ID: ICMAA_26**

## Convergence and stability analysis of abiparametric family of advanceditérativemethods using conformable fractional derivative.

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**Abstract**

In this article, we have presented a new biparametric conformable fractional advancedmethods (BCOFAM) to finding simple roots of nonlinear or transcendental equationsusing the conformable fractional derivative, permitting fractional derivative$T_\beta^\alpha \phi(x) = 0$in the neighborhood of desired roots. Moreover, we have given a comparison of ourproposed methods with other ones and found our method performed better than othersin the sense of stability as well as faster convergence.

Paper ID: ICMAA_27

## Effect of Sinusoidal Pressure gradient on MHD Flow of Viscoelastic fluid in a channel.

**Pratikshya Dash, Kanaka Lata Ojha, Gouranga Charana Dash**
Department of Mathematics, Siksha 'O' Anusandhan University, Bhubaneswar, India.

**Abstract**

Unsteady two-dimensional hydro magnetic oscillatory flow of incompressible viscoelastic fluid in a channel packed with porous material is investigated under the influence of oscillatory pressure gradient. During the discussion, two cases have been studied; constant motion and oscillatory motions of the lower plate. The magnetic field of moderate strength has beenapplied which interacts with conducting fluid to generate an additional body force. In addition to it, the elasticity of the liquid characterizing the non-Newtonian behavior in conjunction with the permeability of the medium adds to the novelty of the study. The striking outcomes of the present study are: The most interesting outcome is the formation of an invented boundary layer in case of the oscillatory lower plate with the moderately higher lapse of time but this doesn't appear in case of the constant motion of lower plate; further,the flow instability is marked in case of a moderately high frequency of oscillation of lower plate. Hence, it is recommended that for the stability of flow and to avoid flow reversal higher frequency of oscillation as well as time span is not desirable.

**Paper ID: ICMAA_28**

## COEFFICIENT ESTIMATES FOR A FAMILY OF ANALYTIC FUNCTIONS ASSOCIATED WITH LIMACON-SHAPED DOMAIN

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**Abstract**

Let A denote the class of all analytic functions having Taylor-Maclaurin series of the form $h(z) = z + \sum_{n=2}^{\infty} h_n z^n$with normalized condition $h(0) = 0$ and $h'(0) - 1 = 0$. In the present investigation, we introduce the new subclasses of analytic functions namely; $R_{lim}(l,\beta)$ and $C_{lim}(l,\beta)$ defined by subordination associated with Limacon-shaped domain. We obtain some initial coefficient bounds and $Fekete - Szegö$inequalities for the functions in the above said classes. Analogous results have derived for the function $h^{-1}$. Further, we discuss Poisson distribution as an application to our results.

**Paper ID: ICMAA_29**

## Multi-criteria decision making problems inan interval number for group decision makingbased on TOPSIS method

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**Abstract**

It is a matter of concern to compare the value of interval numbers,when dealing with a multi-criteria decision making (MCDM) problemsinvolving interval numbers, whose criteria weights are entirely unfamiliar. So, this paper approaches for MCDM based on TOPSIS and theweighted vectors. Also, first we analyze the interval number matrixis converted into two other exact number matrices, which lessens thecomplexity of sorting. Then a factor is provided for determining theweights with entropy weight. Finally, the sequence of each schemeis obtained by using TOPSIS technique. The result of this methodhas described in a simple numerical example. The numerical exampleis to be considered for feasibility and practicability of the problem.

**Paper ID: ICMAA_30**

## The Soret effect on MHD flow with Hall current and induced magnetic field

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**Abstract**

We analyse the influence of the Soret parameter on the MHD mixed convection flow of aviscoelastic fluid over a vertical surface. The induced magnetic field and Hall effects areapplied. The governing equations are solved analytically by the perturbation method. Thepertinent parameters affecting velocity, induced magnetic field (i.m.f), temperature andconcentration are discussed graphically. The main goal and novelty of the research are toinvestigate the impact of the Soret effect and i.m.f along with Hall current on the flowfield. The important findings are as follows: with the rise in S 0 , the induced magneticfield falls in the primary flow direction, whereas a reverse trend is noticed for thesecondary flow direction. We also found that the Soret effect enhances the fluidtemperature and both the components of velocity profiles. The expression of Skinfriction, current density, Nusselt and Sherwood number over the magnetised verticalsurface (m.v.s) are obtained and represented computationally through tabular forms.

**Paper ID: ICMAA_31**

## An Algorithm to Solve Bi-level Linear FractionalProgramming Problem with Trapezoidal FuzzyParameters

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**Abstract**

This paper presents a solution algorithm of a bi-level linearfuzzy fractional programming problem consisting of all its constants andcoefficients expressed as trapezoidal fuzzy numbers. The bi-level fuzzyoptimization is equivalently transformed into bi-level interval valued formusing fuzzy α- and β-cuts respectively in the objective functions and constraints. Subsequently, it generates a bi-level bi-objective linear fractionalprogramming problem. Variable transformation method is implementedto construct linear fuzzy membership functions for the objective functions present at both upper and lower level. Fuzzy goal programmingeliminating over deviations from the aspiration level of fuzzy membership functions along with a proposed modified linearization process offractional functions are together used to determine the compromise solution of the problem. To illustrate the proposed method and justifyits feasibility, an existing numerical problem is solved and the resultsobtained are comparatively analyzed.

**Paper ID: ICMAA_32**

## A Study of Fault Detection and Correction Process in SoftwareReliability Analysis and Optimal Release Time

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**Abstract**

Many software reliability growth models (SRGMs) have been proposed in the past four decades to evaluatethe number of remaining faults and software reliability. The probability of getting failure-free softwarewithin a specified period and environment is known as software reliability, which is recognized as oneof the essential aspects of software reliability. Many research papers deal with the realistic time delaysbetween fault detection and correction process. This paper presents a new SRGM of the fault detectionprocess (FDP) and fault correction process (FCP). Previously, FCP was modeled as a delayed faultdetection process by taking a constant or random time delay. We studied the dependency between theFDP and FCP as the amount of fault dependency, not in time dependency. New models are proposed byadopting different fault dependency functions. These models are validated on two actualmedium sizesoftware system data sets. The results show that the proposed models fit the data set accurately other thanthe existing SRGMs. We have also discussed the optimal release time through a cost model where setup,testing, and debugging costs are introduced in both the testing and operational phases in the cost model.

**Paper ID: ICMAA_33**

## Weighted core-EP inverse of matrices

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**Abstract**

We introduce the notation of E-weighted core-EP and F-weighteddual core-EP inverse of matrices. We then obtain a few explicit expressions for the weighted core-EP inverse of matrices through othergeneralized inverses. Further, we discuss the existence of generalized weighted Moore-Penrose inverse and additive properties of theweighted core-EP inverse of matrices. In addition to these, we proposethe star weighted core-EP and weighted core-EP star class of matricesfor solving the system of matrix equations. We further elaborate onthis theory by producing a few representation and characterization ofstar weighted core-EP and weighted core-EP star classes of matrices.

**Paper ID: ICMAA_34**

## On the generalized Pell (k, i)- numbers and it'sapplication in Cryptography

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**Abstract**

In this paper, we introduce the matrix representation and the inverseof the generalized Pell (k, i)-numbers. By the help of generalizations, weobtain some interesting properties of this number sequence. Furthermore,we give it's application in cryptography and in this proposed scheme, instead of exchanging key matrix, we need to exchange only pair of numbers(k, n), which reduces the time complexity as well as space complexity andbuild up a large key-space.

**Paper ID: ICMAA_35**

## CASSON FLUID FLOW WITH HEAT TRANSFER OVER A STRETCHING SHEET

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**Abstract**

The present study is to show the behaviors of a steady state twodimensional, laminar boundary flow of an electrically conductingMHD casson fluid near a stagnation point of a stretching sheet. It isassumed that the sheet is stretched in its own plane with velocity andtemperatureproportional to the distance from the stagnation point.The flow medium is porous in nature and also it is subjected toradiation and heat source. By suitable similarity parameters thegoverning equations are transformed to ordinary differential equationand solved by Runge-Kutta method of fourth order. The variation ofvelocity and temperature with respect to different parameters such asPrandtl number, Hartman number, Eckert number and velocity
Parameter are discussed with graphs.

**Paper ID: ICMAA_36**

## A FAMILY OF SPECIAL TRIAD IN A PROJECTIVE SPACE OF DIMENSION THREE

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**Abstract**

Given a pair of perspective tetrahedron $(A)$ and $(B)$ where the vertex $B_i$ is on the opposite face of $A_i$ the center and plane of perspectivity are called the pole and polar of each other respectively for the reference tetrahedron $(A)$. In the present study a family of special triads is obtained which is fixed for a fixed reference tetrahedron using a transformation.

**Paper ID: ICMAA_37**

## Sums of three Fibonacci numbers close to a power of 2

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**Abstract**

Let $\{F_n\}n\geq 0$ be the Fibonacci sequence given by $F_{n+2} = F_{n+1} + F_n$ for $n \geq 0$ with theinitial conditions $F_0 = 0$ and $F_1 = 1$. An integer n is said to be close to a positive integer mif it satisfies $|n - m| < \sqrt{m}$. Chern and Cui (Fibonacci Quart. 52(4) (2014), 344–348) foundall the Fibonacci numbers which are close to a power of 2. Consequently, Hasanlizade (2022,arXiv:2206.10356) extended their work by studying the sum of two Fibonacci numbers close toa power of 2.

In this study, we have extended the above works and examined the sums of three Fibonaccinumbers that are close to a power of 2. More explicitly, we have studied the Diophantineinequality$|F_n + F_m + F_l - 2^a| < 2^{a/2}$, in positive integers n, m, l and a with $n \geq m \geq l$. To prove our result, we have used a few timesa Baker-type lower bound for non-zero linear forms in logarithms of algebraic numbers and aversion of the Baker-Davenport reduction method to reduce the large bound.

**Paper ID: ICMAA_38**

## A combined numerical technique for solvingnonlinear Sharma-Tasso-Olver equation

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**Abstract**

This work deals with a new combined approximation technique which isdeveloped to solve a nonlinear model with strong nonlinearity, namely, theSharma-Tasso-Olver (STO) equation. This technique is based on Taylor'sseries expansion which discretizes the time derivative and the Bernsteinpolynomials which are utilized for space derivatives. The STO equationreduces to a system of linear algebraic equations for each time step viasome suitable collocation points. To show the applicability and accuracyof the present method, the numerical results are compared with the sameby some recent existing methods. 2D and 3D graphs of the numerical results have been plotted using the Wolfram Mathematica package.

**Paper ID: ICMAA_39**

## Convergence and stability analysis of a biparametric family of advanced iterative methods using conformable fractional derivative

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**Abstract**

In this article, we have presented a new biparametric conformable fractional advanced methods (BCOFAM) for finding simple roots of nonlinear or transcendental equations using the conformable fractional derivative, permitting fractional derivative in the neighborhood of desired roots. Moreover, we have given a comparison of our proposed methods with other ones and found our method performed better than others in the sense of stability as well as faster convergence.

**Paper ID: ICMAA_40**

## Stagnation point flow of Special third grade fluid over a vertical stretching/shrinking sheet and stabilityanalysis

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**Abstract**

A study is made to determine the similarity solutions for steady stagnation point flow of specialthird grade fluid over a permeable stretching/shrinking sheet. The Lie scaling group of transformations technique has been used for finding a new form of similarity transformations, which effectivelytransformed the governing momentum and energy equation into a new kind of coupled ordinary differential equations (ODEs). The transformed equations are then solved numerically using the shootingtechnique. It is observed that the similarity equations exhibit dual solutions in a certain range ofshrinking strength. The interest lies in examining the effect of physical parameters on flow velocity,temperature distribution, skin friction coefficient and Nusselt number. Thus, emphasis has been givento carrying out a stability analysis to determine the physically reliable solution. The stability analysisshows that the upper branch solution is stable. It is observed that the suction parameter increases therange of dual solutions and the magnitude of the critical point from where the dual solutions bifurcate;however, the non-Newtonian parameter shows the opposite behavior. The momentum, thermal andconcentration boundary layer thicknesses in the upper branch solution are lower than the lower branchsolution.

**Paper ID: ICMAA_41**

## Illustration of buoyant forces on Casson nanofluid flow through an exponential stretching sheet with thermal radiation and chemical reaction

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**Abstract**

The present investigation is intended to follow the characteristics of thermal as wellas solutal buoyancy on the flow of non-Newtonian Casson nanofluid flow over the exponentialstretching sheet embedding with the permeable medium. The interaction of thermal radiationalong with the chemical reaction enriches the flow phenomena significantly. These propertiesare useful due to their recent applications in various industries as well as the biomedical area.The blood flow phenomenon described in the human body is characterized by the use of Cassonnanofluid which is helpful for the drug delivery system. The suitable transformation rules areemployed for the transformation of the proposed governing equation into ordinary andnonlinear. Further, an approximate analytical approach such as Differential Transform Method(DTM) is made used for the solution of transformed governing equations. The illustration ofthe physical behaviour of the contributing parameters involved in the flow phenomena ispresented via graphs and tabular form.

**Paper ID: ICMAA_42**

## Confidence Interval for Variances of Two Normal Populations under Equality RestrictionOn the Mean Parameters

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**Abstract**

This research focuses on finding confidence intervals for the variances of two normal populations whenthe mean parameters are assumed equal. We derived the asymptotic confidence interval using theFisher information matrix of the model. Two intervals using the parametric bootstrap method arederived. A Bayesian interval using Jeffrey's prior also has been obtained numerically. Moreover,generalized confidence intervals are derived using estimators of the mean parameters under equalityrestriction. A numerical comparison among all the confidence intervals has been made using theaverage length and coverage probability.

**Paper ID: ICMAA_43**

## Insight into free convection of an unsteady flow of kerosene conveying copper nanoparticles subject to thermal radiation

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**Abstract**

The present article deals with the analysis of enhanced heat transportphenomenon due to the interaction of radiative heat and heat absorption in the time-dependent flow of nanofluid past a semi-infinite flat plate embedding within a permeablemedium. The inclusion of magnetic field also strengthening the profiles. Because of todaysneed in several industries as well as in biological fluids like the radio therapy, peristalticflow of blood pumping, drug delivery system, etc. the application of nanofluid is vital.Therefore, the implementation of the thermal radiation and heat absorption plays animportant role. For the better enhancement, Cu nanoparticle is considered to dispersed in thekerosene-based liquid. The transformation of the dimensional governing equations needsvarious non-dimensional quantities as well as variables and further, perturbation techniqueis deployed with the suitable choice of perturbation parameter. These transformed equationsare handled by analytically and the variation of the characterizing parameters are illustratedgraphically for the different values setting their range as per the earlier cited in literatures.However, the rate coefficients for the different profiles with their numerically simulatedresults are displayed in tabular form. Further, the important outcomes are; thinning in thevelocity bounding surface thickness is obtained for the augmentation in the resistive force ofmagnetic field within a permeable medium further, nanoparticle concentration and themagnetic parameter enhances the shear rate coefficient.

**Paper ID: ICMAA_44**

## Some Extensions on Dynamic Hilbert-Type Inequalities in Time Scales

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**Abstract**

Hilbert inequality began to take shape in 1908 and continues to be crucial to theadvancement of analysis. In recent years, the evolution of classical inequalitiesis seen in time scale calculus. Time scale calculus is introduced by S. Hilger in(1990). With reference to the literature, this article aims to prove some newdynamic Hilbert-type inequalities in time scale delta and nabla calculus. This isfurther used to obtain the alpha-diamond form of the inequality. In proving theresults, the basic idea is to use some algebraic inequality, H¨older's inequality,Montgomery identity, the chain rule, and the formula of integration by parts ontime scales to obtain the different forms of Hilbert inequality.As an application, the inequality is additionally extended for the class ofisotonic functionals. Also, some particular settings are considered from theliterature. This generalization allow us not only to unify all the related resultsthat exist in the literature on an arbitrary time scale, but also obtain newoutcomes that are analytical to the results of the delta, nabla as well as alpha-diamond calculation.

**Paper ID: ICMAA_45**

## BOHR'S ESTIMATES OF CERTAIN UNIFIED FAMILY OF CLOSE-TO-CONVEXHARMONIC MAPPINGS

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**Abstract**

The classical Bohr phenomenon is about to finding the largest radius for which an analytic function ,with satisfy the inequality In 1914, Harald Bohr obtained that the inequality occurs for . Later,Weiner, Schur and Riesz independently show that the inequality is sharp for The constant is knownas the Bohr radius for the family of analytic functions. Let be the class of harmonic functions , whereand are analytic in . This work is about to study a unified subfamily of denoted by , as harmonicanalogue to the class due to Al-Refai . In this talk we discuss about the Bohr Radius, improvedBohr radius, Bohr-Rogosinski radius for the family . The properties of partial sum of the functionsbelonging to this family are also discussed.

**Paper ID: ICMAA_46**

## Study on Rubik's Cube

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**Abstract**

Rubik's Cube is a widely popular mechanical puzzle that has attractedattention around the world because of its unique characteristics. This projectprovides a basic understanding of the Rubik's Cube, we will alternate between astudy of group theory and of Rubik's cube. Using group theory to find tools tosolve the cube and using the cube to illustrate many of the important topics ingroup theory. Use properties of group theory and some mathematical ideas to makea program and solve of Rubik's cube.

**Paper ID: ICMAA_47**

## Nonlinear radiative heat transfer on Magnetohydrodynamic Casson nanofluid passing through a thin needle

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**Abstract**

The impacts of non-linear radiation on MHD Casson nanoliquid along a thin needle inour proposed new innovation study on thermal analysis in solar magnetohydrodynamicnanotechnology based on the aforementioned features and applications. The complete numericalsolution for the controlled flow boundary layer equations is presented along with the modelling and geometry of the governing flow phenomena. The velocity and temperature affects theparameters like skin friction coefficient, rate of energy transfer, and Sherwood number aregraphically presented.

**Paper ID: ICMAA_48**

## Minimization of Computational Overhead using Matched Pattern Index for Multiple Sequence Alignment

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**Abstract**

The electronically enhanced use of biological information as an area of research known asbio informatics significantly contributed to the upliftment of bio science. Multiple sequenceAlignment (MSA) in Bio Informatics deals with the matching pattern of various DNA or proteinsequences for areas like identification of dead soldiers, parental relationship, identification of diseasesetc. Time bound accurate solution for MSA is remaining a challenge as finding one exact solution usingdynamic programming is infeasible and heuristic solutions are inexact. We developed a referencemechanism for keeping track of the earlier matched patterns indexes and using it to avoid furthercomputations needed for an exact solution. In this both global and local alignment used optimally.Pairwise alignment is done with the globalalignment, score is calculated then in order to keep trackof the matched patterns local alignment is done and the list of matches for each sequence ismaintained. A dynamic list for each sequence containing multiple number of starting indexes ofmatching patterns and the no of characters along with the score. After the unique paired matchingdetails are kept further matching among the sequences is only checked with retained informationamong the already matched ones and directly calculatesthe score. For matches below threshold casesthe aforesaidprocedure is followed. Our method tries to provide the accurate solution by minimizingthe time for computation by avoiding the direct alignments required. Though the time complexity fordynamic programing approach is $n^n$in our approach unique pairwise alignment requires $n^2$ and somen$^k$ where n<k of comparisons.

**Paper ID: ICMAA_49**

## A Fuzzy Inventory Model for both Ameliorating and Deteriorating Items with Shortages underPower Demand Pattern

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Subject Classication: 90B05, 03E72

**Abstract**

In this paper, we devise an inventory model for the retailer's problems for the itemswith constant deterioration rate as well as of weibull ameliorating pattern having powerdemand under shortages. We rst considered the model in the crisp environment having thedeterministic parameters, such as, holding cost, rate of deterioration, and amelioration cost.Subsequently, to deal with the real world situations, we have modeled this problem in thefuzzy environment having impreciseness in the above-mentioned parameters. In particular,we have considered the impreciseness in holding cost, deterioration rate, and

amelioration cost as triangular fuzzy numbers, and used Graded Mean Integration Representation(GMIR) Method for defuzzication. We have proposed a general approach to obtain theoptimal strategy for the proposed inventory problem in both the environments. Finally, sev-eral numerical examples are illustrated to justify the ndings. Lastly, managerial insightsare proposed after carefully investigating the sensitivity behavior of various associated keyparameters.

**Paper ID: ICMAA_50**

## Some exploration on geodesic polynomials in a graph

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**Abstract**

Let G = (V,E) be a graph (finite, simple, connected and undirected).A shortest path between two vertices u and w in G is called a u−w geodesic. We say that a geodesic P is passing through a vertex v in G if v is an internal vertex of P. The length of a longest geodesic in G is called the diameter of G, denoted by diam (G). The eccentricity of a vertex v in G is the maximum distance between v and any other vertex in G. A vertex with maximum eccentricity in G is called a peripheral vertex in G. For two vertices u and v in G, g(u,v) denotes the number of geodesics whose end vertices are u and v. The number of geodesics in G is denoted by $f_G$ (or simply f), and $f_i$ denotes the number of geodesics of length i in G. Clearly, $f_1$ = |E| and for a graph with n vertices,

$$f = \sum_{i=1}^{n-1} f_i = \sum_{i=1}^{d} f_i$$

For a vertex v in G, fiv denotes the number of geodesics of length i having v as an end-vertex in G. The number of geodesics having v as an end-vertex in G is denoted by fGv. Clearly, f1v = deg (v), fiv = 0, ∀i> e(v) .

Definition 1 (R. Rajendra and P.S.K. Reddy). The geodesic sequence of a graph G with n vertices is the sequence, $f_1, f_2, \ldots\ldots f_d$ where $f_i$ is the number of geodesics of length i in G, 1 ≤ i ≤ d and d = diam (G).

Definition 2 (R. Rajendra and P.S.K. Reddy). The geodesic polynomial of a graph G with n vertices, denoted by gG(x) is the generating function (polynomial) of the geodesic sequence $f_1, f_2, \ldots\ldots f_d$ of G; i.e., $g_G(x) = f_1 + f_2 x + f_3 x^2 + \ldots + f_d x^{d-1} = \sum_{i=1}^{d} f_i x^{i-1}$

**Paper ID: ICMAA_51**

## Effect of Sinusoidal Pressure gradient on MHD Flow of Viscoelastic fluid in a channel.

**Pratikshya Dash, Kanaka Lata Ojha, GourangaCharana Dash**

Department of Mathematics, Siksha 'O' Anusandhan University, Bhubaneswar, India.

**Abstract**

Unsteady two-dimensional hydro magnetic oscillatory flow of incompressible viscoelasticfluid in a channel packed with porous material is investigated under the influence ofoscillatory pressure gradient. During the discussion, two cases have been studied; constantmotion and oscillatory motions of the lower plate. The magnetic field of moderate strengthhas been applied which interacts with conducting fluid to generate an additional body force.In addition to it, the elasticity of the liquid characterizing the non-Newtonian behavior inconjunction with the permeability of the medium adds to the novelty of the study. Thestriking outcomes of the present study are: The most interesting outcome is the formationof an invented boundary layer in case of the oscillatory lower plate with the moderatelyhigher lapse of time but this doesn't appear in case of the constant motion of lower plate;further, the flow instability is marked in case of a moderately high frequency of oscillation oflower plate. Hence, it is recommended that for the stability of flow and to avoid flowreversal higher frequency of oscillation as well as time span is not desirable.

**Paper ID: ICMAA_52**

## Buoyant effects on the fluctuating magnetohydrodynamic flow of viscous fluid through a permeable plate with transient conditions

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**Abstract**

The current analysis emphasizes the characteristic of the physical phenomena ofcertain quantities appended in the flow profiles of the conducting viscous fluid through a hotvertical plate. The plate is embedding with permeable medium which may act as a controllingparameter for the assisting and opposing effect caused by the buoyant forces like thermal andsolutal buoyancy. Further, the inclusion of dissipative heat and the heat source/sink alsoenriches the flow phenomena. The novelty of the discussion based upon the transienttemperature and concentration condition. However, the hybrid methodology is

implemented tohandle the non-dimensional set of coupled governing equations. In particular the perturbationtechnique is used to decouple the profiles and reduce to ordinary differential equation andafterwards standard numerical technique is employed. The structural behavior of thecharacterizing parameters is presented in graphical vis-à-vis tabular form. The comparativeanalysis with earlier study also presented in the particular case to get a bench mark to carry outthe further investigation.

**Paper ID: ICMAA_53**

## Two-Warehouse Sustainable Inventory Model with Optimum Carbon Emissions

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**Abstract**

The proposed work formulates a sustainable deteriorating inventorymodel for a linear time-dependent demand. In the present study, the emission dueto transportation is regulated by the optimum green technology (GT)investments. An optimum cost formula is derived with optimum GT investmentfor the problem which considers two warehouses to minimize the carbonemissions due to the transportation of items from main warehouse to rentedwarehouse and then to customers. To avoid the stock-out situation, this workincludes two warehouses, main and rented warehouses. A number of prepaymentoption along with instalment for the purchasing cost is offered to the retailers. Inthe present research. A real case study is introduced which provides an illustrationof the proposed model. The example is solved and followed by a sensitivityanalysis.

**Paper ID: ICMAA_54**

## A New approach to solve a Chance Constrained Financial Portfolio Selection model with Fuzzy coefficients

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**Abstract**

Portfolio optimization analysis has become a major topic for investors. Thetraditional financial portfolio selection (FPS) models have precise information fordecision-makers. The data available in the financial market are unquantified,incomplete, and vague in nature. Hence the parameters required to develop thismodel are both random and fuzzy. Many researchers proposed various techniquesaccording to different situations. In this paper, we have considered a chance-constrained FPS model, where the coefficient are fuzzy numbers. Here amathematical model with solution methodology is derived. Finally, themethodology is justified by an example.

**Paper ID: ICMAA_55**

## Illustration of buoyant forces on Casson nanofluid flow through an exponential stretching sheet with thermal radiation and chemical reaction

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**Abstract**

The present investigation is intended to follow the characteristics of thermal as wellas solutal buoyancy on the flow of non-Newtonian Casson nanofluid flow over the exponentialstretching sheet embedding with the permeable medium. The interaction of thermal radiationalong with the chemical reaction enriches the flow phenomena significantly. These propertiesare useful due to their recent applications in various industries as well as the biomedical area.The blood flow phenomenon described in the human body is characterized by the use of Cassonnanofluid which is helpful for the drug delivery system. The suitable transformation rules areemployed for the transformation of the proposed governing equation into ordinary andnonlinear. Further, an approximate analytical approach such as Differential Transform Method(DTM) is made used for the solution of transformed governing equations. The illustration ofthe physical behaviour of the contributing parameters involved in the flow phenomena ispresented via graphs and tabular form.

Paper ID: ICMAA_56

# A Generalized Quadrature through Kronrod Extension for Analytic Functions

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**Abstract**

*A Generalized quadrature rule of precision eleven for approximate evaluation of line integrals of analytic functions has been constructed. This rule is obtained by taking a suitable convex combination of Gauss-Legendre five point transformed rule and Kronrod extension of Lobatto 4-point transformed rule. An asymptotic error estimate of this rule has been determined. The error obtained by the Constructed rule and constituent rules Gauss-Legendre five point transformed rule and Kronrod extension of Lobatto 4-point transformed rule are compared in text tables figures by using different types of test examples. The constructed rule and it's constituent rules also applied in adaptive routines and the effectiveness of the rule has been compared in the routine. The degree of precision of the rule is also highlighted. it is found the Genralized quadrature is more effective than the constituent rules.*

**Paper ID: ICMAA_57**

# Novel wave solutions of the full nonlinearity form of the Fokas-Lenells model

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**Abstract**

The newly derived solitary wave solutions of the full nonlinearity form of the Fokas-Lenellsmodel are examined in this study. To derive the novel solutions, an effective method isconsidered namely, the sigmoid function method. After applying the proposed method tothe model, it results in distinct wave solutions which include bright, dark, anti-kink andsingular soliton solutions. The most significant effects of the suggested method can be seenin the displayed properties of the retrieved solutions at general order of nonlinearity. Thisshows the efficacy and fruitfulness of the proposed method.

**Paper ID: ICMAA_58**

## Two-Warehouse Sustainable Inventory Model withOptimum Carbon Emissions

**SubhashreeParida and Milu Acharya**
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Abstract

The proposed work formulates a sustainable deteriorating inventorymodel for a linear time-dependent demand. In the present study, the emissiondue to transportation is regulated by the optimum green technology (GT)investments. An optimum cost formula is derived with optimum GT investmentfor the problem which considers two warehouses to minimize the carbonemissions due to the transportation of items from main warehouse to rentedwarehouse and then to customers. To avoid the stock-out situation, this workincludes two warehouses, main and rented warehouses. A number ofprepayment option along with instalment for the purchasing cost is offered tothe retailers. In the present research. A real case study is introduced whichprovides an illustration of the proposed model. The example is solved andfollowed by a sensitivity analysis.

**Paper ID: ICMAA_59**

## THERMOPHORETIC EFFECT ON STAGNATION POINT FLOW OF MHD MAXWELL FLUID TOWARDS A PERMEABLE STRECHIG SURFACE

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**Abstract**

Analysis has been carried out to study the stagnation point flow ofMaxwell fluid towards a permeable stretching sheet. Using suitabletransformations, the governing partial differential equations are firstconverted to ordinary and then solved numerically by fourth–fifth orderRunge–Kutta method with shooting technique by using MATLAB code.The flow and heat transfer characteristics are analyzed and discussed fordifferent values of the parameters. Present work reveals that the velocityincreases whereas the temperature and concentration decreases with theincrease of Maxwell parameter. The thermal and concentration boundarylayer thickness decreases with velocity ratio, Lewis number, Prandtlnumber, Brownian motion and thermophoresis parameters. Comparisonwith known results for Newtonian fluid flow is found to have anexcellent"agreement.

**Paper ID: ICMAA_60**

## Effect Of Chemical Reaction On Nanofluid Flow Over a Time-dependent Stretching Sheet In Presence Of Heat Source

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**Abstract**

An investigation has been carried out to study the effect of chemicalreaction of an unsteady boundary layer flow of a nanofluid over a heatedstretching sheet embedded in a porous medium in the presence of heatsource/sink and magnetic field. The unsteadiness in the flow field iscaused by due to time-dependence of the stretching velocity, free streamvelocity and the surface temperature. The unsteady boundary layerequations are transformed to a system of non-linear ordinary differentialequations and solved numerically using a shooting method together withRunge–Kutta 4 th order scheme. For supporting the results and discussionpart some graphs are included. The striking result reported here in as:Interaction of Magnetic field

with conducting fluid opposes the fluidvelocity irrespective of presence/absence of porous matrix whereasmagnetic field interaction accelerates temperature field. The fluidtemperature and the thermal boundary layer thickness increase forincreasing thermal radiation, Brownian motion and thermophoresiswhereas the effect is opposite for unsteadiness parameter.

**Paper ID: ICMAA_61**

## A Methodical Approach for Graph-based Topic Modelling.

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### Abstract

Online user reviews have developed into crucial sources of knowledge for prospectivecustomers. On the basis of semantic categorization, the importance of internet reviews ininfluencing consumer purchases is expanding. It can be difficult for consumers to categories\ reviews according to their preferences in some circumstances. The majority of social networkstudies have largely ignored the valuable information hidden in digital conversations, such asthe discussion's structure and the relationships between various contents, which are crucial forcomprehending online communication behavior. Instead, they have concentrated only on userrelationships or shared content. This research suggests a graph-based paradigm to evaluatethe form and organization of online interactions. In order to properly use the topic based on theuser's interest, we have developed a graph-based topic modeling that will clearly categories thetopics based on their conversation. This will extract crucial information on social mediacommunication patterns among the users. We used a dataset of TripAdvisor hotel reviews thatincluded about 20,000 customer comments. All user reviews and comments have beentokenized, stop words have been removed. After the data cleaning process, we consider eachword in the corpus is a feature vector. We converted the words into vectors using the Word2Vecmodel, which has captured the semantic content of the close words in the sentence. Each wordin the corpus is used as a vertex to create the topic graph. The distance between the words,which is greater than the threshold values, is used to build the graph's edges. The meandistance between words in the corpus is

calculated using the threshold value. The cosinesimilarity is used to calculate the distance between the words. The edge between two words isassigned if it is higher than the predetermined threshold value. We examined the degreecentrality of each node after generating the graph. The vertex with the highest degree centralityis considered to be the topic, and any nearby vertex that is greater than the tuned thresholdvalue is considered to be part of the same topic.

**Paper ID: ICMAA_62**

## An improved augmented Lagrangian method for the solution of Boolean quadratic programming problem with generalized upper bound constraints

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**Abstract**

Boolean quadratic programming problem with generalized upper boundconstraints (BQP-GUB) is a generalization of the quadratic semi assignmentproblem (QSAP). It has applications in various different fields for example engineering, biology and production planning. In this paper, an improved augmentedLagrangian method (ALM) is proposed for the solution of Boolean quadraticprogramming problem with generalized upper bound constraints (BQP-GUB).First, the BQP-GUB is converted into an unconstrained Boolean quadratic programming problem (UBQP), then, the Boolean constraints of the UBQP areconverted into a class of continuous functions. Further, the obtained problem isreformulated as an equivalent augmented Lagrangian function, and its minimumis obtained using ALM, in which the subproblem is solved using Simulated annealing based Barzilai-Borwein (SABB) method. Numerical results are reportedfor UBQP datasets. Numerical experiments indicate that IALM with SABB performes well with high efficiency compared to some existing methods.

**Paper ID: ICMAA_63**

## Analysis of Amino Acid Sequences Using Cellular Automata Parameters: Reflection, Conjugation & Conjugate-Reflection

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**Abstract**

Mutations in the nucleotides of a codon may cause significant disorders in the evolutionary patterns ofan amino acid sequence. Cellular Automata (CA) parameters like reflection, conjugation andconjugate-reflection etc. are used to characterise the point mutations in amino acid sequences and arealso useful in classifying non-uniform 3-neighbourhood CA rules. Earlier these parameters are usedfor uniform CA and applied to DNA sequences. This talk explains the concepts, methods and presentresults for CA parameters (both synchronous and asynchronous) in the non-uniform domain.

**Paper ID: ICMAA_64**

## Quadratic convex relaxation technique for 0-1 quadratic constraint quadratic programming problems

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International Institute of Information Technology Bhubaneswar

In this paper, the solution of nonconvex quadratically constrained quadratic programming(QCQP) which is NP-hard in nature and have numerous applications in many engineeringproblems is discussed. Semidefinite programming (SDP) relaxation based convexificationmethod is used widely to solve nonconvex QCQPs and is not accepted for large scaleproblems because of its high complexity. Departing from several convexification methods in, literature, a new convexification method termed as nondiagonal quadratic convex relaxationtechnique (NDQCR) was proposed for 0-1 quadratic programming by PÖRN and co-workers.Albeit NDQCR is a is an extension of the Quadratic Convex Reformulation (QCR) where aperturbation of diagonal terms are operated in 0-1 programs, the nondiagonal perturbationsare added in NDQCR. We extend this idea for the solution of nonconvex 0-1 QCQP problemsand compare the optimal solution and CPU times with the original Quadratic ConvexReformulation (QCR) method. The computational experiment is done on the data set ofZamani (2019) which shows the efficacy of the proposed method for 0-1 QCQP.

**Paper ID: ICMAA_65**

## Traversable Wormhole in Modified Brans-Dicke Theory

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Abstract

We obtain wormhole solution in the modified Brans-Dicke theory using the shape function and aconstant redshift function in the static and spherically symmetric metric of wormholes. We study allthe energy conditions and find that there is no violation for this theory contrary to the usualapproaches. It is shown that the wormhole is traversable.

**Paper ID: ICMAA_66**

## A Study of Fault Detection and Correction Process in SoftwareReliability Analysis and Optimal Release Time

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**Abstract**

Many software reliability growth models (SRGMs) have been proposed in the past fourdecades to evaluatethe number of remaining faults and software reliability. The probability of getting failure-free softwarewithin a specified period and environment is known as software reliability, which is recognized as oneof the essential aspects of software reliability. Many research papers deal with the realistic time delaysbetween fault detection and correction process. This paper presents a new SRGM of the fault detectionprocess (FDP) and fault correction process (FCP). Previously, FCP was modeled as a delayed faultdetection process by taking a constant or random time delay. We studied the dependency between theFDP and FCP as the amount of fault dependency, not in time dependency. New models are proposed byadopting different fault dependency functions. These models are validated on two actual medium sizesoftware system data sets. The results show that the proposed models

fit the data set accurately other thanthe existing SRGMs. We have also discussed the optimal release time through a cost model where setup,testing, and debugging costs are introduced in both the testing and operational phases in the cost model.

**Paper ID: ICMAA_67**

## Numerical Approximation of p-dimensional Stochastic Volterra Integral Equation using Walsh Function

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**Abstract**

A numerical method is proposed to solve the following p-dimensionalstochastic Volterra integral equationsusing Walsh function approximation. The main goal is to transform integral equations into algebraic system and solve this further to get an approximatesolution to the integral equation. The convergence and error analysis of theproposed method are studied for the integral equation having functions inLipschitz class. The computation of various examples for which analytical solutionsare available shows that the proposed method is more accurate than the existingtechniques for solving linear p-dimensional stochastic Volterra integral equations.

**Paper ID: ICMAA_68**

## On the stability of the MHD flow over a shrinkingCylinder with heat source

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**Abstract**

The present analysis is devoted to study the stability of MHD stagnation point flowand heat transfer of an electrically conducting viscous incompressible fluid on a horizontalshrinking permeable cylinder in the presence of a volumetric heat source. The constraintsprescribed are as follows: the surface of the cylinder on which the flow takes place is apermeable surface with a constant cross flow as well as linearly varying heat flux. Moreover, thesurface of the cylinder is subjected to linearly varying shrinking velocity with a variable freestream and embodied constant volumetric heat source. The applied constraints of the presentanalysis are to meet the design requirement of the flows while processing the polymeric productsand biological fluid flows through the arteries and veins etc. Besides the above consideration, theapplication of the externally applied magnetic field which acts as a remote controlling devicewith embodied heat source making study realistic and applicable to physical phenomena wherethe stability of solution is warranted. The importance outcomes of the analysis are: increase inMagnetic parameter slightly increases the velocity in the flow domain which is contrary to theresistive nature of Lorentz force along main direction of flow. This can be attributed to theoverpowering effect of stretching/shrinking of the surface, first solution presents a stablefeaturewith an increase in velocity in the presence of heat sink commensurate with the strength, in theprocess of high fluctuation of the temperature there is a point of neutrality of thermal energydistribution irrespective of the presence of heat generation or absorption.

**Paper ID: ICMAA_69**

## Summability of Random Fourier-Jacobi Series

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This article is a study on the summability of random Fourier--Jacobi series of some functions in different spaces. We consider the random series

$$\sum_{n=0}^{\infty} a_n A_n(\omega) p_n^{(\gamma,\delta)}(y),$$

where $p_n^{(\gamma,\delta)}(y), \gamma, \delta > -1$ is an orthonormal Jacobi polynomial, the scalars $a_n$ defined as

$$\int_{-1}^{1} f(t) p_n^{(\gamma,\delta)}(t) dt$$

are the Fourier--Jacobi coefficients of a function $f$. The random variables $A_n(\omega)$ defined as

$$\int_{-1}^{1} p_n^{(\gamma,\delta)}(y) dX(t,\omega)$$

are the Fourier--Jacobi coefficients of symmetric stable process $X(t,\omega)$ of index $\alpha \in [1,2]$. It is established that the random Fourier--Jacobi series is $\Theta$--summable in probability to a stochastic integral, if $a_n$ are the Fourier--Jacobi coefficients of function $f$ in the space $C^{(\eta,\tau)}_{[-1,1]}$. The $Cesáro(C,\phi), \phi \geq 1$summability of random Fourier--Jacobi series is shown, for the symmetric stable process $X(t,\omega)$ of index $\alpha \in [1,2]$ under different conditions of the parameters $\gamma, \delta, \eta$ and $\tau$. The other cases of summability such as Riesz, Rogosinski, and etc. of random Fourier--Jacobi series of some function in the space $C^{(\eta,\tau)}_{[-1,1]}$ is also discussed. Further, the $Nörlund$, generalized $Nörlund$, lower triangular summability of random Fourier--Jacobi series is proved, if $a_n$ are the Fourier--Jacobi coefficients of a function $f \in L^{1,(\gamma,\delta)}_{[-1,1]}$ and $A_n(\omega)$ are associated with the symmetric stable process $X(t,\omega)$ of index one.

**Paper ID: ICMAA_70**

## Dissipative MHD flow of Nanofluid over an inclined stretching sheet with heat source and Soret effect

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**Abstract**

An analysis has been made to illuminate the unsteady MHDslip flow of Nanofluid over an inclined stretching sheet. The heattransfer has been analysed incorporating Darcy dissipation and heatsource. The presence of Soret effect makes the study more congenial.Using Similarity transformation technique, the governing partialdifferential equations are converted into a system of ordinary differentialequations. The reduced system is dealt with 4 th order Runge-Kutta method with shooting technique. The comparison with earlier results gives a reliability of present results.

**Paper ID: ICMAA_71**

## An Unbiased Estimator of Finite Population Variance Using AuxiliaryInformation

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**Abstract**

An unbiased estimator of finite population variance () using auxiliary information has been proposedunder simple random sampling without replacement (SRSWOR) scheme. The efficiency of theestimator under optimality is compared with the usual unbiased estimator , ratio type estimator ()due to Isaki (1983), product type estimator [ similar to Isaki (1983)] and regression type estimator )due to Isaki (1983), exponential ratio type estimator due to Singh et al. (2009), exponential product typeestimator due to Singh et al. (2009) both theoretically and empirically.

**Paper ID: ICMAA_72**

## Business Analytics approach to Evaluate Investors' Attitude : Based on UnstructuredOnline Information

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Keywords : Sentimental Analysis, Opinion Mining, Data Science, Machine learning, Classification, Pattern Recognition

**Abstract**

The Financial theory of this research is inspired by the investors' attitude on stock market andbased on both structured & unstructured information they used for prediction. In generalInvestors have varieties of Preferences, Objectives, Perceptions and importantly

Attitude forinvestment. They consider their investment needs, goals, objectives and constraints in makinginvestment decisions, but it is not possible at all times because of their sentiments and theinformation they are using to predict stock market. This is a known fact that modern stockmarket react very sensitively for their stock prices, so it is important to predict the prices. Theinvestors who put resources into securities exchanges for the most part don't know about theshare trading system conduct. They are confronting the issue of stock exchanging as theydon't know which stocks to purchase and which to offer keeping in mind the end goal toacquire benefits. In this study content analysis is done through prescriptive analytics as a typeof Business analytics approach by doing text opinion mining and sentimental analysis onunstructured secondary big data collected from online platform. In sentimental analysisstochastic model-based approach has been used. In this study impact of opinion on investorsdecision has been studied.

**Paper ID: ICMAA_73**

## Ring learning with error based Signal Leakage attack resilience Authenticated KeyExchange

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**Abstract**

Cryptographic concepts such as key exchange and authentication are used to establish securecommunication between two parties. There are various authentication protocols available toset up asecure network. Still, most of them rely on hard assumptions based on number theory(such as theDiscrete Logarithm Problem and Factorization assumption), which are no longersecure for post-quantum era due to the development of Shor's and Grover'salgorithms.In recent years, various post-quantum secure authentication protocols have been developed, butsome of these protocols have been found to be vulnerable to attacks such asstolen smart cardattacks, invalid login, or signal leakage attacks.In this article, we have discussed how the protocol Dharminder et al. (Dharminder D, Chandran KP.J Ambient IntellHumanizComput. 2020; 11:4089-4100.) is vulnerable to modified version ofsignal leakage attack, and sometimes called improved signal leakage attack. We have alsosuggested a remedy over the current existing protocol suffering from signal leakage attacks. Theproposed protocol is secure against quantum attacks. We have proved the security of the proposedprotocol under ring learning with errors assumption. The proposed authentication and keyagreement need only two messages exchange. We have also found the proposed is efficient in termsof computation with respect to relevant protocols.

**Paper ID: ICMAA_74**

## Effect of induced magnetic field and Hall current on MHD free convective flow of aOldroyd-B liquid in a vertical channel

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**Abstract**

The hydromagnetic flow of Oldroyd-B Model, (an experimentally supported realistic fluidmodel) through a vertical channel with both electrically conducting and non-conductingwalls having asymmetric wall temperatures is studied. The viscoelastic flow subjected totransverse magnetic field has been studied considering Hall current and induced magneticfield (IMF). Analytical solution (using theory of simultaneous differential equation) isobtained to the boundary value problem bringing out the effects of important parameters.Subsequently, for engineering interest, we the skin friction, mass flux and induced currentdensity for relevant parameters. MATLAB software is used for plotting graph and table. Thenovel findings reported here in, may be useful in the design of heat exchanger. There exists athreshold value of Hall parameter when it is exceeded, flow reversal occurs. The higher flowrate at the boundary surface is achieved due to magnetic induction at the cold plate. This alsohas an industrial bearing.

**Paper ID: ICMAA_75**

## Activation energy and binary chemical reaction impact on the MHD Casson-nano fluid flow over extending nonlinear surface in the occurrence of convective boundary condition

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**Abstract**

Activation energy provides sufficient energy by the reactants for appearance of the chemicalreaction with appliances in the industrial engineering, geothermal manufacturing, and

oilstorage. In this article, we address the influence of the activation energy with binary chemicalreaction on the magnetohydrodynamics Casson nanofluid flow over a non-linear stretchingsurface have analysed. Impact of the viscous dissipation, heat absorption and suctionintroduce in the system. Governing equations are highly coupled and nonlinear which issimplified by using the similarity transformation and then solve numerically by using finitedifference method. The velocity and temperature condition at the surface followed up withthe nonlinearity nature. The consequence of several governing factor on the velocity,temperature, concentration, skin friction, Nusselt number and Sherwood number has beendeliberated. Activation energy restricted the rate of heat transfer, while it enhanced the rateof mass transfer. However, a reverse phenomenon observed with enhancement in the value ofchemical reaction parameter.

**Paper ID: ICMAA_76**

## Existence results for vector mixed variational-like inequality

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**Abstract**

In this paper we consider the vector mixed variational like inequalityproblem in Banach space with the ordering induced by a cone. The main involvedoperator here, is set valued mapping. Existence results for vector mixed variational-like inequality have been established with the help of KKM mapping.

**Paper ID: ICMAA_77**

## COEFFICIENT BOUNDS FOR THE FAMILY OF BOUNDED TURNING FUNCTIONS ASSOCIATED WITH TAN HYPERBOLIC FUNCTION

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**Abstract**

Let $A$denote the class of all analytic functions having Taylor-Maclaurin series of the form $h(z) = z + \sum_{n=2}^{\infty} h_n z^n$with normalized condition $h(0) = 0$ and $h'(0) - 1 = 0$. In the present investigation introduced the class of bounded turning functions associated with tan hyperbolic functions. Sharp upper bounds for some of the initial coefficients, $Fekete - Szegö$ functional, third Hankel determinant, Zalcman conjecture and Krushkal inequality are investigated for the class defined. Further, $Fekete - Szegö$ inequality for the function $\xi\, h(\xi)$ and inverse function $h^{-1}$ for the above mentioned class are obtained.

**Paper ID: ICMAA_78**

## DEGREE OF APPROXIMATION OF FOURIER SERIES OF FUNCTIONS IN BESOV SPACE BY DEFERRED RIESZ MEAN

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**Abstract**

In the present work, we estimate the rate of convergence of Fourier series of functions by Deferred Riesz mean in Besov space which is a generalization of H(α, p) space.

Keywords: Deferred Ces`aro mean; Deferred Riesz mean; Fourier series; Besov space.

**Paper ID: ICMAA_79**

## ON THE CONVERGENCE OF RANDOM FOURIER – HERMITE SERIES

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**Abstract**

This article is a study on the convergence of the random Fourier series $\sum a_n A_n(\omega)\psi_n(t)$ in Hermite polynomial. Here $\psi_n(t)$ are orthonormal Hermite functions, that is $\psi_n(t) = \frac{1}{\sqrt{\sqrt{\pi}2^n n!}} e^{\frac{-t^2}{2}} H_n(t)$ and the scalars $a_n$ are Fourier –Hermite coefficients of a function $f$ defined as $a_n = \int_{-\infty}^{\infty} f(t)\psi_n(t)dt$. The random variables $A_n(\omega)$ are the Fourier – Hermite coefficients of a symmetric stable process $X(t,\omega)$ of index γ, defined as $\int_{-\infty}^{\infty} \psi_n(t)dX(t,\omega), 1 < \gamma \leq 2$. They are found to be dependent. It is shown that if $f \in L^p(\mathbb{R}), \frac{4}{3} < p \leq 2$, then the random series convergence to the stochastic integral $\int_{-\infty}^{\infty} f(s,t)dX(t,\omega)$ in mean. Further it is shown that, if $f$ is in the weighted $L^p(\mathbb{R})$ space with Weight $U(t) = e^{\frac{-t^2}{2}}(1+|t|)^b, \frac{-1}{p} < b < 0$ such that $f(t)U(t) \in L^p(\mathbb{R}), 1 < p \leq 2$ then the series $\sum a_n A_n(\omega) H_n(t) U(t)$ converges to $\int_{-\infty}^{\infty} f(s,t)U(t)dX(t,\omega)$ in mean.

**Paper ID: ICMAA_80**

## A NOISEY LACUNARY CUBIC SPLINE INTERPOLATION AND A SIMPLE NOISY CUBIC SPLINE QUASI INTERPOLATION ERROR ANALYSIS

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**Abstract**

Its main purpose is to provide analysis of two errors novel based on cubic spline algorithms. Patchy interpolation is one, while extremely basic quasi-interpolation is the other. From the noisy function data, the novel approach can rebuild the function and its first two derivatives. The method's clear error range is demonstrated and proved. Numerical comparisons and testing are carried out. The effectiveness of our strategy is demonstrated by numerical results.

**Paper ID: ICMAA_81**

## An extension of Tauberian theorems for Double Sequences

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**Abstract**

This work establishes the Tauberian conditions which allows the implication of Pringsheim's convergence of a double sequence of real numbers from its double deferred (D(p; q : r; s))-summability.

**Paper ID: ICMAA_82**

## ESTIMATION OF FERTILIZER REQUIREMENT FOR TARGETED YIELD

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**Abstract**

STCR is a quantitative method to recommend fertilizer doses for obtaining targeted yield based onChemical analysis of soil. It is based on the assumption that definite dosages of fertilizers must beconsumed by the plant as uptake for achieving a particular yield. Once these values of the dosagesare determined, the amount of artificial fertilizers needed to be added to the soil can be computedconsidering contribution of nutrients available in soil. Since its inception as an AICRP project in1967, the method has been extensively used. The

drawback of the method is twofold. Whilecalculating targeted yield, the method assumes that the relationship between uptake andyield is linear. There may not be a linear relationship between the two. Moreover, themethod assumes that uptake of a particular nutrient in the plant depends only on the effectof that fertilizer present in the soil and provided to the soil. Several studies point to the factthat uptake of a particular nutrient depends on all fertilizers applied to the crop. To reducethe error in calculation due to drawbacks of the STCR method presently being followed, inthis paper we have constructed a mathematical model to estimate the fertilizer requirementfor a targeted yield. An experimental data of millet plantation [2] was taken into account, asan example. Newton's unconstrained optimization technique and methods of solving a system of linear equations have been used along with MATLAB and EXCEL to determine thefertilizer requirement for given targeted yield.

**Paper ID: ICMAA_83**

## Karmarkar projective scaling algorithm: An alternative approach

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**Abstract**

This paper delineates a modification of Karmarkar's projective scaling algorithm, which is presented as a simplified form as well as provides more computational efficiency to linear programming problem. The revised algorithm fastens on the concept of Karmarkar's original algorithm and projected scaling algorithm. This method works with a suitable steepest descent direction and a better step size choice. The study describes computational significance of the algorithm by taking numerical experimentation as well as discussed the complexity of the algorithm We also highlight the rate of convergences and linear convergence of the algorithm.

Paper ID: ICMAA_84

# A note on soft lattice with neutrosophy

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## ABSTRACT

Many mathematical tools have been developed to solve the problems of imprecision, vague and uncertain. The concept of soft set has been discovered to deal with these above problems. Due to D. Molodtsov(1999), Soft set theory has a rich potential for applications in several directions like economics, engineering, medical science etc. A pair $(F, A)$ is called soft set over $U$, where $F$ is a mapping given by $F : A \to P(U)$. A soft set over $U$ is a parametrized family of subsets of the universe $U$. For $e \in A$, $F(e)$ may be considered as the set of $e-$approximate elements of the soft set $(F, A)$. For eg. suppose $U = \{h_1, h_2, h_3, h_4, h_5, h_6\}$ is the set of houses, $A - \{e_1, e_2, e_3, e_4\} - \{$ expensive, beautiful,wooden, cheap $\}$ is the set of parameters. Suppose $F(e_1) = \{h_2, h_4\}, F(e_2) = \{h_1, h_3\}, F(e_3) = \{h_3, h_4, h_5\}$ and $F(e_4) = \{h_1, h_3, h_5\}$. Here $F(e_1)$ means $h_2$ and $h_4$ houses are expensive, similarly the others. The soft set $(F, A)$ is a parametrized family $\{F(e_i), i = 1, 2, 3, 4\}$ of subsets of the set $U$ and gives s a collection of approximate descriptions of an object.

Neutrosophy is a new branch of vagueness philosophy. It is the study about the origin, nature and scope of neutralities as well as their interactions with different additional spectra. Neutrosophic sets have a significant role for clustering, segmentation and classification in numerous medical image processing applications. Netrosophic set is defined by three membership function that is true(T), indeterminate(I) and false(F) respectively. where $]0^-, 1^+[$ is the non-standard unit interval. The neutrosophic set $A$ is a set of objects defined on the universe of discourse $U$ as

$$A - \left\{ \left\langle \frac{x}{\mu_A(x), \nu_A(x), \omega_A(x)} \right\rangle : x \in U \right\},$$

where the function $\mu, \nu, \omega : U \to ]0^-, 1^+[$ and $^-0 < \mu_A(x) + \nu_A(x) + \omega_A(x) < 3^+$, $\forall x \in U$, where $\mu_A(x)$ denote the degree of truthness, $\nu_A(x)$ denote the degree of indeterminacy and $\omega_A(x)$ denote the degree of falsity.

The lattice structure appeared in the middle of 19th century in the form of Boolean algebra due to George Boole in 1854. Boolean algebra deals with operations on logical values

and binary variables 0 and 1. In 1930s the general development of lattice theory was due to G. Birkhoff. For $H = (H, \preceq)$ be a partially ordered set, H is called a lattice if for any two elements $p$ and $q$ of $H$ have a least upper bound $p \vee q$ and a greatest lower bound $p \wedge q$ are in $H$.

The purpose of the article is to expand the scope of soft set, neutrosophic set and lattice set theory. We introduced here a concept of neutrosophic soft lattice. Let $L$ be a lattice, $E$ be set of parameters on $L$ and $A \subseteq E$. Let NL be the set of all neutrosophic lattices, then the collection $(F_S, A)$ is called neutrosophic soft lattice over $L$, where $F_S$ is a mapping given by $F_S : A \to NL$.

Paper ID: ICMAA_85

## New Generalized Geometric Difference Sequence Spaces with Geometric Laplace Transformation

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In this current study, the most apparent aspect is to submit a new geometric sequence space. The new geometric sequence spaces is now being introduced as follows

$$(C, 1)_G(\Delta_G^m) =$$
$$\left\{ x = (x_i) \in \omega(G) : {}_G\lim_{n\to\infty} (e \odot e^n) \oplus {}_G\sum_{i=1}^{n} (\Delta_G^m x_i \ominus L)^G = 1, \text{ for some } L \right\},$$
$$[C, 1]_G(\Delta_G^m) =$$
$$\left\{ x = (x_i) \in \omega(G) : {}_G\lim_{n\to\infty} (e \oslash e^n) \ominus {}_G\sum_{i=1}^{n} \Delta_G^m x_i \ominus L|^G = 1, \text{ for some } L \right\},$$
$$(V, \lambda)_G(\Delta_G^m) =$$
$$\left\{ x = (x_i) \subset \omega(G) : {}_G\lim_{n\to\infty} (e \odot e^{\lambda_n}) \ominus {}_G\sum_{i\in I_n} (\Delta_G^m x_i \ominus L)^G = 1, \text{ for some } L \right\},$$

$$[V, \lambda]_G(\Delta_G^m) =$$
$$\left\{ x = (x_i) \in \omega(G) : {}_G\lim_{n\to\infty} (e \oslash e^{\lambda_n}) \ominus {}_G\sum_{i\in I_n} |\Delta_G^m x_i \ominus L^G - 1, \text{ for some } L \right\}.$$

We investigate its topological properties , inclusion relations, Geometric statistical convergence and Geometric property of Orlicz function and we also check its dual properties. Moreover, We discuss about the properties and applications of geometric Laplace transformations.

Paper ID: ICMAA_86

# CHANCE-CONSTRAINED PROGRAMMING PROBLEM WITH TWO PARAMETERS FUZZY EXPONENTIAL RANDOM VARIABLE

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**Abstract:**

A method for solving CCP(Chance Constrained Programming) with a two-parameters exponential random variable with density is given by

$$f(x) = \frac{1}{\lambda} e^{\frac{-1(x-\mu)}{\lambda}}$$

Here the parameters μ and $\lambda$ are called location and scale parameters of the exponential distribution We call the location parameter μ as the minimum guarantee time and, $\lambda$ is the mean of the distribution. Also, the solution of CCP is derived in a mixed environment i.e., the parameters are both random as well as fuzzy. The problem is converted to its deterministic equivalent by the fuzzy probability theory. Finally, the method is justified by numerical examples.

Paper ID: ICMAA_87

# Degree of approximation of conjugate Fourier series of $H_p^\omega$-functions by using $R_1(\beta)$-mean, for $\beta = 2$.

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**Abstract**

In this paper we have established a result on degree of approximation of functions belonging to the generalized Hölder metric space $H_p^\omega$ using $R_1(\beta)$-mean of its conjugate Fourier series, for $\beta = 2$ and the estimation involves Jackson's order is given by

$$\|\tilde{\omega}_n(\tilde{f}) - \tilde{f}(\pi/n)\|_p^\nu = O\left(\frac{1}{\log n}\right),$$

where $\omega$ and $\nu$ are moduli of continuity such that $\nu(t)$ and $\frac{\omega(t)}{\nu(t)}$ are nondecreasing.

# LIST OF CONFERENCES OF O.M.S.

| | | | |
|---|---|---|---|
| 50. | 50th | 2023 ( 21st -22nd January) | Institute of Mathematics & Applications Andharua, Bhubaneswar -751029 |
| 49. | 49th | 2022 ( 26th -27th March) | P.G. Department of Mathematics, Utkal University Vani Vihar, Bhubaneswar-751004 |
| 48. | 48th | 2021 (10th-11th April ) | Institute of Mathematics and Applications, Andharua, Bhubaneswar-751029. |
| 47. | 47th | 2020 (15th – 16th Feb) | National Institute of Science and Technology, Palur Hills, Berhampur-761008. |
| 46. | 46th | 2019 (19th-20th Jan) | Silicon Institute of Technology, Patia, Bhubaneswar-751024. |
| 45. | 45th | 2018 ( 3rd-4th Feb) | Parala Maharaja Engineering College, Sitalapalli, Berhampur-761003. |
| 44. | 44th | 2017 ( 31st March-1st April) | Ravenshaw University, Cuttack-753003 |
| 43. | 43rd | 2016 (16th-17th Jan) | Indus College of Engineering, Barkud Heights, Sundarpada, Bhubaneswar -752050. |
| 42. | 42nd | 2015 (7th-8th Feb) | Vyas Nagar Autonomous College, Jajpur Road Jajpur-755019. |
| 41. | 41st | 2014 (4th-5th Jan) | KIIT University, Bhubaneswar-751024. |
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| 39. | 39th | 2012 (4th-5th Feb) | Vivekananda Institute of Technology (VVTECH), Chhatabar, Bhubaneswar-752054. |
| 38. | 38th | 2011 (8th-9th Jan) | ITER, S O A University, Bhubaneswar-751030. |
| 37. | 37th | 2010 (6th-7th Feb) | Indira Gandhi institute of Technology (I.G.I.T), Sarang -759146, Dhenkanal. |
| 36. | 36th | 2009 (7th-8th Feb) | Institute of Mathematics and Applications (IMA), Andharua, Bhubaneswar-751003. |
| 35. | 35th | 2008 (2nd-3rd Feb) | Sailabala Women's College, Cuttack-753001. |
| 34. | 34th | 2007 (28th-29th Jan) | Vyasanagar College, Jajpur road, Jajpur -755019. |
| 33. | 33rd | 2006 (4th-5th Feb) | School of Mathematical Sciences, Sambalpur University, Jyoti Vihar, Sambalpur-768019. |
| 32. | 32nd | 2005 (5th-6th Feb) | National Institute of Science and Technology, Palur Hills, Berhampur-761008 |
| 31. | 31st | 2004 (7th-8th Feb) | Institute of Mathematics and Applications, Bhubaneswar-751003. |
| 30. | 30th | 2003 (22nd-23rd Feb) | Institute of Advanced Computer and Research , (presently known as Gandhi Institute of Advanced Computer and Research), Barijhola, Rayagada-765002. |
| 29. | 29th | 2002 (23rd-24th Feb) | Orissa Engineering College, Nabajyoti Vihar , Nijigarh Kurki, P O : Jatani , Bhubaneswar-752050. |
| 28. | 28th | 2001(27th-28th May) | Institute of Mathematics and Applications (Pathani Samanta Planetorium), Bhubaneswar. |

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| 27. | 27th | 2000 (11th-12th March) | Utkal University, Vanivihar, Bhubaneswar-751004. |
| 26. | 26th | 1998 (24th-25th Dec) | S.C.S. College, Chandan Hajuri Road , Puri-752001 |
| 25. | 25th | 1998 (23rd-25th Jan) | Utkal University, Vani Vihar, Bhubaneswar – 751004. |
| 24. | 24th | 1997 (8th-9th Feb) | Kavi Samrat Upendra Bhanj College, N.H-59 , Bhanjanagar-761126 , Ganjam. |
| 23. | 23rd | 1996 (2nd-3rd Feb) | Berhampur University, Bhanj Vihar, Berhampur-760007. |
| 22. | 22nd | 1995 (3rd-4th March) | Revenshaw College, Cuttack-753003. |
| 21. | 21st | 1994 (27th-28th Feb) | Fakir Mohan College, Balasore-756019 |
| 20. | 20th | 1993 (20th-21st Feb) | Salipur College, Salipur -754202 , Dist : Cuttack |
| 19. | 19th | 1992 (22nd-23rd Feb) | Utkal University, Vani Vihar, Bhubaneswar-751004 |
| 18. | 18th | 1990 (28th-29th Dec) | REC, Rourkela-769008. |
| 17. | 17th | 1990 (3rd-4th March) | Sambalpur University, Jyoti Vihar, Sambalpur-768019. |
| 16. | 16th | 1989 (14th-15th Jan) | Khallikot College, Khallikote-760001. |
| 15. | 15th | 1988 (13th -14th Feb) | BJB college, Kalpana Road , Bhubaneswar-751014. |
| 14. | 14th | 1987 (1st-2nd March) | Revenshaw college, Cuttack-753003. |
| 13. | 13th | 1985 (23rd-24th Dec) | Sambalpur University, Jyoti-Vihar,Sambalpur-768019. |
| 12. | 12th | 1984 (30th-31st Dec) | Banki College, Banki-754008. |
| 11. | 11th | 1984 (29th-30th Jan) | U C E, Burla-768018. |
| 10. | 10th | 1983 (12th-13th Feb) | O U A T, Bhubaneswar -751003. |
| 9. | 9th | 1982 (14th-15th Feb) | Sambalpur University, Jyoti Vihar,Sambalpur-768019. |
| 8. | 8th | 1981 (7th-8th March) | BJB College, Kalpana Road , Bhubaneswar-751014 |
| 7. | 7th | 1980 (27th-28th Jan) | Utkal University Vani Vihar, Bhubaneswar-751004. |
| 6. | 6th | 1977 (19th-21st Dec) | Kendrapara College, Kajala, Kendrapara-754211 |
| 5. | 5th | 1976 (21st-23rd Dec) | Berhampur University, Bhanj Vihar, Berhampur-760007. |
| 4. | 4th | 1975 (20th - 22nd Dec) | GM College, Sambalpur-768004 |
| 3. | 3rd | 1974 (22nd-24 Dec) | Revenshaw College, Cuttack-753003 |
| 2. | 2nd | 1974 (20th-22nd Jan) | Dept. of Mathematics, REC, Rourkela-769008 |
| 1. | 1st | 1973 (20th-21st Jan) | P. G. Dept. of Mathematics, Utkal University, Vanivihar, Bhubaneswar-751004. |

# FELICITATION IN DIFFERENT CONFERENCES OF O.M.S.

**50th Annual Conference : 21st and 22nd January 2023**
**Venue : Institute of Mathematics & Applications,Andharua,Bhubaneswar-751029**

(i) Prof. Arabind Das, Retd from Ekamra College,Bhubaneswar
(ii) Prof. Prasanna Kumar Satpathy , Retd. From SCS College,Puri
(iii) Sri Ashok Pradhan, Retd School teacher of Satyabadi High School

**49th Annual Conference : 26th and 27th March 2022**
**Venue : P.G.Department of Mathematics,Utkal University,Vani Vihar,Bhubaneswar-751004**

(i) Prof. Maheswar Mishra (Retd from Govt. College)
(ii) Prof. Dayanidhi Parida (Retd. From Govt. College)
(iii) Prof. Gourang Charan Dash (Retd. From UCE , Burla)
(iv) Prof. Durga madhab Mishra (Retd from G.M.College,Govt.)
(v) Sri Nagendra Kumar Mishra (Retd. Teacher,Pyari Mohan Academy,Cuttack)
(vi) Late Prof. Shankar Prasad Mishra (Founder General Secretary of OMS and former Professor and Head of P.G.Department of Mathematics,Utkal University,Vani Vihar)

On the occasion of Golden Jubilee Celebration, following members of OMS are rehonoured.

(vii) Prof. Siba Prasad Mishra
(viii) Prof. Rama Sankar Rath
(ix) Prof. Gokulananda Das
(x) Late Prof. Ramanath Mohanty
(xi) Late Prof. Bama Charan Das
(xii) Late Prof. Brajabandhoo Misra
(xiii) Late Prof. Ghanashyam Samal
(xiv) Late Prof. Tribikram Pati

**48th Annual Conference : 10th and 11th April 2021**
**Venue : Institute of Mathematics & Applications,Andharua,Bhubaneswar-751029**

(i) Sri Khetrabasi Das(Retd.) , Manpur Nodal U.P.School, Ali , Dist: Kendrapara
(ii) Prof.(Dr.) S .A. N. Moorthy (Retd. Kendrapara College)
(iii) Prof. Surendra Nath Mohapatra (Retd. Kendrapara College)
(iv) Prof.(Dr.) Rabindra Kumar Patnaik (Retd. He was at Pillani and Silcon Institute)

**47th Annual Conference : 15th and 16th February 2020**
**Venue : National Institute of Science and Technology (NIST) ,Palur Hills,Berhampur-761008**

(i) Sri Lalit Mohan Das(Retd.) ,H(Habback).H. School,G Udayagiri ,Kandhamal
(ii) Prof. (Dr.) Chandra Kishore Mohapatra(Retd.),Sambalpur University
(iii) Prof. (Dr.) Sudarsan Padhy(Retd.) , Utkal University
(iv) Prof. (Dr.) Umakant Mishra (Retd.), Berhampur University

**46th Annual Conference : 19th and 20th January 2019**
Venue : **SILICON INSTITUTE OF TECHNOLOGY(SIT),SILICON HILLS ,PATIA BHUBANESWAR-751024**

(i) Late Sri Narayan Pati : Retired from Govt School,Cuttack
(ii) Late Prof.Subash Chandra Jena ,Retired from Govt.College,Odisha

45th Annual Conference : 3rd and 4th February 2018
Venue : Parala Maharaja Engineering College (PMEC),Sitalapalli,Berhampur-761003, Dist: Ganjam
Sri Madan Mohan Samal ,Retired Teacher , Jayaram High School, Karilopatana, Kendrapara
Late Prof.(Miss) Priti Mohapatra (Utkal University)
Late Prof.Shantilata Mishra ( Utkal University )
Prof. Chakradhar Das (Retired from NIT,Rourkela)
Prof.Tarini Charan Panda ( Retired from Berhampur University)

44th Annual Conference : 31st March and 1st April 2017
Venue : Ravenshaw University,Cuttack-753003
Prof. (Mrs) Subhadra Rath (Rtd . from Berhampur Univ.) ,
Late Prof. Akshya Kumar Mohanty (Rtd.from V.N.College,Jajpur Road)
Sri Umakant Mishra ( Rtd. School teacher from Govt. High School, Medical Campus, Berhampur )

43rd Annual Conference : 16th and 17th January-2016
Venue : Indus College of Engineering,Barakuda Heights ,Bhubaneswar-752050,Khurdha
Sri Prafulla Chandra Samantaray (Retired school teacher) Jamapara Boys High School, Jampara, Kendrapara
Sri Shyam Sundar Panda (Retired School teacher), Prithwiraj High School, and DIET,Bolangir
Prof. Gopal Chandra Hotta (Retired from Govt. College ,Khalikote,Ganjam )
Late Prof.Krutibas Dutta (Statistics) (Rtd. from Sambalpur University, Jyoti Vihar,Burla)

42nd Annual Conference : 7th and 8th February-2015
Venue : Vyasa Nagar Autonomous College , Jajpur Road
Sri Bhikari Charan Sahu ,Sri Ananta Charan Sethi (School teachers).
Prof.Narahari Parhi, Prof.Indulata Shukla , Prof. Bhagaban Patra (Univ/College)

41st Annual Conference : 4th and 5th January-2014
Venue : KIIT University ,Bhubaneswar-24
Sri Raghunath Mohapatra , Sri Parsuram Sahoo (school teachers).
Prof.Sudarsan Nanda (Rtd. from IIT,Kharagpur)
Prof.Trilochan Biswal (Rtd from BJB College)
Late Prof. Sashikanta Mishra (Rtd from BJB College)

40th Annual conference : 29th and 30th December 2012
Venue : Sambalpur University, Jyoti Vihar ,Burla
Sri Pramod Kumar Mishra , Sri Prafulla Kumar Puhan ,Sri Bhojraj Swain ( School teachers )
Prof.Banamali Mishra ,Prof.Chittaranjan Samantaray,Prof.Udaya Nath Samantaray,
Prof.Purna Chandra Das (Univ./College teachers)

39th Annual Conference : 4th and 5th February-2012
Venue : VIVTECH ,Chhatabar,Bhubaneswar-752054
Sri Bankim Chandra Moharana, Sri Laxaman Kumar Sahu (school Teachers)
Prof.P.C.Das ( Former Prof.,IIT,Kanpur),Prof.Dipti Rath(BU), Prof.B.B.Panda (SU),
Late Prof.Sribatsa Nanda(REC,RKL), Late Prof. Jairam Parida(REC,RKL), Late Prof.Sridhar P.Mohanty(IIT,Kanpur) (Univ/College teachers)

38th Annual Conference : 8th and 9th January-2011
Venue : ITER,SOA University, Bhubaneswar
Sri Dular Singh Nayak (School teacher).
Prof. Srigopal Mohanty( Statistics,Canada) , Prof. (Miss) Bhabani Rout(Ravenshaw) ,
Prof.Muralidhar Samal(Ravenshaw), Prof.Braja Kishore Roy (Univ/College teachers)

37th Annual Conference : 06-Feb-2010 to 07-Feb-2010
Venue : Indira Gandhi Institute of technology, Sarang, Dhenkanal
*Prof. R. K. Panda, Prof. S pattanayak, (College/Univ)*
*Shri Debesh Chandra Mukherjee. (School teacher, Talcher)*

36th Annual Conference : 07-Feb-2009 to 08-Feb-2009
Venue : Institute of Mathematics and Applications, Bhubaneswar
*Prof. Karamat Ali, Prof. R. S. Rath, Prof. M.N. Mishra (Statistics,Sambalpur Univ.),*
*Prof. J. Sarangi (Statistics,UU), Prof. B.P. Acharya & Sri Sishir Kumar Sathpathy*

35th Annual Conference : 02-Feb- 2008 to 03-Feb-2008
Venue : Sailabala Women College, Cuttack
Prof. Gokulananda Das (Rtd. From Utkal University,Vani Vihar)
Shri Madan Mohan Mahanty ( Rtd. from ,BSE,Cuttack )

29th Annual Conference : 23rd and 24th February 2002
Venue : Orissa Engineering College ,Bhubaneswar
Prof. Jyotirmoy Sinharoy ( Utkal University)

25th Annual Conference : 24-Jan-1998 to 25-Jan-1998
Venue : Utkal University, Vani Vihar, Bhubaneswar
Prof. Tribikram Pati (University) , Sri Brundaban Singh

24th Annual Conference : 08-Feb-1997 to 09-Feb-1997
Venue : K S U B College, Bhanjanagar
Prof. N.N. Swamy , Sri Dandapani Panigrahi & Sri Gopinath Khadenga

23rd Annual Conference : 02 Mar-1996 to 03-Mar-1996
Venue : Berhampur University, Bhanj Vihar ,Berhampur
Prof. Nanda Kishore (Berhampur University) and Sri Debaraj Pattnaik

22nd Annual Conference : 03-Mar-1995 to 04-Mar-1995
Venue : Ravenshaw College , Cuttack
Sri B.N Ray, Prof. Siba Prasad Mishra, Sri Anirudha Mohanty

21st Annual Conference : 27-Feb-1994 to 28-Feb-1994

Venue : Fakir Mohan College, Balasore
Late Prof.Minaketan Das , Smt. Sindumati Devi , Sri Sachindra Chandra Das,
Late Sri Lambodar Acharya

20th Annual Conference : 20-Feb-1993 to 21-Feb-1993
Venue : Salipur College ,Salipur
Prof. Umakanta Mahapatra , DR.(Mrs) Prativa Devi, Shri Bhagaban Mishra
& Shri Chandra Sekhar Dalua

19th Annual Conference : 22-Feb-1992 to 23-Feb-1992
Venue : Utkal University, Vani Vihar, Bhubaneswar
Prof. Ghanshyam Samal , Sri Sudhansu Sekhar Dubey & Sri Khageswar Das

18th Annual Conference : 22-Dec- 1990 to 23-Dec- 1990
Venue : REC, Rourkela
Prof. A. K Das(REC,RKL) , Dr. K .C. Nayak(REC,RKL) & Shri Bana Bihari Singh .

17th Annual Conference : 03- Mar-1990 to 04-Mar-1990
Venue : Sambalpur University, Jyoti Vihar
Prof. B S K R Somayajulu & Sri Kanhu Charan Panda

16th Annual Conference : 14-Jan-1989 to 15-Jan-1989
Venue : Khallikot College , Khallikot
Prof. Madan Mohan Nanda, Shri P.V. Chalapati Rao
and Shri Jugal Kishore Panigrahi

15th Annual Conference: 03-Feb-1988 to 04-Feb- 1988
Venue : BJB College, Bhubaneswar
Prof. Sankarshan Mohapatra , Prof. Jayanarayan Panda & Shri Padmanabha Das

14th Annual Conference : 01-Mar-1987 to 02-Mar-1987
Venue : Revenshaw College , Cuttack
Prof. Sarasi Mohan Das ( Principal of Stewart Science College , Cuttack)
Prof. Siba Kumar Panda ( Principal of BJB College, Bhubaneswar)
Sri Pranabandhu Jena (Teacher of Bhadrak High School )

13th Annual Conference : 23-Dec-1985 to 24-Dec-1985
Venue : Sambalpur University, Jyoti Vihar
Prof. Brajabandhoo Misra & Shri Indu Bhushan Dasgupta

12th Annual Conference : 30-Dec-1984 to 31-Dec-1984
Venue : Banki College, Banki
Prof. Ramanath Mohanty (Founder President of OMS),
Prof. Bama Charan Das ,
Shri Nanda Kishore Rath (School teacher,Cuttack )

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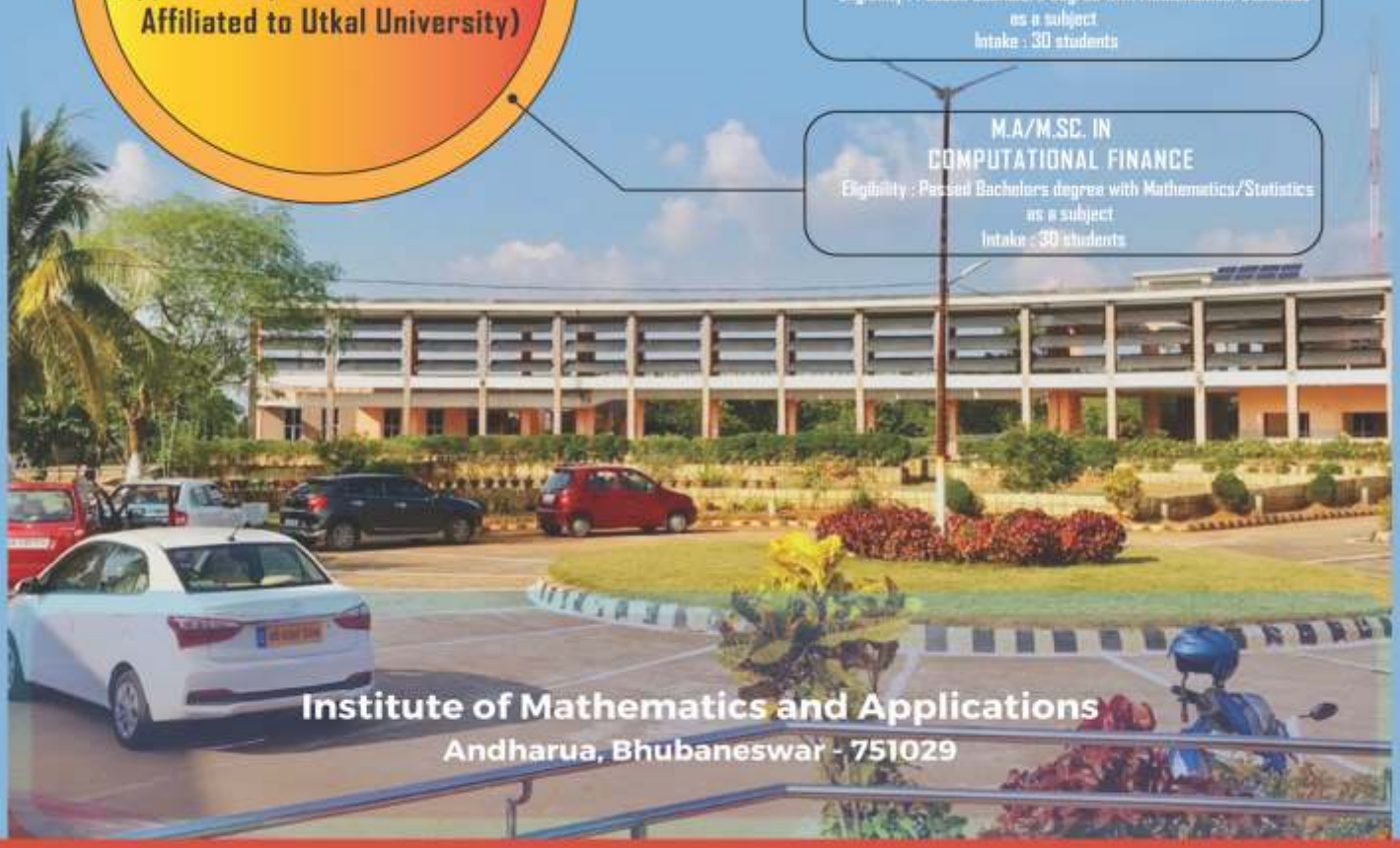


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