70th Congress of Indian Society of Theoretical and Applied Mechanics

(ISTAM-2025, An International Conference)

10-12 December, 2025

Mathematics Division
School of Advanced Sciences and Languages
VIT Bhopal University

ISTAM-2025
10-12 December, 2025

VIT BHOPAL
www.vitbhopal.ac.in

Mathematics Division
School of Advanced Sciences and Languages
VIT Bhopal University
Kothrikalan, Sehore, Madhya Pradesh, India-466114

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DEPARTMENT OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION

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ISTAM-2025

The 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM) — ISTAM-2025 — is being held from 10 to 12 December 2025 at VIT Bhopal University, Kothrikalan, Sehore District, Madhya Pradesh, organized by the Mathematics Division of the School of Advanced Sciences and Languages. Established in 1955, ISTAM has grown into a premier international forum for scientists, engineers, and technologists from India and abroad to engage in research discussions spanning theoretical and applied mechanics. Its core mission is to promote interdisciplinary exchange and address emerging societal and engineering challenges through advancements in mechanics. As an international conference, ISTAM-2025 aims to bring together emerging and established researchers, developers, and practitioners to foster meaningful interactions, stimulate new ideas, and encourage collaborations among research groups. This 70th Congress offers a dynamic platform for participants from both academia and industry to present their original work, share insights, and exchange knowledge, methodologies, and applications in the following areas:

Conference topics	
Section I: Fluid Mechanics	Section II: Solid Mechanics
FM1 Aerodynamics and Propulsion	SM1 Aerospace Structures
FM2 Atmospheric Sciences and Oceanography	SM2 Computational Solid Mechanics
FM3 Biofluid Dynamics	SM3 Control Structures
FM4 Boundary Layer and Compressible Flows	SM4 Elasticity
FM5 Computational Fluid Dynamics	SM5 Experimental Method in Solid Mechanics
FM6 Electro hydrodynamics and Magnetohydrodynamics	SM6 Fracture Mechanics
FM7 Experimental Methods in Fluid Dynamics	SM7 Mechanics of Composites
FM8 Geophysics and Astrophysics	SM8 Viscoelasticity and creep
FM9 Heat and Mass Transfer	SM9 Robotics and Control
FM10 Heat Transfer and Fluid Flow in Porous Media	SM10 Wave Propagation Fluid Mechanics
FM11 Low Reynold's Number Flow & Environmental Fluid Dynamics	
FM12 Mathematical Modelling	
FM13 Multiphase Flow	
FM14 Non-Newtonian Fluid Flow	
FM15 Stability of Fluid Flow	

Further details can be found at https://vitbhopal.ac.in/istam-2025/

About the Organizers

School of Advanced Sciences and Languages (SASL)

The School of Advanced Sciences and Languages (SASL) in VIT Bhopal is principally concerned with blending the best knowledge of science and humanities with Engineering to align the expertise of our students with the ever changing technological requirements. The school offers numerous core and elective courses, developed in collaboration with international academia and industrial experts, in Mathematics, Chemistry, Physics, English and Humanities. The school imparts knowledge by employing student centered teaching approaches via state-of-the-art studio classrooms equipped with wave 2.0 technology. The school is also involved in the research where researchers and scholars in partnerships with government, industry and nonprofit organizations, develop cutting-edge technology and innovations to serve our society. The research carried out by our faculty members, with diverse research profiles and with industrial and international working experience, ranges from basic areas such as Drug Design, Microbiology, Molecular Modeling, Energy & the Environment, Materials, Catalysis, Nonlinear Dynamics, Differential Equations, Numerical Methods, Graph Theory, Space Science, Astrophysics, Solar Physics and Computational Linguistics to interdisciplinary areas such as Biotechnology, Nano-Electronics, Computational Biology, Machine Learning in Biology & Chemistry, Sociolinguistics, Teaching Pedagogy etc. The school imparts knowledge of natural sciences and languages to the B. Tech, Int. M.Tech, M.Tech, MCA and PhD students by employing student centered teaching approaches via CALTech (Collaborative and Active Learning through Technology), including hands-on experience in the state-of-the-art laboratories & studios.

VIT Bhopal University

VIT Bhopal University, envisioned with a new global outlook will empower its participants to attain excellence through learning. The comprehensive teaching methodology designed by the University redefines the approach to learning, educating and building knowledge-based societies in the country. Collaboration with reputed national and international organizations as well as strategic partnerships with universities around the world are being established to prepare a globally competent generation of professionals.

Acknowledgment

We express our sincere and heartfelt gratitude to the university management for granting us the opportunity and extending their wholehearted support to host **ISTAM-2025** and inspiration throughout the entire conference. Their vision, encouragement, and constant guidance have been instrumental in bringing this prestigious event to our institution. We deeply appreciate their commitment to fostering a vibrant academic environment that promotes research, innovation, and scholarly collaboration.

We are eternally grateful to The Indian Society of Theoretical and Applied Mechanics (ISTAM) for providing us the opportunity and the honour of hosting 70th Congress of ISTAM this year. It has been a privilege to play host to this esteemed event, which unites prominent scholars, practitioners, and researchers from all across the nation and beyond.

The event would not have been the same high-quality academic meeting it was without the Executive Council of ISTAM's steady direction, unfaltering backing, and insightful recommendations. The Scientific and Technical Committees' contributions are greatly appreciated; their careful evaluation and considerate suggestions maintained the high standards set by the Congress.

The event's success would not have been possible without the hard work, cooperation, and dedication of the organizing committee, technical teams and student volunteers.

All of us are deeply indebted to the sponsor, "Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation" under "Research & Development Programme in Water Sector and Implementation of National Water Mission" scheme that have helped make this Congress a reality.

Finally, we would like to express our gratitude to all of the delegates whose active participation and attendance contributed to the ISTAM Congress becoming an exceptional academic event.

Dr. Reena Jain
Convenor, ISTAM-2025
On behalf of the Organizing Committee

Preface

It gives us immense pleasure to present this Souvenir of the **70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025)**-an event that stands as a distinguished forum for advancing knowledge, fostering innovation, and strengthening collaborations in the dynamic domains of theoretical and applied mechanics. Since its inception in 1955, ISTAM has upheld a legacy of academic excellence, serving as a cornerstone for India's scientific community. Continuing this tradition, the present edition of the Congress offers a vibrant platform for discourse, discovery, and development.

A major highlight of this Congress is the inclusion of five memorial lectures honoring B. R. Seth, P. L. Bhatnagar, B. Karunes, A. S. Gupta, and G. I. Taylor, along with twelve invited talks given by distinguished researchers. Their pioneering work continues to shape the direction of modern mechanics. The insights shared during these sessions illuminate the current state of research and inspire new lines of inquiry for the next generation of scholars.

This year's Congress has received an overwhelming academic response, with over 202 research abstracts submitted from eminent scholars, scientists, and young researchers across the country and abroad. After rigorous review by the technical committees, a rich collection of high-quality contributions has been curated, reflecting both the depth and breadth of contemporary research in mechanics. Out of 202 submitted abstracts, 12 have been selected for the Young Scientist Award presentation, and 93 have been chosen for contributed talks. These contributions cover a wide spectrum of themes including fluid dynamics, solid mechanics, computational methods, nonlinear systems, biomechanics and vibration analysis.

In addition to technical sessions and special lectures, selected papers from the event will be considered for publication in International Journal of Numerical Methods for Heat & Fluid Flow, De Gruyter Proceedings in Mathematics, and Springer's Proceedings, thereby extending the impact of the research beyond the confines of the event. Such publications reinforce the commitment of ISTAM to nurture rigorous scholarship and to promote research

We are pleased to host this prestigious Congress at VIT Bhopal University, where sustained support from our university leadership and academic administration has enabled the creation of a scholarly environment conducive to hosting an event of such calibre. Their vision for promoting high-quality research and fostering academic excellence has significantly enriched the intellectual ethos surrounding this Congress.

The Souvenir you now hold has been thoughtfully compiled to encapsulate the spirit of the Congress. It features key messages, programme details, thematic highlights, and a snapshot of the diverse academic contributions presented this year. We hope it serves as a source of inspiration to researchers, educators, and students alike—encouraging them to pursue new challenges and contribute meaningfully to the evolving landscape of mechanics.

As we embark on this intellectually rewarding journey, it is our hope that the ideas exchanged here will ignite new collaborations, stimulate deeper inquiry, and strengthen the global community of scholars dedicated to theoretical and applied mechanics. The Congress stands not merely as a gathering of minds but as a collective commitment to advancing knowledge for the benefit of science, industry, and society at large.

Dr. Hemant Kumar Nashine
Organizing Secretary, ISTAM-2025
On behalf of the organizing team

Message from Chancellor

Dr. G. VISWANATHAN
Founder & Chancellor
Former Member of Parliament
Former Minister, Govt. of Tamil Nadu.
President, Education Promotion Society for India, New Delhi

The foundation of VIT is rooted in **research and innovation**, with numerous students and staff actively engaged in various research projects throughout the year. The School of Advanced Sciences and Languages (SASL) demonstrates a strong commitment to research. In line with VIT's broader focus on high-quality research output—where for instance, **VIT consistently ranks among the top Indian institutions for Scopus-indexed publications**—SASL at VIT Bhopal also champions a robust research environment. I am happy to announce that the Mathematics Division, School of Advanced Sciences and Languages, will be hosting the 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025), a prestigious international conference, from December 10th to December 12th, 2025. This forum is the perfect place to gather the most recent advancements in computational algorithms and experimental approaches in a wide range of disciplines related to Fluid and Solid Mechanics. Madhya Pradesh has been witnessing a significant push in its higher education sector, with **enrollment in higher education growing by over 10% in recent years**, indicating a fertile ground for advanced scientific discourse. The establishment of the ISTAM-2025 platform by SASL to explore advanced research is commendable. Participation in conferences like this offers numerous opportunities to gain fresh insights and stay updated on the latest advancements and trends in scientific research. Academic conferences are critical knowledge hubs; for example, **studies indicate that about 60% of researchers primarily rely on conferences for early-stage research dissemination and networking**, showcasing their vital role. This platform will showcase novel methodologies, innovative technologies, undisclosed findings, and early-stage research. I look forward to all participants having a productive and enriching experience. I extend my best wishes to the Organizing Committee of ISTAM-2025 for their unwavering dedication and hope the conference achieves great success.

Dr. G. Viswanathan

Message from Vice President

Mr. SANKAR VISWANATHAN
Vice President
VIT Bhopal University
Kothrikalan, Sehore
Madhya Pradesh, India-466114

I'm pleased to note that the School of Advanced Sciences and Languages (SASL) is organizing the 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025), a prestigious international conference, scheduled to take place from December 10th to December 12th, 2025.

This international conference will provide ample opportunities for discussions and deliberations in the field of Mechanics of Fluids and Solids for the academia and the scientists alike. Such conferences are crucial for facilitating the knowledge exchange that drives this growth.

With a thoughtfully curated program and a diverse lineup of distinguished speakers, ISTAM-2025 promises to be intellectually enriching and beneficial to all participants.

I commend the organizing team for their dedicated efforts in planning this event and extend my heartfelt best wishes for its resounding success.

Mr. Sankar Viswanathan

Message from Assistant Vice President

Mrs. Kadhambari S. Viswanathan
Assistant Vice President
VIT Bhopal University
Kothrikalan, Sehore
Madhya Pradesh, India-466114

It's great to see that the School of Advanced Sciences and Languages (SASL) is hosting the 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025), from December 10th to 12th, 2025.

Advanced sciences play a crucial role in enhancing **reasoning abilities, critical thinking, problem-solving skills, creativity, and spatial thinking**. Moreover, a significant part of the appeal in these fields comes from continuously learning new concepts, mastering innovative techniques, and tackling fresh challenges. Attending conferences like ISTAM-2025 provides an excellent opportunity for participants to discover new ideas and exchange insights with experts from institutions across India and around the globe. SASL utilizes **CALTech (Collaborative and Active Learning through Technology)**, a student-centered teaching methodology, to impart knowledge of natural sciences and languages across various disciplines. This approach includes providing hands-on experience in state-of-the-art laboratories and studios. Research consistently shows that **hands-on learning deepens engagement in STEM, with one study finding that 92.6% of participants identified hands-on lab work as key to inspiring their pursuit of STEM degrees and careers**.

The International Conference ISTAM-2025, operating aims to serve as a vital forum. It will enable researchers to connect with a diverse array of individuals worldwide to discuss new paradigms in of computational and experi¬mental techniques in the field of Fluid and Solid mechanics. These discussions will be fuelled by innovative research, multidimensional methodologies, and technological advancements.

I'm confident that this international conference will offer an exceptional platform and bring substantial benefits to the academic community. My sincere thanks go to the organizers for their meticulous planning and expert execution in ensuring the success of this event. This conference will undoubtedly help VIT broaden its global reach.

Mrs. Kadhambari S. Viswanathan

Message from Pro-Vice Chancellor

Dr. T.B.Sridharan
Pro-Vice Chancellor
VIT Bhopal University
Kothrikalan, Sehore
Madhya Pradesh, India-466114

I'm delighted that the School of Advanced Sciences and Languages (SASL) is organizing the 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025), set to be held from December 10th to 12th, 2025.

A strong foundation in **mathematics and computational techniques** is crucial for advancing education and research in science, technology, and engineering. ISTAM has been bringing together the researchers from the diverse fields of Mechanics to promote quality research and to provide the opportunity for young researchers to interact with eminent researchers across the globe.

Technological advancements have brought tremendous progress and convenience to our lives. Recognizing and adapting to these ongoing innovations is essential for maintaining a competitive edge and effectively addressing societal needs. As a result, it is imperative that academic institutions equip students with the skills necessary to thrive in a digitally driven world. Looking at India specifically, **the number of students pursuing STEM fields continues to rise, with millions graduating each year**, highlighting the critical need for platforms that enhance their computational and analytical skills.

I'm confident that this international conference will serve as a valuable platform for students, researchers, and faculty to exchange ideas and engage in meaningful discussions on the conference themes. I extend my sincere congratulations to the organizing committee for their commendable efforts and wish ISTAM-2025 great success

Dr. T.B.Sridharan

Message from Registrar

Mr. K.K. Nair
Registrar
VIT Bhopal University
Kothrikalan, Sehore
Madhya Pradesh, India-466114

I am delighted to note that the School of Advanced Sciences and Languages (SASL) at VIT Bhopal University will host 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025).

The study of advanced sciences nurtures vital skills such as logical reasoning, critical thinking, problem-solving, creativity, and spatial understanding. The true joy of these disciplines lies in the process of exploration—discovering new ideas, mastering innovative techniques, and addressing complex challenges. ISTAM has been bringing together the researchers from the diverse fields of Mechanics to promote quality research and to provide the opportunity for young researchers to interact with eminent researchers across the globe.

At SASL, we champion student-centered pedagogy through **CALTech (Collaborative and Active Learning through Technology)**, ensuring dynamic, interactive, and technology-enabled learning experiences. Our academic programmes integrate hands-on training in modern laboratories and studios, fostering both scientific inquiry and language proficiency.

I am confident that this international forum will offer a vibrant platform for students, researchers, and faculty to engage in enriching discussions centered on the conference themes. I extend my sincere appreciation to the organizing committee for their remarkable efforts and wish **ISTAM-2025** resounding success.

Mr. K.K. Nair

Message from Dean, School of Advanced Sciences and Languages

Dr. Hemant Kumar Nashine
Dean, School of Advanced Sciences and Languages
& Organizing Secretary, ISTAM-2025

Greetings from ISTAM-2025 !

It is my great honour and privilege to announce, 70th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2025, an international conference), is hosting by the School of Advanced Sciences and Languages (SASL) at VIT Bhopal University. The conference is scheduled to be held from December 10–12, 2025.

This international conference will offer ample opportunities for meaningful discussions and in-depth deliberations in the fields of Fluid and Solid Mechanics, benefiting both the academic community and scientific researchers alike. The conference aims to serve as a vibrant platform for sharing recent developments, presenting innovative ideas, and identifying promising directions for future research.

I extend a warm and heartfelt welcome to all delegates and participants. On behalf of the entire ISTAM-2025 team, I express my sincere gratitude to our management, esteemed keynote and invited speakers, participants, and sponsors for their invaluable support. I also place on record my deep appreciation for the organizing committee whose dedication and hard work have made this event possible.

I am confident that ISTAM-2025 will be a rewarding, insightful, and collaborative experience for all.

Dr. Hemant Kumar Nashine

Message from President, ISTAM

Dr. Damodar Maity
Professor
Department of Civil Engineering, IIT Kharagpur
& President, ISTAM-2025

For a country to become an economic leader and to remain so, research in science and technology must be at the forefront of its agenda. India, as a developing nation, must continue its focused efforts to advance towards becoming a developed country. Conferences, where experts exchange ideas and set future research directions play a vital role in this journey.

The Indian Society of Theoretical and Applied Mechanics (ISTAM), founded in 1955 under the leadership of Prof. B. R. Seth and Prof. K. S. Krishnan at IIT Kharagpur, has completed a remarkable seventy year journey. Its annual conventions, hosted across IITs, NITs, Universities and premier institutes, have consistently fostered high-quality interdisciplinary research and attracted participants from India and abroad.

I am delighted that VIT Bhopal University has graciously agreed to host this year's annual congress. On behalf of the Society, I extend my sincere thanks to the organizers and a warm welcome to all participants of the 70th ISTAM Congress.

I hope this forum becomes a platform for "Simplifying the Complexity" and leads to meaningful outcomes. With the active engagement of researchers and academicians, I am confident this International congress will be highly productive. The interactions planned over the next three days will greatly benefit young researchers and encourage valuable academic exchange.

I wish the 70th Congress of ISTAM a great success and look forward to an inspiring and enriching meet.

Dr. Damodar Maity

Message from Secretary, ISTAM

Prof. Jagadeesh Kumar MS
Professor
Department of Mathematics, VIT Vellore
& Secretary, ISTAM-2025

The Indian Society of Theoretical and Applied Mechanics (ISTAM) was founded in 1955 under the dynamic leadership of Professor B. R. Seth as its Secretary and Prof. K. S. Krishnan as its President, with its headquarters at IIT Kharagpur. Since its inception, the Society has hosted annual conventions at prestigious institutions, including IITs, Universities, NITs, and other renowned engineering colleges across India. ISTAM serves as a platform for promoting interdisciplinary research in theoretical and applied mechanics, attracting researchers from India and abroad.

The 70th Congress of ISTAM, an international conference, is being held at VIT Bhopal University, Bhopal from December 10–12, 2025. I extend my sincere gratitude to the administration of VIT Bhopal University for graciously hosting this event. The response to the congress has been overwhelming, with approximately 202 researchers from India and internationally submitted the abstracts. On behalf of ISTAM, I thank all the distinguished researchers for their enthusiastic participation. To ensure global participation , online presentation facilities has been arranged for foreign nationals.

A thorough review has been made before accepting the papers. Selected papers of this conference will be published in Scopus indexed journals. I am confident that this congress will foster collaboration among researchers and contribute to advancements in the field. It is my pleasure to welcome all participants, and I am certain that the event will facilitate fruitful discussions and lasting connections.

Prof. Jagadeesh Kumar MS

Indian Society of Theoretical and Applied Mechanics, ISTAM

The ISTAM was established in 1955 in India with it's headquarters at Indian Institute of Technology, Kharagpur. The Society was formed to provide a platform for scientists, technologists, and engineers to share and discuss the current research work they conducted individually or in groups to seek solutions to emerging problems for better living conditions. During the congress, five memorial lectures in honour of B. R.Seth, P.L. Bhatnagar, B. Karunes, A.S. Gupta and G.I. Taylor are given by eminent researchers. Also, several invited lectures have been arranged to cover the current trends of various theoretical and applied mechanics topics. The Annual Congress of the Society has been held at various IITs, NITs, Universities, Engineering colleges and other reputed research establishments in different parts of the country. It has been attracting a large number of researchers not only from our country but also from abroad. The society has gone a long way in promoting inter-disciplinary research in Basic and Applied Sciences. Presently, the society has 33 corporate members and 1308 life members. Extended abstracts submitted are peer-reviewed and are published in the form of e-proceedings. Full-length papers presented at the Conference will be published in our Souvenir volume/ reputed journals.

Corporate Members of ISTAM

- ☞ Bangalore Institute of Technology, Bangalore, Karnataka
- ☞ BMS College of Technology, Bangalore, Karnataka
- ☞ Banaras Hindu University, Varanasi, Uttar Pradesh
- ☞ Indian Institute of Science, Bangalore, Karnataka
- ☞ Indian Institute of Technology Bombay, Mumbai, Maharashtra
- ☞ Indian Institute of Technology Kanpur, Kanpur, Uttar Pradesh
- ☞ Indian Institute of Technology Kharagpur, Kharagpur, West Bengal
- ☞ Indian Institute of Technology Madras, Chennai, Tamil Nadu
- ☞ Indian Institute of Technology Delhi, Hauz-Khas, New Delhi
- ☞ Karnataka Regional Engineering College, Surathkal, Karnataka
- ☞ M.S. Ramaiah Institute of Technology, Bangalore, Karnataka
- ☞ CSIR-National Aerospace Laboratories, Bangalore, Karnataka
- ☞ New Mangalore Port Trust Authority, Mangalore, Karnataka
- ☞ PSG College of Technology, Coimbatore, Tamil Nadu
- ☞ National Institute of Technology Warangal, Warangal, Telangana
- ☞ Sri Jayachamarajendra College of Engineering, Mysure, Karnataka
- ☞ University of Mysore, Mysure, Karnataka
- ☞ College of Engineering, Anna University, Chennai, Tamil Nadu
- ☞ Andhra University, Visakhapatnam, Andhra Pradesh
- ☞ MEPCO Schlenk Engineering College, Sivakasi, Tamil Nadu
- ☞ National Institute of Technology Hamirpur, Hamirpur, Himachal Pradesh
- ☞ Indian Institute of Technology Guwahati, Guwahati, Assam
- ☞ B.N.M Institute of Technology, Bangalore, Karnataka
- ☞ Netaji Subhas Institute of Technology, New Delhi, Delhi
- ☞ University College of Engineering, Osmania University, Hyderabad, Telangana
- ☞ M.E.S College of Arts, Commerce & Science, Bangalore, Karnataka
- ☞ Bengal Engineering & Science University, Shibpur,Howrah, West Bengal
- ☞ VIT University, Vellore, Tamil Nadu
- ☞ Alliance College of Engineering and Design, Alliance University, Bangalore, Karnataka
- ☞ Christ University, Bangalore, Karnataka

Presidents & Secretaries of ISTAM

#	President	Year	#	President	Year
1	Prof. K.S.Krishnan	1955-1956	29	Prof. V.V. Ramana Rao	1997
2	Prof. S.R. Sengupta	1957-1958	30	Prof. A.P. Verma	1998
3	Prof. A.N. Khosla	1959-1960	31	Prof. Tarun Kant	1999-2000
4	Prof. D.S. Kothari	1961-1963	32	Prof. M. Venkatachalappa	2001
5	Prof. B.R. Seth	1964-1965	33	Prof. J.K. Jain	2002-2003
6	Prof. V.M. Ghatage	1966-1967	34	Prof. H.S. Paul	2004
7	Prof. S. Bhagavantham	1968	35	Prof. S.K. Sinha	2005
8	Prof. B.M. Belgaumkar	1969-1970	36	Prof. T.K.V. Iyengar	2006
9	Prof. P.L. Bhatnagar	1971	37	Prof. B. Pradhan	2007
10	Prof. B. Karunesh	1972-1973	38	Prof. Gautam Biswas	2008
11	Prof. Jagadish Lal	1974-1975	39	Prof. D.K. Tripathy	2009
12	Prof. S. D. Nigam	1976	40	Prof. V.D.Sharma	2010
13	Prof. M.K. Jain	1977	41	Prof. S.K. Som	2011
14	Prof. J. N. Kapur	1978	42	Prof. S. K. Satsangi	2012
15	Prof. A. Bhattacharya	1979-1980	43	Prof. Peeyush Chandra	2013
16	Prof. Shankar Lal	1981	44	Prof. P. G. Siddheshwar	2014
17	Prof. N. Rudraiah	1982-1983	45	Prof. T. Amaranath	2015
18	Prof. D.K. Sinha	1984	46	Prof. B. V. Rathish Kumar	2016
19	Prof. A.S. Gupta	1985	47	Prof. S. K. Bhattacharyya	2017
20	Prof. A.C. Malhotra	1986	48	Prof. K. C. Deshmukh	2018
21	Prof. B.L. Dhoopar	1987	49	Prof. P. V. S. N. Murthy	2019
22	Prof. L.S. Srinath	1988	50	Prof G.P. Raja Sekhar	2020
23	Prof. A.K. Rao	1989	51	Prof. G Radhakrishana-macharya	2021
24	Prof. J.S. Rao	1990-1991	52	Prof. Swaroop Nandan Bora	2022
25	Prof. C.K. Majumdar	1992	53	Prof. I.S.Shivakumara	2023
26	Prof. P. Niyogi	1993	54	Prof. S.Sreenadh	2024
27	Prof. S.K. Sarma	1994	55	Prof. Damodar Maity	2025
28	Prof. N.K. Gupta	1995-1996			

#	Secretary	Year	#	Secretary	Year
1	Prof. B.R. Seth	1955-1962	9	Prof. D.K. Tripathy	1997-2003
2	Prof. M.K. Jain	1963-1968	10	Prof. B. Pradhan	2004-2006
3	Prof. S.D. Nigam	1969-1972	11	Prof. P.V.S.N. Murthy	2007-2009
4	Prof. R.S.Nanda	1973-1978	12	Prof. G.P.Rajasekhar	2010-2012
5	Prof. C.N. Kaul	1979-1981	13	Prof. P.V.S.N. Murthy	2013-2015
6	Prof. P. Niyogi	1982-1984	14	Prof. Damodar Maity	2015-2018
7	Prof. J.P. Agarwal	1985-1992	15	Prof. Dipak Kumar Maiti	2019-2024
8	Prof. S.B. Sinha	1993-1996	16	Dr. M S Jagadeesh Kumar	2025-2027

Earlier ISTAM Congress Venues

Congress	Year	Host Institute
Sixty ninth	December, 2024	Christ (Deemed to be University)
Sixty eighth	December, 2023	National Institute of Technology Warangal
Sixty seventh	December, 2022	Indian Institute of Technology Mandi
Sixty sixth	December, 2021	Vellore Institute Technology, Andhra Pradesh
Sixty fifth	December, 2020	GITAM Hyderabad
Sixty fourth	December, 2019	IIT Bhubaneswar
Sixty third	December, 2018	Dayananda Sagar University, Bangalore
Sixty second	December, 2017	Osmania University, Hyderabad
Sixty first	December, 2016	Vit University, Vellore
Sixtieth	December, 2015	Malaviya National Institute of Technology, Jaipur
Fifty ninth	December, 2014	Alliance University, Bangalore
Fifty eighth	December, 2013	Bengal Engineering and Science University, Shibpur
Fifty seventh	December, 2012	Defense Institute of Advanced Technology, Pune
Fifty sixth	December, 2011	S.V. National Institute of Technology, Surat, Gujarat
Fifty fifth	December, 2010	National Institute of Technology, Hamirpur, H.P.
Fifty fourth	December, 2009	Netaji Subhas Institute of Technology, New Delhi
Fifty third	December, 2008	University College of Engineering, O.U., Hyderabad
Fifty second	December, 2007	B.N.M. Institute of Technology, Bangalore
Fifty first	December, 2006	A.U.College of Engineering, Visakhapatnam
Fiftieth	December, 2005	Indian Institute of Technology, Kharagpur
Forty ninth	December, 2004	National Institute of Technology, Rourkela
Forty eighth	December, 2003	Birla Institute of Technology, Mesra, Ranchi
Forty seventh	December, 2002	Indian Institute of Technology, Guwahati
Forty sixth	December, 2001	Regional Engineering College, Hamirpur, H.p.
Forty fifth	December, 2000	Mepco Schlenk Engineering College, Sivakasi
Forty fourth	December, 1999	Regional Engineering College, Warangal
Forty third	December, 1998	Psg College of Technology, Coimbatore
Forty second	December, 1997	South Gujarat University, Surat
Forty first	December, 1996	Cochin University of Technology, Cochin
Fortieth	December, 1995	M.A.C.T. Bhopal
Thirty ninth	December, 1994	Andhra University, Visakhapatnam
Thirty eighth	December, 1993	Indian Institute of Technology, Kharagpur
Thirty seventh	January, 1993	G.B.Pant University of Agriculture and Technology, UK
Thirty sixth	December, 1991	Indian Institute of Technology, Bombay
Thirty fifth	December, 1990	Anna University, Madras
Thirty fourth	December, 1989	Psg College of Technology, Coimbatore
Thirty third	December, 1988	Institute of Technology, B.h.u., Varanasi
Thirty second	December, 1987	Indian Institute of Technology, Bombay
Thirty first	October, 1986	Jiwaji University, Gwalior

Congress	**Year**	**Host Institute**
Thirtieth	December, 1985	Indian Institute of Technology, New Delhi
Twenty ninth	December, 1984	Karnataka Regional Engg. College, Suratkal
Twenty eighth	December, 1983	Andhra University, Waltair
Twenty seventh	December, 1982	Jadhavpur University, Calcutta
Twenty sixth	December, 1981	Coimbatore Institute of Technology, Coimbatore.
Twenty fifth	December, 1980	Indian Institute of Technology, Kharagpur
Twenty fourth	February, 1980	Regional Engineering College, Rourkela
Twenty third	December, 1978	Regional Engineering College, Warangal
Twenty second	December, 1977	Sardar Vallabhabhai Regional Engg. College, Surat
Twenty first	December, 1976	Bangalore University, Bangalore
Twentieth	December, 1975	Institute of Technology, B.h.u., Varanasi
Nineteenth	December, 1974	Indian Institute of Technology, Kharagpur
Eighteenth	December, 1973	Indian Institute of Technology, Madras
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Thirteenth	December, 1968	Central Mech. Engg. Res. Institute, Durgapur
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Presidential Lecture

Presidential Lecture

Mechanics of Bamboo Reinforced Concrete Composites for Climate-Resilient Infrastructure

Damodar Maity

President, ISTAM 2025

Professor, Department of Civil Engineering, IIT Kharagpur

Developing climate-resilient infrastructure requires sustainable materials supported by rigorous mechanics-based understanding. Bamboo Reinforced Concrete (BRC) composites offer a promising low-carbon alternative to steel reinforcement. However, their wider adoption depends on reliable mechanical models and design guidelines. This address presents the mechanics, design framework, and field performance of BRC systems developed by us.

Engineered and treated bamboo strips are used to address durability and bond variability. The mechanics of BRC is governed by bamboo's orthotropic behavior, concrete nonlinearity, and the bond slip interaction between bamboo and concrete. A rational limit state design methodology and closed form equations for BRC members have been formulated and validated through extensive experimental studies. The predicted load deflection response, failure modes, and bond characteristics closely match with experimental observations.

This developed technology has been successfully implemented in real structures, including modular dwelling units (1-BHK and 2-BHK at a school premises) and over twenty security service rooms constructed inside IIT Kharagpur campus. After a decade of service, these BRC structures show no visible signs of distress, validating the long-term structural integrity predicted through mechanical design models. Most recently, the technology has been extended to boundary wall construction, demonstrating scalability and robustness. Sustainability assessments show significant reductions in cost, embodied energy, and CO_2 emissions compared to conventional RCC structures. The study establishes BRC as a credible, mechanics driven pathway to climate resilient and sustainable infrastructure.

Key Words: Finite Element Analysis, Bond Strength, Bamboo reinforced concrete composite, Climate resilient infrastructure, Sustainable building material

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Memorial Lectures

G I Taylor Memorial Lecture

The Electrified Life of Soft Matter: From Taylor's Droplet to the Living Cell

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The pioneering work of G. I. Taylor on the electromechanics of droplets remains one of the most elegant and enduring testaments to the interplay of fields, forces, and forms in continuum physics. His seminal insights into the deformation and breakup of fluid interfaces under electric stresses laid the conceptual foundation of droplet electrohydrodynamics. Nearly a century later, this classical paradigm is being reborn in an unexpected realm — that of living soft matter, where the boundaries are no longer inert but responsive, adaptive, and often sentient. This lecture envisions a modern reincarnation of Taylor's ideas in the context of vesicles, cells, and other membrane-bound entities, whose electromechanical coupling is governed by a far richer tapestry of biophysical interactions. When electric fields impinge upon these deformable, heterogeneously charged interfaces, the emergent morphodynamics are no longer dictated solely by surface tension and viscosity, but are entwined with membrane elasticity, cytoskeletal remodelling, ionic fluxes, and active transport processes. These phenomena unlock a new window into electrically modulated biological transformations, from membrane poration and vesiculation to mechanotransduction and cell differentiation. By reinterpreting Taylor's droplet electromechanics through the lens of cellular physiology, this talk aims to establish a unified theoretical and experimental framework that couples electrohydrodynamic stresses with biomembrane mechanics. Such coupling not only unravels the physics behind phenomena such as electroporation, electrofusion, and electrotaxis, but also paves the way for predictive models of electrically driven disease progression, including cancer metastasis and neurodegeneration, where cellular morphology and electrical signalling are deeply intertwined. Through in-silico simulations, microfluidic analogues, and advanced biophysical imaging, this deliberation demonstrates how living systems re-enact Taylor's vision, yet transcend it, evolving from passive droplets to electrically self-regulating entities. The Taylor cone of the past thus morphs into a Taylor cell of the future: a dynamic object whose electromechanics speak the universal language of soft matter physics, but whose behaviour whispers the secrets of life itself. This rebirth of G. I. Taylor's electromechanical legacy invites a broader reflection on how classical mechanics can merge with the living world, inspiring a new generation of interdisciplinary explorations at the confluence of fluid dynamics, electromagnetism, and biological function.

A S Gupta Memorial Lecture

Viscous flow attack on macroscopic cavities in a granular material: the story of two sufficiently distant spherical cavities of arbitrary configuration

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The effect of a void of characteristic size R_0 in a granular material with permeability k on an otherwise undisturbed uniform flow U_∞ is investigated analytically by GPRS et al. [1], [2]. The cavity region is assumed to be two-dimensional, and its cross section slightly deviates from a circle. They determined the flow field by matching the solution of the Stokes equation inside the hole with the generalized Darcy's equation or Brinkman's equation in the granular material. There it is shown that when the permeability parameter is much larger than unity, which corresponds to the case for typical groundwater flow, the velocity at the center of the circular cylindrical hole U_0 becomes $3U_\infty$. Based on these analytical investigations, Kaneko et. al. [3] conducted experiments on the viscous flows in a homogeneous porous permeability medium k with two-dimensional holes of equal radius R 0 . They varied the center-to-center distance and the orientation of the holes concerning the undisturbed flow and analysed the flow field around these holes. They observed that the volume flux into each hole increases by about 30% when the center-to-center distance is $\approx 2:5R_0$ and the orientation angle is $\approx \deg 30$ compared with the flux into a single circular hole. In contrast, it decreases by about 20% when the distance is $\approx 2:5R_0$ and orientation is $\approx \deg 90$. For the audience's benefit, this talk summarizes the results in [1], [2] and [3] briefly. Consequently, the talk focuses on "Viscous flow around spherical macroscopic cavities in a granular material – focusing two distant spherical cavities of arbitrary orientation" [4], [5]. We consider Stokes equation inside and the Darcy-Brinkman equation outside the cavities. In particular, we focus on the interaction of two equal size cavities in tandem position where the other cavity's asymptotic effect. The present analysis gives a reasonable estimate on the volume flow into the cavity, and local enhancement of stresses. This work is applicable to predict the microscale waterway formation in that material, onset of landslides, collapse of cliffs and river banks, etc.

References

[1] Raja Sekhar, G P & Sano, Osamu 2000 Viscous flow past a circular/spherical void in porous media—an application to measurement of the velocity of groundwater by the single boring method. Journal of the Physical Society of Japan 69 (8), 2479–2484.

[2] Raja Sekhar, G P & Sano, O 2003 Two-dimensional viscous flow in a granular material with a void of 426 arbitrary shape. Physics of Fluids 15 (2), 554–567.

[3] Kaneko, Yoshifumi & Sano, Osamu 2005 Collapse and merging of cavity regions in a granular material due to viscous flow. Physics of Fluids 17 (3), 033102.

[4] Sano, Osamu, Karmakar, Timir & Sekhar, GP Raja 2022 Viscous flow around three-dimensional macroscopic cavities in a granular material. Journal of Fluid Mechanics 931.

[5] Sano, Osamu, Karmakar, Timir & Sekhar, GP Raja 2023 Viscous flow around three-dimensional macroscopic cavities in a granular material: asymptotic theory for two sufficiently distant spherical cavities of arbitrary configuration, Journal of Fluid Mechanics 964.

B Karunes Memorial Lecture

Structural Response Under Extreme Underwater Loadings

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Underwater explosions and implosions are inherently complex and unique physical phenomena markedly distinct from those occurring above the surface. This distinctiveness is primarily attributed to the incompressible nature of water, which fundamentally alters the propagation and impact of shock and pressure waves. The lecture will focus on experimental investigations to study the shock loading and fluid-to-structure interaction between the gas bubble generated by an underwater explosion (UNDEX) and a nearby rigid and flexible plate. Experiments are performed by clamping plates to a support structure that is either air backed, or water backed. Though the shockwave produced by the initial detonation of an explosive can be a great source of damage during an UNDEX event, the resulting gas bubble's collapse can be an even greater source of damage. Results show that the explosive standoff distance, plate rigidity, and hydrostatic pressure can greatly change the bubble's shape, size, migration speed, migration direction, jetting behavior, and damage to the nearby plate. The UNDEX bubble's collapse and concurrent bubble jetting are shown to be the primary causes of plate damage, including rupture, for the dimensionless standoff parameters studied. Experiments are also performed to investigate sympathetic implosions and interaction of an imploding cylinder with a nearby structure. State of the art pressure vessel facilities are used to study the implosion process. These pressure vessels are outfitted with several windows to allow the use of the 3D Digital Image Correlation (DIC) technique. The pressure histories generated by the implosion event are captured from dynamic pressure transducers mounted close to the specimen in all the experiments. These pressure histories are then related to real time deformations and velocities occurring on the shells. High speed images coupled with 3D-DIC technique are captured for better understanding of the deformation mechanisms and collapse modes of the structures during the experiments. The continuous evolution of this research area is essential for advancing maritime technology, ensuring the safety of undersea operations, and protecting marine environments from the adverse effects of extreme subaqueous loadings.

P L Bhatnagar Memorial Lecture

Diffusion and Dissipation of Ultrasonic Wave in Multi-Scale Materials–Evaluation of Microstructure Development and Stress-State

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The microstructural study of composites, such as cementitious composites, holds immense importance from both fundamental and applied research perspectives. Concrete, a mesoscale cementitious material, exhibits high heterogeneity and inherently complex behavior. Its multiphase nature evolves continuously over time—from the initiation of hydration to complete maturity. The hydration products and the aggregate–matrix Interfacial Transition Zone (ITZ) play crucial roles in defining the microstructural arrangement, which, in turn, governs the mechanical and durability properties of concrete. Ultrasonic diffusion-based techniques offer a distinct advantage for characterizing microstructural behavior in heterogeneous materials, as they can decouple the attenuating parameters—diffusivity and dissipation. In a heterogeneous concrete medium, when the sizes of heterogeneities are almost of equal order with the propagated wavelength, extreme mode conversion takes place inside the material. The

process of interaction consists of microscopic events (like scattering), which lead to macroscopic phenomenon in the medium in terms of wave-diffusion. This results in an attenuated response with multiple scattered, incoherent components in the ultrasonic wave field. Wave attenuation through mediums majorly depends on three factors such as geometric divergence, diffusion, and dissipation/ absorption. Diffusion is related to wave scattering by the aggregate and microstructure. Dissipation/ Absorption causes the loss due to the conversion of mechanical energy into heat energy during the internal friction of a viscoelastic matrix. The present talk will elaborate on ultrasonic diffusion analysis for evaluation of the microstructure development at two scales: cement (microscale) and concrete (mesoscale), using different transmission modes of ultrasonic wave propagation. Ultrasonic measurements were processed in the time–frequency domain to determine diffusivity and dissipation parameters using the Spectral Energy Density (SED) distribution over the complete time window. Further, the understanding is further used to evaluate the stress-state in the heterogeneous medium. A pattern-based Dynamic Wavelet Fingerprint analysis (DWFP) is performed to process a continuous wavelet scalogram of the experimental ultrasonic data to find stress-sensitive nonlinear features. Here, the 3D wavelet scalogram (produced by Continuous Wavelet Transform-CWT) on a 2D binary feature is used. The change in the nonlinear DWFP parameters with different levels of stress in the structure is determined. The pattern-based nonlinear parameter has been found to be very sensitive to changes due to loss of stress. The key point is to underscore that the DWFP-based signal analysis methodology can be very useful for stress monitoring in the structure and to characterise the microstructure of concrete causing nonlinear behaviour under varying stress levels. The developed methodology will be helpful in developing real-time health monitoring and assessment strategy for in-service structures.

Keywords: Ultrasonic wave, Diffusion, Microstructure, Dynamic Wavelet Fingerprint, Stress-State

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B R Seth Memorial Lecture

Mathematical Analysis on Recent Developments of Thermoelasticity : Challenges and Prospectives

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"Coupled thermoelasticity" is a subject that deals with the thermomechanical responses of elastic solids under the impact of non-uniform temperature and mechanical loading. It is an important area and has vast applicability in various branches of science and engineering. The first coupled dynamical thermoelasticity theory introduced by Biot(1956) is regarded as an elegant framework for investigating a variety of issues involving the coupling effects of mechanical and thermal fields. However, this model does not provide an adequate or sufficient description of solid's behaviour in some typical situations, specially when subjected to high heat flux, rapid transient loading, such as short laser pulses, or when the temperature is very low. This has drawn widespread attention of researchers to overcome this apparent drawback of classical theory of thermoelasticity over the years. Several interesting non classical theories have therefore been developed. Challenges and perspectives of various models have also been analyzed in literature. The objective of this Lecture will be to present mathematical analysis on some recently developed theories and highlight some useful results.

Invited Lectures

Invited Lecture

Is hyperchaos possible in 3-dimensional non-autonomous systems?

Mahesha Narayana

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The weakly nonlinear stability analysis of the gravity-modulated Rayleigh-Bénard convection problem yields a three-dimensional non-autonomous dynamical system. Second harmonics in the Fourier series expansion of temperature were considered, while neglecting them in the case of the velocity field under the assumption of small-scale convective motions. Bifurcation analysis is carried out for varying combinations of modulation parameters. It is found that gravity modulation, in general, stabilizes the convective system under consideration. The occurrence of hyperchaos within the three-dimensional non-autonomous system is observed, induced by modulation, emerging for varying, random combinations of frequency and amplitude values. This result is new in the literature and contradicts the established result that hyperchaos requires at least four dimensions.

Invited Lecture

Approximating Solutions of Nonlinear Operator Equations via Fixed Point Theory

Deepak Khantwal And Rajendra Pant

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In this talk, we present the importance and brief development of fixed-point theory. We then show some fixed-point results for a broader class of contraction mappings that unify and extend the classes of generalized quasi-contractions, Suzuki contractions, and others. Moreover, we provide illustrative examples to support our results and discuss their application to delay differential equations.

Invited Lecture

Peristaltic Flow Alterations with Transient Growth of Tumor

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Cancer remains a major global health concern because of its complex biological behavior and the dynamic interactions between tumor cells and their surrounding microenvironment. The disease progresses through uncontrolled tissue growth, forming tumors that both indicate and drive its severity. When tumors develop within physiological systems such as the gastrointestinal tract, bile ducts, ureters, or blood vessels, they can gradually obstruct fluid transport, impair organ function, and reduce the effectiveness of treatments like drug delivery and hyperthermia. These effects are more severe in confined regions where fluid movement depends on peristaltic transport, driven by rhythmic muscular contractions. In such regions, tumors can create local flow disturbances, increase pressure, and alter shear stress, which contribute to symptoms such as pain, inflammation, and therapy resistance. Understanding how tumor growth influences these flow dynamics is vital for improving treatment strategies and patient outcomes. The tumor microenvironment (TME), composed of cancerous and stromal cells, extracellular matrix components, and diverse biochemical and mechanical signals, plays a central role in these processes [1]. Rahman et al. [2] developed a mathematical model to analyse the drug diffusion and tumor cell death by emphasizing the influence of local flow dynamics on treatment outcomes. By extending this study, Pandey and Prajapati [3] investigated the tumor impact into oesophagus using the bump function into a more generalized and dynamic framework. Kumar et al. [4-5] analyzed electro-magneto-hydrodynamic peristaltic flow for drug transport, demonstrating how tumor-induced obstruction affects heat transfer and entropy generation. Despite these developments, the effect of tumor growth on fluid motion within deformable peristaltic channels remains insufficiently studied. This work addresses that gap by developing a mathematical model for peristaltic modulated flow obstructed by transient tumor. The results highlight how physical parameters affect velocity, pressure, shear stress, streamlines, and particle trajectories. Early-stage tumor growth causes minor flow disturbances, but as tumors enlarge, they elevate local pressure, increase wall shear, and distort streamlines. These findings provide insight into the complex interactions between tumors and fluid transport in magnetically influenced physiological systems, improving our understanding of flow disruptions and their potential impact on organ function and treatment outcomes.

Invited Lecture

From Microorganisms to Mathematics: Unravelling Bioconvective Dynamics

Jaimala Bishnoi

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Bioconvection is a fascinating manifestation of self-organization that emerges in suspensions of motile microorganisms—such as algae or bacteria—whose collective, biased swimming induces convective motion in the surrounding fluid. This interplay between biological activity and fluid mechanics produces rich and intricate patterns, including plumes, vortices, and cellular arrays. Understanding these phenomena calls for a rigorous mathematical treatment of the coupled biological–physical system governing such dynamics. This lecture presents a mathematical exploration of bioconvective flows, emphasizing the formulation and stability analysis of models for microorganism-laden fluids. Beginning with the derivation of governing equations rooted in the Navier–Stokes framework and microorganism transport theory, the discussion traces how mechanisms like gravitaxis and gyrotaxis, together with density stratification, trigger

instabilities in an otherwise quiescent medium. Through linear stability analysis, the onset of bioconvection is characterized, and the influence of key dimensionless parameters—particularly the bioconvective Rayleigh number—is examined in depth. Recent developments revealing the transition from ordered to more complex dynamical states, especially in non-Newtonian fluids, are highlighted. The talk also outlines emerging applications in environmental and biomedical engineering, including microfluidic transport and bioreactor optimization. By weaving together biological insight and mathematical modeling, this presentation aims to illuminate the intricate dynamics of active suspensions and inspire further inquiry into their far-reaching scientific and technological implications.

Invited Lecture

Hydromagnetic effects on couple stress fluid flow through an embedded porous sphere

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The present talk explores the steady flow of an incompressible couple stress fluid through a porous (solid) sphere embedded in another unbounded porous medium. A uniform magnetic field is applied in the direction perpendicular to the flow. The stream function solution for the governing equations of motion is obtained analytically. Appropriate boundary conditions are used on the surface of the porous (solid) sphere, and uniform velocity conditions are employed at infinity. Expressions for flow velocities, vorticities, couple stresses, tangential stresses, and normal stresses of the fluid have been investigated. The variations of the couple stress parameter, permeability parameter, and Hartman number on flow velocities, streamlines, and the drag coefficient have been plotted and discussed.

Invited Lecture

Fractal Wavelet Neuronal Conjunction Analysis for Complex systems

Bhardwaj, Rashmi

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Visiting Associate of Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune

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Water is life and is the most precious resource on Earth. Earth is covered with 702.5% is freshwater and 1% is easily accessible freshwater; thus only 0.007% of Earth's water is accessible. The survival of life on Earth is directly proportional to presence to water among other important resources. Water remains to be a natural resource with no replacement. In today's era where science and technology are growing every hour and innovating new technologies and devices to make life easier and comfortable, but no artificial intelligence could either replicate or replace the need for water on Earth. The present study deals with the qualitative exploration of water quality components like potential-of-Hydrogen (pH), chemical-oxygen-demand (COD); biochemical-oxygen-demand (BOD); dissolved-oxygen (DO) of Yamuna River in India at different sample sites. Various sample sites designated for highly reported pollutants using artificial intelligence through Least Square Support Vector Regression (LSSVR) and hybrid of Wavelet and LSSVR. It is observed that hybrid of Wavelet and Least Square Support Vector Regression (W-LSSVR) predicted good quality accurately among the two prototypes simulated on the basis of the simulation errors i.e. root mean square error (RMSE); mean absolute error (MAE); coefficient of determination (R 2) and execution time for both prototypes. RMSE values decrease overall on training and validating via W-LSSVR as compared to LSSVR. It is observed that MAE values show a lesser decrease as it is in RMSE; on an average MAE has

lesser variability and R 2 has a greater variability as per simulations. The simulation is carried out to analyze the level of various pollutants in the Yamuna River at different sites for the consideration of quality of water. The observed pattern from the study may help for future prediction of the quality of water parameters, so that it prohibits the further decay of water quality which may prove to be lethal to the environment. These forecasts may be helpful for the formulation of policies, planning and execution for protection of environment and quality of water.

Keywords:Fractal, Least Square Support Vector Regression, Wavelet Decomposition, Water quality, Wavelet-LSSVR (WLSSVR), coefficient of determination.

Invited Lecture

Homogenisation of a poroelastic model for fiber-reinforced hydrogels

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In this talk, the analysis and homogenization of a poroelastic model for the hydro-mechanical response of fiber-reinforced hydrogels will be shown. The medium is considered to be a highly heterogeneous two-component media composed of a connected fiber-scaffold with periodically distributed inclusions of hydrogel. We show that the resulting mathematical problem admits a unique weak solution and investigate the limit behavior (in the sense of two-scale convergence) of the solutions with respect to a scale parameter, characterizing the heterogeneity of the medium. We obtain an effective model where the micro variations of the pore pressure give rise to a micro stress correction at the macro scale.

Invited Lecture

Fluid dynamics and heat transfer in heated and cooled capillary bridges

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Liquid bridges formed within liquid-liquid-solid systems are central to various industrial applications, ranging from specialized rheometry to silicon crystal growth. These systems are governed by Marangoni effects arising from immiscible interfaces and thermal, solutal, or electrical gradients. This study investigates the fluid dynamics and heat transfer of a water capillary bridge suspended between two insulated solid discs and immersed in silicone oil. The system is influenced by an external thermal ring, acting variously as a heater or cooler. We analyze the impact of the ring's location on flow topology and thermal distribution. Our results demonstrate a stark contrast between heating and cooling configurations regarding maximum interfacial velocities, net heat transfer, and stagnation point position. Notably, the cooler ring configuration exhibits superior stability in both flow and bridge shape. Conversely, the heater configuration yields anomalous heat transfer rates, interface deformations, and circulation patterns, particularly at larger height-to-radius ratios or when the thermal source is positioned in close proximity to the solid discs.

Young Scientist Award

FM12-PA0012

Effect of Shape Deformation Mode on the Locomotion of an Microswimmer

Shiba Biswas

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The study of microswimmers, including microorganisms and synthetic particles, propel through viscous environments at low Reynolds numbers by generating non-reciprocal surface motions. The squirmer model by Lighthill and Blake captures this behavior using prescribed tangential surface-active slip velocity and classifies swimmers as pushers, pullers, or neutrals based on their sigh of Stresslet. While spherical squirmers with different swimming strategies (pusher, puller, and neutral) are well studied, many real swimmers have fixed, non-spherical shapes, which significantly alters the swimmer's hydrodynamics with its environment.

SM11-PA0013

Harry-Dym Equation: Symmetries & Solutions

Hari Om Jangid

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Harry-Dym equation arises in the study of nonlinear dispersive wave phenomena and has applications in modeling the evolution of certain types of shallow water waves and nonlinear lattice dynamics. Kruskal introduced the Harry-Dym equation to the research community, which was an unpublished work of Harry Dym. This completely integrable nonlinear evolution equation is defined as follows:

$$\frac{\partial h}{\partial t} - h^3 \frac{\partial^3 h}{\partial x^3} = 0,$$

where $t > 0$is time, $x \in \mathbb{R}$ is a space variable and $h(t, x)$ is wave profile. Its structure reflects a strong nonlinear dispersion, where the wave speed and shape evolution are influenced by the amplitude, allowing for the formation of soliton-like solutions.

FM8-PA0017

Exact Riemann Solver for Laminar Multiphase Flow

Lilu Sahu

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In recent years, the mathematical study of multiphase laminar flows has garnered significant interest, particularly with the Riemann problem. Zhang recently derived a conservative form of two-phase flow with two velocities by considering no-slip at the liquid-gas interface, equal density in each layer, along with a common pressure law for both layers. Mathematically, it is modeled as follows:

$$\begin{cases} (\rho_l^1)_t + (\rho_l^1 \bar{u})_x = 0 \\ (\rho_l^2)_t + (\rho_l^2 \bar{u})_x = 0 \\ (\rho)_t + (\rho \bar{u})_x = 0 \\ (\rho \bar{u})_t + (\rho \bar{u}^2 + \rho \vec{u}^2 + p)_x = 0 \\ (\vec{u})_t + (\vec{u}\bar{u})_x = 0 \end{cases} \qquad x \in \mathbb{R}, t \in \mathbb{R}^+,$$

where ρ_l^1 and ρ_l^2 represent the densities of the liquid in layers-one and -two, respectively, the term $\bar{u} = \frac{u_2+u_1}{2}$ signifies the vertically averaged velocity while $\hat{u} = \frac{u_2-u_1}{2}$ denotes the standard deviation of the velocity and pressure $p = k\rho, k > 0$. The model takes into account both the standard deviation of the flow velocity in the two layers and the mean flow velocity in each layer, which makes a generalization to the drift-flux two-phase flow.

FM10-PA0044

Investigation of stability and chaos in Darcy-Bénard convection in the presence of feedback control and Robin boundary condition on temperature

Vinit Vinod Revankar

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The paper deals with the investigation of linear and weakly nonlinear analyses of Darcy Bénard convection in the presence of feedback control and third type boundary condition on temperature. The two isothermal bounding surfaces are rigid. The setup of feedback control comprising of sensors and actuators is incorporated. The linear theory is carried out using the combination of single term Galerkin method, Maclaurin series expansion and Newton-Raphson method of multiple variables. The truncated Fourier Galerkin representation for velocity and temperature is incorporated to derive the Vadasz Lorenz model to investigate the nonlinear analysis of the study. The influence of the controller gain parameter and the Biot number on the onset of convection has been analyzed. Results from the study reveal that the controller gain parameter stabilizes the system and further delays the onset of chaos. Results also reveal that with increase in Biot number, a long-term periodic motion can be favored over chaotic motion. It is also shown that the volume of the trapping region expands with increase in controller gain parameter. The outcomes of the study are illustrated through the bifurcation diagram, the largest Lyapunov exponents, and phase space plots.

FM13-PA0049

A Study on the Influence of Water's Maximum Density on Regular and Chaotic Rayleigh–B´enard Convection

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This paper investigates the influence of the anomalous property of water at 3.98° in Rayleigh–B´enard Convection. The Density Temperature relation is approximated up to the cubic term for accuracy. A linear stability analysis is carried out to determine the onset of regular convection for the four isothermal boundary combinations: Free- Free, Rigid-Free, Free-Rigid, and Rigid-Rigid, using the single-term Galerkin method followed by Maclaurin series solution, for different surface temperatures. On obtaining the critical Rayleigh number marking the onset of regular convection, a weakly nonlinear stability analysis is performed to obtain a three dimensional Lorenz-like system. The appearance of a strange attractor is examined for all the cases, marking the chaotic convection. Later, Hopf bifurcation is observed using phase portraits, bifurcation diagrams and largest Lyapunov plots. It is observed that with an increase in lower or upper surface temperatures, there is an advancement in the regular and chaotic convection. The maximum density effect exerts a stabilizing influence on the system when the lower surface temperature approaches the temperature of maximum density, while it has a destabilizing effect when the upper surface temperature approaches this critical temperature.

FM10-PA0064

Stability characteristics at interface between couple stress fluid and viscous fluid in porous media with effect of heat and mass transfer

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This work examines the linear stability at interface of couple stress fluid and viscous fluid within planar geometry filled with porous medium. The couple stress fluid lies in upper region while lower region contains viscous fluid in porous media. Further, the authors have assumed the flow to be irrotational. The couple stress model and Darcy–Brinkman approximation are used to derive the governing equations of the model. To established the relationship between perturbation growth and wave number, the potential flow theory is employed. This relationship is analyzed, and the perturbation's growth is plotted for the various flow parameters. The marginal stability condition is studied using Newton-Raphson method. The results shows that surface tension and interfacial heat transfer stabilize the system, whereas Reynolds number promote instability. The study reflects the interplay among inertia, interfacial transport, and microstructural effects on interface deformation.

FM13-PA0074

Influence of the Prandtl number on the stability of convective rolls and chaotic onsets in an extended Lorenz model of a rotating convective system

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This work investigates the influence of the Prandtl number on the Hopf bifurcation from steady convection that signals the destabilization of convective rolls, and the emergence of chaotic dynamics, in an extended five-dimensional Lorenz model for rotating Rayleigh–B´enard convection. We study how changes in the system's rotation rate impact the stability of convective roll solutions and the onset of chaos on a wide range of Prandtl numbers. The analysis involves computing the Hopf bifurcation Rayleigh number (the Hopf-Rayleigh number) and examining the system's dynamics through largest Lyapunov exponent plots and three-dimensional projections of the fivedimensional phase space trajectories. Comparisons are drawn with an analogous fivedimensional magnetoconvective Lorenz system to highlight similarities in the behavior under variations of the Prandtl number.

FM7-PA0112

Effects of four types of Gravity Modulation on Rayleigh-Bénard Convection in a Radiating Fluid

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This study presents a detailed investigation of the onset of Rayleigh–Bénard convection in a radiating fluid, incorporating the effect of four types of gravity modulation. Two asymptotic cases, transparent and opaque media, are considered under the assumption that the wavelength is independent of the optical properties of the fluid, representing a gray medium. The horizontal boundaries are taken to be flat, maintained at uniform temperatures, and assumed to be black bodies. The simplest approximation for solving the one-dimensional radiative equilibrium equation, the Milne–Eddington approximation, is employed. Using a modified Venezian approach, expressions for the critical Rayleigh number are obtained for both media. Weakly nonlinear stability analysis, performed via a Fourier–Galerkin expansion, leads to a time-periodic Lorenz system. Applying the method of multiple scales, the Lorenz model is reduced to a one-dimensional Stuart–Landau equation to examine heat transport in the system. The analytical solution of the Stuart–Landau equation reveals that the delay in the onset of convection is greater in the opaque medium compared to the transparent medium. The effects of various radiation parameters, dimensionless quantities, and the amplitude and frequency of gravity modulation on the onset of convection, as well as on heat and mass transport, are examined. The results indicate that gravity modulation acts to stabilize the system and enhance heat and mass transport.

SM2-PA0126

Seismic Force Angle Variation and its Influence on Drift and Torsion in Asymmetric Building Structures

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Seismic performance is one of the most critical aspects in the design of tall buildings because earthquakes impart large lateral forces and dynamic effects that can govern both safety and serviceability. The seismic performance of tall buildings is strongly influenced by their plan configuration. While conventional rectangular and square floor plans have been extensively studied and form the basis of many codal provisions, modern urban constraints and architectural requirements often necessitate irregular plan geometries.These irregular shapes often induce torsional irregularities, making them more vulnerable to earthquake forces.

SM10-PA0155

Electroosmotically driven flow of non-Newtonian hybrid nanofluid through a porous overlapping irregular stenosed artery: Drug delivery application

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This current study explores a mathematical model for the unsteady electroosmotic flow of non-Newtonian blood hybrid nanofluid through a stenosed artery featuring two stenosis-overlapping and irregular. In this problem, the authors have utilized silver (Ag) and titanium dioxide (TiO_2) in the blood, which leads to the formation of Ag-TiO_2/blood hybrid nanofluid. Due to the realistic conditions, the authors have assumed the hematocrit-dependent viscosity approach along with viscous dissipation, Joule heating, thermal radiation, and chemical reaction effects. Additionally, the magnetic field and electric field are applied in the radial direction and axial direction of the blood flow. The non-linear partial differential equations that govern the flow, such as continuity, momentum, energy, and concentration, are solved using the forward time-centered space numerical technique with the help of MATLAB software. The plots for various flow variables such as velocity, temperature, concentration, wall shear stress, flow resistance, Nusselt number, and Sherwood number are presented for different hemodynamical parameters. The findings report that the inclusion of nanoparticles in the blood enhances blood velocity in the stenosed regime. Moreover, the wall shear stress has a higher magnitude for irregular stenosis than the overlapping stenosis. The outcomes of the study can be used in magnetically targeted drug delivery, blood clot extractions, and the treatment of cardiovascular diseases.

SM1-PA0160

Miura-Ori Origami-Inspired Deployable Space Structures: Design and Performance for Small Satellites (CubeSats)

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This study focuses on the design and analysis of Miura-Ori inspired deployable structures intended for space applications such as solar panels, radiators, and shielding elements. The primary objectives of this work are

- To demonstrate the compactness and deployment efficiency of Miura-Ori inspired foldable surfaces.
- To analyze packing efficiency and mechanical response, including load–deflection behavior and angular misalignment over folding cycles.
- To illustrate conceptual integration into a CubeSat platform as a representative application.
- The overarching aim is to provide a proof-of-concept that validates the suitability of Miura-Ori origami designs for next-generation deployable aerospace structures.

FM7-PA0180

Study of flow pattern and velocity profile having various Reynolds numbers fluids through rectangular microchannel

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The behaviour of fluid flow in microchannels differs significantly from that in large-scale channels. In this study, fluid flow at different Reynolds numbers is investigated within a rectangular microchannel. The Navier–Stokes equations play a crucial role in analysing such flows; however, obtaining exact analytical solutions is often challenging. To address this, we numerically simulated the problem using ANSYS Fluent and analysed the results through graphical representations and tabulated data. The findings reveal that, even with increasing Reynolds number, the flow in the rectangular microchannel remains laminar. This behaviour is clearly observed through the visualization of velocity contours. The outcomes of this research are particularly relevant for applications in lab-on-chip technology and the design of advanced microchannels for microfluidic systems.

Contributory Talks

FM1-PA0070

Temperature-Driven Improvements in Formability and Part Quality in Incremental Sheet Forming of Aluminium Alloy AA6061-T6

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The present study investigates the effect of various forming temperatures on the fractur depth, geometrical accuracy and surface roughness of the formed part through Heat-assisted Incremental Sheet Forming (HAISF). A sheet of AA6061 T6 of thickness 1 mm was selected as test material owning to its excellent strength-to-weight ratio and widespread application in automotive industry. All the experiments were conducted at fixed process parameters, 0.4 mm of step depth, 600 mm/min of feed rate and 1250 RPM of spindle speed, while varying the forming temperature up to 400°C. To support and validate the experimental results, Finite Elemental Analysis (FEA) was carried out using ABAQUS dynamic/explicit module. The results show that the formability of the material increases drastically at elevated temperature, as the samples formed at room temperature failed at around 9.2 mm. While the samples formed at elevated temperature reached the target depth of 30 mm at a steep wall angle of 62°. The forming temperature up to 300°C helps increase the dimensional accuracy and surface roughness due to reduced springback and increased plasticity as the flow stress reduces drastically. While the higher temperature (around 400°C) increases the formability but reduces the geometrical accuracy and surface finish due to over-softening of the material. The simulation results supported the experimental observation and predicts the fracture depth with the accuracy of over 90%.

FM1-PA0079

Numerical Investigation of Natural Frequencies and Mode Shapes of a Warren Truss Bridge

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Steel truss bridges play a pivotal role in a country's transportation facilities. They symbolize the socio-economic condition of a country. Consequently, structural health monitoring is one of the important areas to deal with in the domain of structural engineering. In order to carry out health monitoring of a structure, such as a truss bridge, finding its natural frequencies and mode shapes is a critical step. In this study, a 3D finite element model of a Warren truss bridge is developed in ABAQUS, and modal analysis is performed to determine its natural frequencies and mode shapes, which are subsequently reported.

FM1-PA0095

Machine Learning-Based Precipitation Forecasting in Complex Terrain: Leveraging Hybrid Model Architectures

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The purpose of this study is to assess and contrast the predictive capabilities of hybrid and conventional Machine Learning models for Himachal Pradesh's daily precipitation forecasts. The models that are being examined include XGBoost, Gated Recurrent Units (GRU), Long Short-Term Memory (LSTM), and a number of hybrid combinations, including XGBoost-LSTM, XGBoost-GRU, XGBoost-LSTM-GRU, and XGBoost-GRU-LSTM. In order to support efficient hydrological planning and disaster preparedness in regions with complex terrain, the study aims to identify models that offer the highest accuracy in rainfall prediction by utilising more than 20 years of meteorological data covering important variables like wind speed, temperature, humidity, and surface pressure.

FM1-PA0134

Effect of Static and Rotating Microcylinder on the Aerodynamic characteristics of Airfoil

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The aerodynamic influence of a 3.5 mm diameter cylindrical rod aligned ahead of the leading edge of an airfoil with NACA 63(4)-0321 profile was tested in a low-speed subsonic wind tunnel. The test airfoil was 3D printed utilizing PLA material at a resolution of 100 µm. The test model was equipped with a total of 46 pressure ports (1 mm diameter) Equidistributed over suction and pressure sides which was then pneumatically connected to an MPS4264 miniature Scanivalve pressure scanner. Experiments were carried out at the Reynolds number of 1.71×10^{-5}, with the rod located 7.5 cm from the leading edge with an inclination of 0°, tested in static and rotating (25 and 50 RPM) conditions powered by a 12V DC motor. The airfoil was subjected to angles of attack ranging from deg 0 to deg 50 with increments of 5°. Results show that the flow control methods improved suction peaks at lower angles of attack, thereby enhancing the lift characteristics. The influence of microcylinder inclination with respect to chord will be performed to further investigate aerodynamic effects which will be discussed in full-length paper.

FM1-PA0159

Seismic Performance Prediction of Frame Structures Using Hybrid Numerical and Data-Driven Models

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Seismic performance prediction of frame structures remains a critical challenge in advancing performance-based earthquake engineering. Numerical approaches such as finite element modeling provide accurate insights into structural behavior but are computationally demanding, while purely data-driven models often lack robustness under extrapolation. To address this, a hybrid numerical–data-driven framework is proposed that integrates OpenSeesPy-based simulations with deep learning models for accurate and efficient seismic response forecasting.

FM2-PA0054

Prediction of Remaining Useful Life of an Aircraft Engine using mRMR and CNN

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The aviation industry is expanding rapidly, and with that growth comes an increased focus on flight safety and engine reliability. Since aircraft engines operate under harsh conditions of high temperature, pressure, and stress, identifying possible faults and estimating their Remaining Useful Life (RUL) at an early stage is crucial. In this work, the N-CMAPSS dataset from NASA's Prognostics Data Repository is used to predict the RUL of aircraft engines. The dataset contains multiple sensor readings related to altitude, temperature, and pressure for several engine units. To prepare the data, dimensionality reduction techniques are applied—first using the minimum Redundancy Maximum Relevance (mRMR) algorithm to select the 12 most significant sensors, and then applying Principal Component Analysis (PCA) to extract 19 key features. Four models Linear Regression (LR), Ensemble Bagged Tree (EBT), Gaussian Process Regression (GPR), and Convolutional Neural Network (CNN) are trained and compared using Mean Absolute Error (MAE) and Root Mean Square Error (RMSE).

FM3-PA0176

Forecasting Soil Moisture Using Machine Learning and Satellite Sensors

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The soil moisture at various depths (from $0 - 100$ cm) is one of the key environmental variable in rainfall, drought, and agricultural studies. Surface and root zone soil moisture have a great influence on growth of crops and helps in water management, rainfall prediction, solving drought related situations, and flood forecasting. The soil moisture data can be monitored with the help of installed in-situ sensors at different stations. Installing sensors is labor intensive and can disturb the soil, which makes it difficult to record soil moisture observations accurately over

large areas. So, the satellite based monitoring of soil moisture products become more effective method for large scale data as compared to in- situ sensors based soil moisture observations. There are various satellite based sensors including Soil Moisture and Ocean Salinity (SMOS), Advanced Microwave Scanning Radiometer 2 (AMSR2), and Soil Moisture Active Passive (SMAP) providing soil moisture observations upto 5 cm depth. For analyzing and predicting soil moisture much deeper, there is requirement of some more satellite based datasets like Copernicus Global Land Service (CGLS), GLDAS (Global Land Data Assimilation System), ISRO MOSDAC (Meteorological & Oceanographic Satellite Data Archival Centre), and NRSC (National Remote Sensing Centre) Bhuvan.

FM4-PA0003

Electro-osmotic flow of couple stress nanofluid in a stenotic artery with the effects of nanoparticle aggregation and thermal radiation

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The present work aims to investigate the electro-osmotic transport of a couple stress nanofluid through a constricted tube, consolidating the impacts of nanoparticle aggregation and thermal radiation. The problem was approached analytically by first simplifying it through mild constriction assumptions. Then, Laplace and Hankel transforms were employed to solve the resulting equations. It is found that nanoparticle accumulation adjusts the thermal conductivity and thickness, impacting stream effectiveness and thermal exchange. Thermal radiation improves heat transfer processes by affecting temperature distribution and energy exchange dynamics. These findings give experiences into nanoscale intelligent in physiological streams, with potential applications in hyperthermia medications and other nanofluid-based biomedical innovations.

FM4-PA0123

Electroosmotic Ciliary Peristalsis of Tri-Hybrid Nanofluids in the Presence of Gyrotactic Microorganisms

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Advanced nanofluids, combined with bio-inspired transport mechanisms, hold promise for applications in microfluidic devices, cancer treatment, targeted drug delivery, biomedical engineering, and biosensors. This study investigates ciliary-driven peristaltic transport of a Casson blood-based tri-hybrid nanofluid, which includes Fe_2O_3, ZnO, and TiO_2 nanoparticles, together with the influence of gyrotactic microorganisms in a symmetric channel. This model integrates the effects of electroosmosis, thermal radiation, internal heat generation, viscous dissipation, Joule heating, and an inclined magnetic field to represent physiological and microfluidic conditions accurately. The use of lubrication theory simplifies the intricate nonlinear governing equations by assuming conditions of long wavelength and low Reynolds number, which are particularly suitable for peristaltic and ciliary-induced flows in narrow channels. The Debye-Hückel approximation is used to linearize the distribution of electric potential, thereby addressing electroosmotic effects. The resulting reduced system is subsequently addressed through the homotopy perturbation method, which yields efficient and precise approximate analytical solutions. Lamina-shaped nanoparticles reduce fluid temperature owing to their elevated surface area-to-volume ratio and flat structure.

FM4-PA0201

Peristaltic Flow of Jeffrey nanofluid in an Elastic Tube

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Peristaltic flow of Jeffrey nanofluidina flexible vertical tube is investigated under long wavelength and low Reynolds number assumptions. Exact solutions are obtained for the equations governing the flow field. The expressions for axial velocity, temperature and pressure gradient are obtained.The influence of elasticity on the volume flux of the fluid is studied in detail. It is noticed that the pressure rise increasedwith an increase of Jeffrey parameter for different caseswith pure water and nanofluids. Similar behavior is observed for variation in heat source/sink parameter and elastic parameters.The different combination of metallic nanofluids like pure water H_2O,Copper-waternanofluid$CuO + H_2O$, Silver-water$Ag + H_2O$ and Titanium oxide-water nanofluid$TiO_2 + H_2O$ are considered to understand the significance of different physical parameters on peristaltic transport of Jeffrey nanofluids in an elastic tube.

FM5-PA0047

Linear Stability Analysis of the Heimenz Flow past a Stretching Sheet in the Presence of Slip Mechanisms

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The linear stability analysis of the Hiemenz flow past a stretching sheet in the presence of slip mechanisms is investigated in this work. The inclusion of slip conditions, such as velocity slips, modifies the boundary behavior by allowing non-zero velocity gradients at the surface, significantly influencing the flow stability characteristics. The analysis focuses on how these slip effects alter the onset of instability in the boundary layer flow. The governing partial differential equations (PDEs) describing the flow and perturbations are transformed into a system of ordinary differential equations (ODEs) through similarity transformations. These ODEs are then solved numerically and the results are presented graphically.

FM5-PA0101

Merkin Stability Analysis of the Crane Stretching Plate Flow in a Nanofluid

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This study investigates the Crane stretching plate flow of nanofluids composed of the base fluid water (H_2O) and the aluminium alloy AA7072 nanoparticles. The study examines coupled heat and mass transfer phenomena, emphasizing the role of velocity fields in influencing thermal and concentration gradients. By using Merkin's framework, the linear stability analysis of the flow is discussed along with the stability. The governing partial differential equations are transformed into ordinary differential equations using similarity transformations. Further, the time factor is introduced at the perturbation stage where the perturbations are defined using Merkin's framework. This system is then analysed for the stability based on the eigenvalue.

Furthermore, the study gives insights in the bifurcation of drag and rate of heat and mass transfer. Applications include polymer extrusion, aerodynamic heating, and cooling technologies. By integrating stability analysis with transport modelling, this research fills key gaps in the literature and enhances predictive understanding of flow transitions and transport efficiency in complex flow systems.

FM5-PA0153

Dissipative effect on Couette-Hartmann flow of elasticoviscous hybrid nanofluid within an asymmetric channel with linearly varying wall temperature

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The overwhelming applications of nanofluids, in industrial heat exchangers, advanced cooling systems for microelectronics, biomedical fluid transport, and energy systems, where efficient heat transfer is critical, motivated the research investigators to explore the heat transfer characteristics of nanofluids. Overall, the outcomes offer valuable insights into how hybrid nanofluids enhance heat transfer efficiency and flow stability under the influence of magnetic fields, thereby contributing to the advancement of engineering and technological processes. Many physicists have taken an interest in suspending metallic nanoparticles in common base fluids, which was first proposed by Choi and Eastman . With nanoscience gaining popularity, it is crucial to understand the behavior of fluids and nanofluids on various surfaces, including stretched sheets, cylinders, plates, and channels. This fact helps analyze the variation of drag force, thermal conductivity, heat and mass flux mechanisms, and other crucial industrial aspects. Furthermore, a suspension's thermophysical properties, such as particle size and shape, influence its thermal conductivity. Chon and Kihm explained the mechanism by which the Brownian motion of particulates in the base liquid influences the thermal conductivity of nanofluids. The study of Chon and Kihm stimulated scientists to examine the thermodynamic attributes and potential uses of nanofluids in various industries. Ahmed and Batin explored the significance of a magnetic field on flow through porous media under an induced magnetic force and viscous dissipation. Mutuku-Njane and Makinde looked at the MHD boundary layer flow of nanofluids through a porous surface, considering Newtonian heating. Oztop and Abu-Nada conducted numerical experiments on naturally occurring convection in slightly heated rectangular enclosures comprised of nanofluids. In recent years, numerous researchers have presented significant findings on nanofluids . The study of multifaceted boundary layer flow, heat, and mass transfer across surfaces with pores is critical due to its diverse scientific and operational uses in various industries. Many investigations have been performed to examine the natural convection phenomenon in an incompressible, electrically conducting, viscous nanofluid subjected to an external magnetic field with Joule dissipation. Viscous dissipation immensely affects the spread of temperature because it acts as an energy source. Additionally, Joule dissipation acts as a volumetric heat source in MHD flows. Research on heat transport has grown in recent decades due to its multiple practical uses. For example, it is utilized to heat-treat components transported between a feeding roll and a winding roll, cool metallic sheets, or electronic chips, and promote crystal growth.

FM5-PA0200

Influence of an axial velocity on the transient and steady motions of linear Ekman boundary layer

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The unsteady and steady dynamics of linear Ekman boundary layer subject to an imposition of axial velocity is investigated. We considered a homogeneous fluid with kinematic viscosity $\boldsymbol{v}$ occupying the space above an infinite plate $\boldsymbol{z = 0}$ and both rotate about the $\boldsymbol{z}$ - axis with an angular velocity $\vec{\boldsymbol{\Omega}}$. In addition, the fluid is blown across the plate with an uniform axial velocity $\boldsymbol{U}$ in a direction normal to the plate. At time $\boldsymbol{t = 0}$, the rotation speed of plate is simultaneously increased by the small amount $\epsilon\vec{\Omega}$. This problem originally has been studied by Smith (QJMM, 1979, 1981). He found the exact solution to the transient problem by Laplace transform and then discussed the steady solution. The same problem has been reinvestigated here, but the mathematical analysis is little different and is made relatively simple. We obtain the approximate solution to the time dependent situation using the combination of perturbation and Laplace transform technique for large t by taking the limit $\boldsymbol{s \to 0}$ and achieved the steady state solution by final value theorem. Further, the steady state dynamics which represent dispersive and diffusive phenomenon is investigated using different perturbation methods.

FM6-PA0096

Propagation of Normal Shock Waves in Magnetised Turbulent Ideal Gas

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A parametric study is done to investigate the change in fluid properties due to normal shock wave and turbulent flow interaction, taking into account the influence of the magnetic field, which is essential for advancing aerospace technologies, fluid dynamics and magnetohydrodynamics systems. The analysis begin with the derivation of governing equations for compressible and turbulent flow that relate to the Rankine-Hugoniot relations and take into account the effects of magnetic flux. The study examines into the manner in which magnetic fields impact downstream flow characteristics and the compression process across the shock. Mach numbers are calculated upstream and downstream of the shock, analysing the change of flow from supersonic to subsonic conditions. The study also assesses the generation of entropy across the shock.

FM6-PA0099

Combined effects of radiation and induced magnetic field on MHD flow problem

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The purpose of the present analysis concerns the MHD flow of fluid, which is naturally convective and electrically charged through two vertical insulated walls. Influences of radiative heat flux and induced magnetic field are taken. We found exact expressions for the temperature field, the velocity field, and the induced magnetic field by solving the set of dimensionless coupled governing equations. The influences of several constraints such as magnetic and radiation on the profiles of the velocity, the temperature field, and the induced magnetic field are displayed with graphics. The outcome of the radiation raised the velocity, the temperature field, and the induced magnetic field in view of enhancing the thickness of the boundary layer.

FM6-PA0181

Evolutionary dynamics of weak shock wave in radiative magnetogasdynamic under the effect of acceleration due to gravity

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In this article, we have explored the evolutionary dynamics of weak shock in an ideal gas for unsteady, one-dimensional cylindrical symmetric flow under the effect of magnetic field, thermal radiation, and gravitational acceleration. The method used in this study involves series expansion near the wavefront based on the assumption that the strength of the wave is small. This method makes use of the idea of rays and results in a coupled set of first-order evolutionary equations that define the wave strength and amplitude of the first-order discontinuities. The obtained evolutionary equations capture the wave behavior and allow us to determine the critical value of the initial jump discontinuity's strength and the position at which the compression wave steepens into the weak shock wave. From the evolutionary equation the decay of the expansion wave is also discussed. The solution also captures the effect of key parameters, including adiabatic index, magnetic field strength, thermal radiation, and gravitational parameter.

FM7-PA0004

Application of the Literature-derived modified penetration model to quantify drug particle depth in the viable epidermis post stratum corneum transit

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The drug in the powdered form is administered via a micro-shock tube device within the body of an individual without the need of needle. The effect of different pressure ratio (PR) on the penetration depth is not studied in detail. We considered four different PRs, i.e., 9, 15, 40, and 60 to investigate the penetration depth. Numerical simulations were performed, and the penetration depth attained by the drug particle for these PRs was computed using the literature-derived modified penetration model. The simulation results were subsequently compared to the experimental results for verifying the solution. It was observed that the higher PR of 60 propelled the particles at a high velocity compared to other PRs of 9, 15, and 40, confirming the particle's higher penetration depth. The penetration depth achieved at PR= 60 confirms the drug particle delivery at the epidermis region without discomfort caused to the patient.

FM7-PA0051

A Revised SIMPLE Algorithm on collocated grids for Fluid Flow in Lid–Driven Cavities

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In this paper, the ISTEC – N (Incompressible Flow Solver with Two Explicit N Correction Loops) algorithm, which is an extension of the SIMPLE (Semi – Implicit Method for Pressure Linked Equations) algorithm on collocated grids is modified through revised under – relaxed discretised equations and use of a unified MWI (Momentum Weighted Interpolation). The revised algorithm, ISIREC – N (Incompressible Flow Solver with Imposed Relaxation and Explicit N Correction Loops) focuses on the reduction of inner iterations due to N and grid size, contributing to the robustness of the algorithm. The ISIREC – N is discussed for the classical lid – driven square cavity for Reynolds number (Re) till 10^4.

FM7-PA0100

The Numerical analysis of MHD hybrid nanofluid flow over rotating disc influence of thermal Radiation and slip boundary condition

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The improvement of heat transfer in magnetohydrodynamic (MHD) hybrid nanofluid flow across a rotating disk is examined with the effects of activation and radiation. Water-based hybrid nanofluid system is subjected to a zero-mass flow condition and convective boundary conditions. Prior to being converted into a system of ordinary differential equations (ODEs) by suitable similarity transformations, the governing partial differential equations (PDEs) are first formally constructed. The built-in solver bvp5c in MATLAB is used to solve these ODEs numerically. The findings are displayed using profiles of temperature, concentration, and velocity as well as analyses of the Nusselt number and skin friction coefficient. Graphical analyses also demonstrate important physical parameters affect the behaviour of heat transport and local skin friction.

FM7-PA0103

Peristaltic flow analysis in an asymmetric porous channel using magnetohydrodynamics effect

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In this work a mathematical model is developed for peristaltic flow analysis in an asymmetric permeable channel. The problem is modelled in the form of continuity equation and momentum equations, along with appropriate boundary conditions. The impact of external forces i.e., magnetohydrodynamics and velocity slip parameter are analysed. A semi-analytical method i.e., differential transformation method (DTM) is used to solve the transformed nonlinear ordinary differential equations. The impact of pertinent parameters on the velocity are revealed by graphs. From the outcomes, the velocity profiles decreased when increasing the values of slip parameter for phase angle 90°. Moreover, the dual behaviour in velocity outlines were noticed when escalating the values of Hartmann number for phase angle is zero.

FM7-PA0108

Analysis of Cross-Diffusion Effects on MHD Hybrid Casson–Williamson Fluid Flow Over a Paraboloid Surface of Revolution

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In this study, the combined effects of Soret and Dufour cross-diffusion, thermal radiation, and chemical reaction on the magnetohydrodynamic (MHD) hybrid Casson–Williamson fluid flow over an upper paraboloid of revolution are investigated. The model represents a hybrid nonNewtonian system, accounting for both **shear-thinning** (Casson) and **viscoelastic** (Williamson) behaviors, making it applicable to numerous industrial processes such as polymer extrusion, food processing, and biomedical transport.

FM7-PA0109

Three component convection in a Viscoelastic Oldroyd-B fluid with two-frequency vertically oscillating time-dependent body force

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The triple diffusive convection extends the concept of double diffusive convection concept, where a third diffusive factor, such as a second solute or chemical species, is introduced into the system. This third component can lead to more complex interactions, unique flow patterns, and instabilities. Studying the third component influencing convection is essential for understanding multi-component systems, such as oceanic currents where temperature, salinity and sediments interact or industrial processes like chemical mixing or desalination. Understanding these interactions is vital for modelling in environmental and engineering contexts, alongside solving complex fluid dynamic problems in nature. Viscoelastic fluid is a non-Newtonian fluid exhibiting viscous and elastic behaviour. These fluids deform under stress, exhibiting fluid

properties, and additionally have the efficacy to return to their original shape, exhibiting elastic properties. The applications of these fluids are seen in biomedical engineering for drug delivery, cosmetics, food, and polymers. The periodic variation of a specific system parameter is termed modulation. Modulation can influence the initiation and the convection behavior and, eventually, the system's stability. Modulation can hinder or hasten the initiation-of-convection, depending on its amplitude and frequency. Modulations in Rayleigh-Bénard convection are applied to enhance heat transfer in industrial systems, improving mixing in chemical and biomedical mixing and controlling crystal growth. It also plays a crucial role in space science in studying convection in microgravity environments and developing thermal management systems for planetary habitats.

FM7-PA0114

Slip and convective effects on MHD hybrid nanofluid flow over a radiated extending surface: A sensitivity analysis of heat transport

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With the rising demand for efficient cooling processes and the growing industrial applications of nanotechnology, this study investigates the heat transfer behavior of a steady, two-dimensional magnetized flow of a water-based hybrid nanofluid over a permeable extending surface. The hybrid nanomaterials, silver (Ag) and single-walled carbon nanotubes (SWCNT), exhibit excellent thermal conductivity, significantly enhancing heat transfer efficiency. The energy profile is influenced by heat radiation and a non-uniform heat source. Additionally, the effects of velocity partial slip and mixed convective thermal boundary conditions are incorporated at the surface. The governing equations are converted into a dimensionless system and numerically solved employing the bvp4c approach in MATLAB. A sensitivity analysis is conducted to assess the impact of key input constraints on heat transfer performance. Results indicate that increasing magnetization slows energy distribution, while heat source/sink effects and the Biot number enhance fluid temperature.

FM7-PA0115

Thermal and inertial drag optimization of magneto-radiative nanofluid flow across stretching metallic sheets

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To prevent surface-flaws and ensure subsequent processing steps, nanofluid flows are employed in stretching and rolling mills to thermally regulate the moving metal sheets in manufacturing stages. The motion-induced pressure on the metal strip causes its resemblance to an elongating sheet. Focused on this current scenario, the present article scrutinizes the shear and heat transfer rate of the magneto-radiative flow of the nanofluid spray past a stretching metal strip to optimize cooling efficiency. The sheet is assumed to be permeable to understand flow dynamics in a detailed way. Moreover, the incorporation of heat-generating source, linear thermal radiation, and Joule and viscous dissipation further enriches the analysis of the heat transfer rate in this study, that have gained essential interest due to their energy transfer characteristics and

potential applications. To streamline the analysis, the governing equations are converted into non-dimensional forms of ordinary differential equations and computed numerically employing the shooting mechanism integrated with fourth-order Runge-Kutta approach. Moreover, a statistical elaboration of shear and heat transfer rate, applying sensitivity analysis, contributes to the depth of the study. However, the results expose that the accelerating magnetization and porosity result in a reduction in the velocity profile for both suction and injection cases.

FM7-PA0118

Linear and Non-Linear Analysis of Triple Diffusive Convection in a Newtonian fluid with Internal Heat Source under Different Boundary Combinations

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A linear and non-linear study of triple diffusive convection with internal heat generation in a Newtonian fluid is analyzed. Linear stability analysis, using the Galerkin method, yields the critical Rayleigh number for stationary convection across all 16 iso concentration boundary combinations. Results show that the internal Rayleigh number and diffusivity ratios promote convection, while both solute Rayleigh numbers delay its onset. For the non-linear case, a seven-mode Lorenz model is derived via Fourier expansion, and expressions for the time dependent Nusselt and Sherwood numbers are obtained. The analysis reveals enhanced heat transfer in three-component convection compared to single and two-component cases

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FM7-PA0128

Assessment of Tio_2 Nanofluid Dynamics in Stenotic Arteries

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This work develops a mathematical model to examine the flow of Casson fluid enriched with TiO_2 nanoparticles through a stenotic artery. Using similarity transformations, the governing equations are reduced to a nondimensional form and are solved. Numerical results are illustrated graphically to analyze the influence of key flow parameters. The findings reveal that an increased volume fraction of TiO_2 nanoparticles enhances blood flow, whereas the applied magnetic field suppresses it. Furthermore, the geometry of stenosis is shown to exert a significant impact on the flow characteristics.

FM7-PA0130

Unsteady Flow inside a Cavity with a Discrete Heater at High Rayleigh Numbers

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This study presents a numerical investigation of two-dimensional natural convection in a square cavity containing a centrally located discrete heater. The primary objective is to examine the transition from steady laminar flow to unsteady flow regimes as the Rayleigh number (Ra) is systematically varied from 10^7 to 10^8. The governing equations are solved using the finite volume method on a uniform staggered grid. Advection terms are discretized with the QUICK scheme, while diffusion terms are treated using central differencing. A TDMA-based algorithm is employed to solve the discretized equations at all nodal points. The onset of unsteadiness is identified by plotting the time history of streamlines, isotherms and Nusselt number, which reveal the emergence of periodic oscillations. In addition, surface radiation effects are incorporated using the net radiation method to assess their influence on the thermal and flow fields. The results highlight the suppressive role of radiation within the cavity and demonstrate the modifications it induces in the transition toward time-dependent flow regimes

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FM7-PA0131

Fourier Neural Operator-Based Machine Learning Framework For Accurate MHD Flow Prediction: Comparative Analysis Against CFD

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Machine learning surrogates can significantly accelerate computational fluid dynamics (CFD) simulations but must ensure robustness across varying flow regimes and geometries. This study presents a Fourier Neural Operator (FNO)-based surrogate for full-field prediction of velocity, temperature, and Lorentz-force distributions in two-dimensional buoyancy-driven magnetohydrodynamic (MHD) convection. A multi–Signed Distance Function (SDF) encoding integrates geometry and boundary information within the input tensor, enabling a single model to generalize across eight enclosure geometries and multiple magnetic field orientations. A high-fidelity Open FOAM dataset comprising $1,536$ simulations spans Rayleigh numbers ($\mathrm{Ra} = 10^3 - 10^6$), Hartmann numbers (Ha = 0-100), and diverse magnetic orientations. The surrogate achieves a mean coefficient of determination (R^2) of 0.985, on 40 unseen test cases, with a median absolute percentage error of 0.81% and overall errors within 0.23–2.41%. The model accurately reproduces convection rolls, boundary layers, and magnetic damping effects, with the 24-mode configuration offering the best trade-off between accuracy and efficiency. A Monte Carlo uncertainty analysis with $\pm 5\%$ parameter perturbations showed $< 2\%$ mean relative variation across all fields, confirming robustness and physical consistency. The proposed framework enables rapid, accurate, and physics-consistent predictions across wide parametric and geometric domains, supporting real-time MHD analysis and design optimization.

FM7-PA0132

Impact of Hemodynamic factors on unsteady MHD blood flow through a tapered stenosed artery with body acceleration

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Deposit of cholesterol, fat, and lipids in the lumen artery creates an unwanted and unnatural growth is called stenosis. Progressive stenosis hampers the cardiovascular system, creating a significant risk to survival. Hemodynamic analysis of blood flow can elucidate the pathology of stenosis, enabling accurate diagnosis and effective treatment. A mathematical model is formulated to study blood flow through a mild stenosed, tapered and inclined tube subjected to a magnetic field and body acceleration. A comparative numerical study is made with the obtained series solution to investigate the validity of results. The relationship between flow characteristics and pertinent parameters is addressed. By employing the Frobenius method, flow governing equation are solved and derived the expression for velocity distribution. Computed numerical results are illustrated through graphs. One can control the flow distribution by regulating the magnetic field and body acceleration.

FM7-PA0135

Effect of Two Component on Regular, Chaotic, and Periodic Motions in Rayleigh-Bénard Convection of a Micropolar Fluid

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When micron-sized particles are suspended in a Newtonian fluid, the stress tensor becomes asymmetric. Because these particles possess spin, angular momentum conservation cannot simply be derived from linear momentum but requires an additional governing equation. The paper addresses this situation by modelling a micropolar fluid under Rayleigh–Benard two-component convection, where the behaviour ranges from regular convection to periodic motion and chaos as the scaled Rayleigh number is varied. To capture weakly nonlinear convection, a sixth-order scaled Lorenz model is employed. This model conserves energy and ensures bounded solutions within a six-dimensional ellipsoid while maintaining the dynamical traits of the classical Lorenz model. The onset of convection and chaos is quantified through scaled critical and Hopf-Rayleigh numbers. It is found that particle suspensions with solute additives postpone the emergence of both periodic flow and chaotic dynamics relative to a pure Newtonian fluid.

FM7-PA0136

Linear and nonlinear analysis of Rayleigh-Bénard convection in Newtonian dielectric fluid with symmetric and asymmetric boundary conditions

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Rayleigh–Benard convection (RBC), a classical paradigm in fluid mechanics, arises when a horizontal fluid layer heated from below and cooled from above becomes unstable due to the competition between buoyancy forces and stabilizing viscous and diffusive effects. The onset of convection is characterized by a critical Rayleigh number that marks the transition from

purely conductive heat transfer to convective transport. RBC has been extensively studied as a benchmark problem for understanding instability, pattern formation, and nonlinear evolution in thermally driven flows, with implications across both natural phenomena and technological systems.

FM7-PA0137

Dual boundary condition effects on thermal transport and stability of micropolar nanofluid flows

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To meet the demands of precise heat management in compact engineering systems, it is essential to examine micropolar nanofluid flow between parallel surfaces. Understanding the thermodynamic behavior, microrotation effects, and boundary layer properties under magnetic and thermal influences is crucial for the development of new cooling methods. The main study focuses on exploring heat transfer in micropolar nanofluid between parallel plates, taking into account thermophoretic diffusion, an applied magnetic field, and Brownian motion under two thermal boundary conditions: Prescribed Surface Temperature (PST) and Newtonian Heating (NH), along with a stability analysis. We develop a mathematical model that includes these characteristics and examine their effects on heat transmission and flow. Using a 2-D coordinate framework, the governing equations for temperature, concentration, velocity, and microrotation are developed along the flow and transverse directions. Equations for conservation between two parallel plates are formulated by applying two boundary conditions for momentum, thermal energy, and concentration. The nonlinear partial differential equations are converted into a dimensionless form via a nonsimilar transformation. The temperature, flow, and concentration profiles are then clearly captured by solving the resultant system using the Bvp4c method. The main computational tool used in this study to do calculations is MATLAB. To increase predicted accuracy even more, a data-driven model built on backpropagated neural networks and optimized using the Levenberg–Marquardt Algorithm (LMA) is employed. Solutions obtained from the Bvp4c approach are used for training and evaluating the model for a range of parameter combinations. The approach's robustness is illustrated by validation metrics such as regression plots, mean squared error (MSE) and error histograms. The LMA-MSE predictions and reference results show strong agreement with MSE values that vary between 10^{-7} and 10^{-12}, highlighting the efficiency and precision of the proposed intelligent computing framework.

FM7-PA0139

Pacemaker Effects on Weakly Nonlinear Instability and Heat/Mass Transport in Poiseuille Flows of Binary Mixtures

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A weakly nonlinear analysis is executed for the dissipation of viscous instability in a two-phase fluid mixture undergoing Poiseuille flow, incorporating the effects of Soret coupling and viscous heating. In the baseline formulation, the disturbance dynamics reduce to a cubic Landau amplitude equation whose coefficients are evaluated in closed form, allowing the onset and nature of stationary convection rolls to be determined from the sign of the Landau coefficient. In the present extension, slow spatial modulation of the disturbance envelope is introduced into the multiple-scale expansion, transforming the temporal Landau equation into a spatially extended real Ginzburg Landau equation with diffusion and higher-order nonlinear terms. This generalization captures pacemaker behaviour, where localized regions act as persistent pattern sources that emit rolls into the surrounding stable state. The pacemaker mechanism

is shown to arise naturally in subcritical regimes already identified through the sign change of the Landau coefficient, providing a direct link between the original bifurcation analysis and the emergence of localized sources. The influence of separation ratio, Gebhart number, Prandtl number and Lewis number on pacemaker onset, drift, and stability is quantified, and numerical simulations of the amplitude equation illustrate both stationary and propagating pacemakers. The results extend the original viscous dissipation instability framework to include localized pattern generation and control in binary-mixture Poiseuille flows.

FM7-PA0141

Theoretical Modeling of MHD Jeffery-Hamel Fluid Flow in Arteries: Collocation Technique

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This paper explores a new collocation technique using the Chebyshev polynomial (CCM) to investigate the magnetohydrodynamic (MHD) Jeffery-Hamel blood flow through an arterial tube. Applying the Chebyshev collocation method on the reduced one-dimensional third-order differential equation, a system of nonlinear algebraic equations is obtained and solved numerically. The impact of transverse magnetic field intensity on the flow parameters is examined and the numerical results are cross-checked with the Bernstein collocation method's solution. The present study confirms that the proposed method ensures both accuracy and efficiency. Furthermore, the product of the plate angle (α) and Reynolds number (Re) enhances the flow speed, whereas the strong magnetic field significantly modifies the flow behavior

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FM7-PA0142

DTM approach to MHD Jeffery-Hamel Nanofluid flow

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This study investigates the Jeffery-Hamel flow of a water-based Au Nano fluid in a convergent-divergent channel under the influence of a magnetic field. Effective thermo physical properties are evaluated using standard mixture relations, and the governing equations are reduced to a third-order nonlinear ordinary differential equation through similarity transformation. The reduced nonlinear ODE is analysed by using the Differential Transform Method (DTM). It is observed that the enhancement of gold nanoparticles produces substantial alterations in effective viscosity, even at low concentrations. Eventually, it affects the velocity profile. The derived results substantiate the accuracy and efficiency of DTM in capturing nonlinear Nano fluid flow behavior.

FM7-PA0169

Stability of Rivlin–Ericksen Nanofluid Bioconvection with Gyrotactic Microorganisms under Vertical Throughflow and Internal Heat Source: Applications to Bioreactors and Microfluidics

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This study investigates the onset of bioconvective instability in a Rivlin–Ericksen nanofluid laden with gyrotactic microorganisms, considering the combined effects of vertical throughflow and internal heat generation. The fluid layer is confined between two infinite horizontal boundaries, and the governing equations account for viscoelasticity, nanoparticle Brownian motion, thermophoresis, and microorganism motility. Linear stability analysis, employing the normal mode technique with Galerkin approximations, is used to evaluate the critical thermal Rayleigh number for both stationary and oscillatory modes. The influence of Brownian diffusion, thermophoresis, and throughflow on the stability threshold is systematically examined. The results reveal that vertical throughflow significantly alters the onset of instability, acting as either a stabilizing or destabilizing mechanism depending on its direction. Internal heat generation and microorganism activity accelerate the onset of convection, whereas viscoelastic effects impart a stabilizing influence. These findings provide new insights into the interplay of transport mechanisms in nanofluid bioconvection with practical relevance in bioengineering and thermal management applications. number consistently promotes destabilization.

FM7-PA0179

Effect of Internal Heat Generation on Bioconvective Instability in Nanofluids with Thermotactic Microorganisms

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Thermotactic microorganisms play a vital role in bioremediation, biodegradation, and the food and agriculture industries. Their thermostable and thermoactive enzymes make them particularly suitable for moderate-temperature bioprocesses, thereby enhancing efficiency and overall performance. Motivated by these properties and applications, the present study investigates the effects of both linear and nonlinear internal heat sources on the onset of bioconvection in a nanofluid layer containing thermotactic microorganisms. A mathematical model is developed using Buongiorno's model for nanofluid together with Pedley's model for microorganisms. The dimensional flow equations are transformed into a set of ordinary non-dimensional differential equations through similarity transformations and normal-mode analysis. The resulting eigenvalue problem is solved numerically via the finite difference method implemented in MATLAB's bvp4c routine, subject to zero nanoparticle flux and rigid-rigid boundary conditions. The influence of key flow parameters on the onset of bioconvection is analysed and presented in graphical and tabular form. A key novel insight of this study is that, under top heating in a nanofluid containing thermotactic microorganisms, linear internal heat generation destabilizes the system by driving microorganisms upward toward the hotter boundary, whereas nonlinear internal heat generation exerts a stabilizing influence by suppressing their accumulation near the heated wall. This contrasting behaviour, not explicitly reported in earlier works, provides a new comparative perspective on the stability of bioconvective nanofluids. It is further observed that, in both cases, an increase in the Peclet number consistently promotes destabilization.

FM7-PA0184

Nanoparticle Shape Effects on Heat Transfer and Convective Instability in Weakly Magnetized Rotating Systems

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This investigation explores the dynamics of rotating Rayleigh–Bénard convection in a weakly conducting nanofluid layer confined between stress-free, isothermal boundaries. Both the initiation of convection (primary instability) and the subsequent transition to time-dependent flow (secondary instability) are examined using linear stability analysis to determine the corresponding critical parameters. The convective heat transport in these regimes is quantified through the Nusselt number, serving as an indicator of thermal efficiency. The influence of nanoparticle geometry is assessed by considering five particle shapes—spherical, brick-like, cylindrical, platelet, and blade types. Among these, blade-shaped particles induce the greatest destabilization of the system and yield the highest rate of heat transfer in both instability regimes. The analysis incorporates three nanofluid compositions: H_2O–Cu, H_2O–Al_2O_3, and a hybrid mixture H_2O–Cu–Al_2O_3. The hybrid nanofluid demonstrates an earlier onset of convection and superior thermal performance compared to the mono nanofluids. Furthermore, the inclusion of a weak magnetic field reveals that increasing magnetic strength suppresses convective motion, delaying both primary and secondary instabilities and consequently diminishing the overall heat transport.

FM8-PA0038

Riemann problem for two layer two-phase flow model with Chaplygin pressure law

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Two-phase flow modelling has been a subject of extensive research due to its relevance in engineering, biomedical, and geophysical applications. Advanced numerical frameworks for two-velocity, two-phase models were proposed by Zhang and Sheng. Wei and Sun proposed a two-phase flow model governed by the Chaplygin gas equation of state: $p = -A/\rho$, where $A > 0$ is a constant and ρ is the density. These studies collectively highlight the growing interest in modelling multi-phase flow using hyperbolic systems. In this present study, we investigate the solution of the Riemann problem associated with a system of quasilinear hyperbolic partial differential equations that models laminar two-phase flow with different velocities for each phase and each layer.

FM9-PA0122

Experimental Investigation of the Effects of Turbulence Intensity on the Aerodynamic Characteristics of Stepped Airfoils

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Over the years, optimization of aerodynamic characteristics through simple and energy-efficient passive flow control methods has gained significant attention, among which, the introduction of steps on the surface of the airfoil to create a geometric discontinuity has been widely studied. NACA 63(4)-021 is chosen as the baseline model and the modified model featuring steps of varying size along the span on its pressure side. In order to access the aerodynamic characteristics of the airfoils, the surface pressure measurements were taken by using a MPS4264 pressure scanner corresponding to a sampling frequency of 700Hz. A modified model with incorporated steps on the pressure side was used to determine the effect of a geometric modification whereas, a self-made passive grid made by using a parallel array of round bars was placed along the length of the test section in order to obtain the desired turbulence intensity (TI). All the experiments were carried out at Re=2.48×105 and all the models were tested from 0° to 70° with an increment of 5°. With a freestream TI = 0.44% and the grid generated turbulence of TI = 6.81%, 8.58%, 10.38%, 12.59%. The CL, CD and CP plots were plotted to obtain a better understanding of the aerodynamic behavior, and the results revealed that the modified model exhibits improved aerodynamic characteristics compared to the baseline, with an maximum increase of 37.9% in CLMAX at TI= 6.81%.

FM9-PA0129

Aerodynamic Characteristics of Slotted Airfoils under Varying Turbulence Intensities: An Experimental Approach

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In recent years, there has been increasing interest in improving aerodynamic performance using simple and energy-efficient passive flow control techniques. Among these, slotted airfoils have attracted significant attention due to their potential to delay flow separation. To investigate these effects experimentally, this study employs the NACA 63(4)-021 airfoil as the baseline, along with a modified version incorporating slots. Experiments were conducted in a low-speed subsonic wind tunnel, where the airfoil models were pneumatically connected to a Scanivalve pressure scanner to obtain surface pressure data. The airfoil models were tested at $Re = 2.58x10^5$, across a wide range of angles of attack from deg 0 to deg 60, in deg 5 increments. Aerodynamic force coefficients—including lift (CL) & drag (CD) were then calculated using the pressure integration method. The resulting data was analyzed to assess changes in aerodynamic characteristics. Measurements will be taken under various turbulent inflow conditions to assess the effects of turbulence intensity on airfoil characteristics which will be detailed in the full-length manuscript.

FM10-PA0032

Dual Reciprocity Boundary Element Method for Brinkman–Maxwell Viscoelastic Flow Past a Dual-Row Array of Circular Cylinders in a Porous Microchannel

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This work presents a computational investigation of the steady, incompressible flow of a viscoelastic fluid through a porous microchannel embedded with multiple cylin- drical obstacles. The fluid motion is governed by the Maxwell–Brinkman model, wherein the Maxwell constitutive relation captures viscoelastic behavior, while the Brinkman term accounts for the resistance due to the porous matrix. The Dual Reciprocity Boundary Element Method (DRBEM) is employed to solve the governing equations, formulated in terms of streamfunction and vorticity. A distinctive feature of the model is the incorporation of the Beavers–Joseph boundary condition, which permits partial slip at the interface between the free fluid and the porous region along the flow direction. The study systematically explores the effects of obstacle size, interfacial slip length, and fluid elasticity on the velocity distribution and wall shear stress. Additionally, streamline and vorticity patterns are analyzed to elu- cidate key characteristics of the flow structure. The results offer insights that are pertinent to the optimization of microfluidic devices and have potential applications in biomedical engineering and MEMS technologies.

FM10-PA0033

Thermosolutal convection of the Horizontal Throughflow in a Power-Law fluid Saturated Porous layer with Variable gravity

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This study aims to examine the initiation of instability in horizontal through flow within a thermosolutal power-law fluid that saturates in a horizontal porous bed, taking into account the influences of viscous dissipation and varying gravity. The boundary wall of this horizontal porous bed is impermeable, maintaining constant temperature and solute concentration. The generalized Darcy's equation for power- law fluids is used in the momentum balance, incorporating the Oberbeck-Boussinesq approximation to account for buoyancy effects in this system. It is believed that the viscous dissipation has significant role in the thermal instability analysis. The fundamental thermal and solutal profiles were analyzed in a horizontal throughflow are established analytically, followed by a linear stability analysis of this foundational solution. The instability of the flow field is evaluated through normal mode analysis, which identifies the critical thermal Rayleigh number values related to the wave number. The eigenvalue problem is numerically solved with the Runge-Kutta method in MATLAB.

FM10-PA0035

Effect of Variable Gravity on Thermosolutal Convection in a Power-Law Fluid-Saturated Porous Layer with Soret Effect and Concentration-Based Internal Heat Source

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The current research examines thermosolutal convection in a horizontal porous bed, occupied by a power-law fluid and it is exposed to a heat source based on concentra- tion and the Soret effect, while considering varying gravitational conditions. Both of these physical processes greatly affect the concentration field within porous mate- rials. In this case, the fluid flow is generated by maintaining consistent and varying temperatures and concentrations at the boundary walls. The primary flow being analysed by dealing a uniform throughflow, that is tilted in relation to the horizontal X-axis. Taking into account the heat source (γ), the Soret effect (Sr), and variable gravity ($G(z)$), leads to nonlinear temperature and concentration profiles. The layer with pores is warmed and seasoned from beneath. The standard mode technique is utilized to address the non-dimensional governing equations. The effect of variable gravity in a horizontal porous layer was examined through linear stability analysis. The linear instability analysis is conducted through the application of the shooting method utilizing the RK technique. This theoretical and numerical investigation seeks to investigate the influence of the gravitational field on the flow of a power-law fluid moving through a porous bed. It also examines the analysis of thermal and solutal instability with a heat source and the Soret effect in a porous medium occupied by a power-law fluid.

FM10-PA0045

Double-diffusive Hadley flow with effect of viscous heating in a horizontal porous layer

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The present study investigates the onset of convective instability in a double-diffusive Hadley flow through a shallow horizontal porous layer, driven by combined thermal and solutal gradients under the influence of inclined gravity. The basic flow exhibits a linear velocity profile with a non-vanishing mass flow rate, resulting from a Hadley-type circulation. The impact of viscous heating on the critical conditions for the onset of instability is assessed. The system is governed by six key dimensionless parameters: the horizontal and vertical thermal Rayleigh numbers and the horizontal and vertical solutal Rayleigh numbers, which characterize the inclined thermal and solutal gradients; the Peclet number, associated with the base horizontal flow rate; and the Gebhart number, which quantifies the effect of viscous dissipation. The critical vertical Rayleigh number and the corresponding critical wavenumber are evaluated for specified values of the horizontal Rayleigh number, Peclet number, and Gebhart number. Numerical techniques, including the shooting method with Runge–Kutta integration, are employed to analyze the system's stability. The results identify the critical conditions for instability and highlight the significant role of internal heat generation in modifying the convection thresholds.

FM10-PA0072

Thermodynamic Irreversibility in Fluid Flow over a Rotating Stretchable Porous Disk

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This work investigates the motion of fluids over a rotating, stretchable disk within a porous domain, incorporating the effects of activation energy. The porous region is modeled using Brownian motion, and thermophoretic diffusion frameworks are integrated into the formulation to capture nanoscale transport phenomena. Additionally, entropy generation analysis is conducted to assess the irreversibilities arising from heat transfer, fluid friction, and particle diffusion. This study is motivated by the growing significance of heat transfer in advanced industrial processes, including power generation, thermal management in electronics, nuclear reactors, and biomedical systems. Suitable similarity transformations are employed to reduce the governing partial differential equations to a coupled set of nonlinear ordinary differential equations, which are then solved numerically. The influence of key parameters such as thermophoresis, Brownian motion, and activation energy is examined through graphical illustrations. Results reveal that the entropy generation intensifies with stronger thermophysical interactions in the system.

FM10-PA0125

Gravity Modulated Convection in a Nanofluid saturated Porous Medium

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Convection in porous media saturated with nanofluids is of significant interest due to its relevance in engineering and technology. In this study we specifically examine the onset of convection in water based nanofluids containing conventional metallic (Cu–water) and metal oxide nanoparticles (Al_2O_3–$water$). When such systems are subjected to a vertical gravity modulation of arbitrary amplitude and frequency, the onset of convection becomes more complex. Several studies have investigated the effects of time-dependent gravity modulation in both fluid and fluid saturated porous media. Markman and Yudovich examined a horizontal fluid layer subjected to periodically modulated gravitational field and studied the effect of modulation frequency on stability. Malashetty and Padmavathy performed linear stability analysis on a horizontal fluid and fluid-saturated porous layers and showed that the gravity modulation can affect the stability. They found that the low frequency g-jitter has a significant effect on the stability of the system. Because of the limitations of the solution procedures which they have adopted, their investigations were restricted to either small amplitude or low frequency or high frequency. Hence in this work, we focus our attention to obtain results over a broad and arbitrary range of frequencies and amplitudes.

FM10-PA0158

Effect of Viscous Dissipation on Onset of Thermal Convection in a Porous Medium with Horizontal Throughflow

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In the present study, we examine the effect of viscous dissipation on the onset of natural convection in a two-dimensional fluid-saturated Brinkman porous layer with horizontal through flow. The fluid saturated porous medium is modelled using Darcy's law considering the medium is uniformly heated from below, with lower and upper boundaries kept impermeable, also assumed that the linear Oberbeck-Boussinesq approximation is applicable. The onset of thermal convection is performed by two approaches: one is using the linear instability analysis, and the other is the nonlinear stability analysis (energy functional). The Chebyshev-tau method, together with the QZ algorithm, is used to solve the linear perturbed equations. Our findings conclude that the effect of viscous dissipation on the onset of natural convection has non-monotonic effect (dual nature) for the transverse case and monotonic effect in the case of longitudinal wave propagation.

FM10-PA0168

The linear and nonlinear stability of double diffusive convection with nonlinear Boussinesq approximation, magnetic field and uniform internal heat source

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This study investigates the linear and nonlinear stability analyses of double-diffusive convection in a horizontal fluid saturated porous layer, incorporating the nonlinear Boussinesq approximation, a uniform internal heat source and magnetic field effect. The flow dynamics are characterized by the Forchheimer law to account for quadratic drag effects. The linear and non-linear stability analyses are performed. The nonlinear stability analysis is performed via the energy method. The eigenvalue problems derived from linear and nonlinear stability analysis are computed numerically through the Chebyshev–tau method. The results show that both the magnetic field and internal heat source strongly affect the thresholds. A comparison of linear and nonlinear stability thresholds identifies the region of subcritical instabilities. It is observed that increasing the Hartmann number (Ha^2) delays the onset of convection.

FM10-PA0170

Thermo Bioconvection in Suspension of Gravitactic Microorganism under Magnetic Field in Local Thermal Non-Equilibrium Porous Medium

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This study investigates the initiation of thermal bioconvection influenced by magnetic field in a porous medium inhabited by gravitactic microorganisms under local thermal non-equilibrium conditions between two horizontally aligned surfaces heated from below. Magnetic effect is modeled using Maxwell's equations, microorganism concentration by Pedley's model, and porous flow by the Darcy–Brinkman model. Density variations are incorporated through the Oberbeck–Boussinesq approximation. The system is subjected to normal mode analysis for linear stability investigation, with the corresponding eigenvalue problem solved using Galerkin method. The analysis reveals that the system exhibits only stationary convection, as the computed values of frequency remain negative under both boundary conditions. Numerical results show that for free-free boundaries, increasing the interphase heat transfer parameter from 0 to 10^4 raises the critical Rayleigh Darcy number by $\approx 945\%$, while the magnetic parameter increases it by $\approx 9 \times 10^5\%$. For rigid-rigid boundaries, the respective rises are $\approx 6019\%$ and $approx6 \times 10^5\%$. The study further shows that stronger magnetic fields enhance Lorentz forces, stabilizing the system by raising critical thresholds for thermal and bioconvective instabilities, especially under rigid–rigid boundaries. Enhanced interphase heat transfer and thermal conductivity delays convection, while microorganism motility and permeability trigger earlier instability.

FM10-PA0182

Investigation of Thermal and Flow Characteristics of Casson Fluid in Porous Medium under Magnetohydrodynamic Influences

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The influence of an inclined magnetic field on the flow and thermal behavior of Casson fluid within a rectangular porous channel is being investigated in this mathematical model. The investigation focuses on the determination of velocity profile, temperature distribution, and flow rate by applying analytical derivations, graphical interpretations, and numerical simulations. A comparative assessment between Casson and Newtonian fluid models is also presented, wherein graphical representations show the fundamental differences in velocity profile, thermal distribution, and flow rate with the variation of the Casson parameter, Darcy number, porosity, Hartmann number, inclination angle, Brinkman number, and Reynolds number. The numerical findings validate the analytical outcomes and emphasize the non-Newtonian features of Casson fluids under magnetohy- drodynamic (MHD) circumstances.

FM10-PA0183

Flow of immiscible couple stress fluid and Jeffery fluid in a porous pipe: Effects of magnetic field

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This study investigates the magnetohydrodynamics (MHD) flow of two immiscible fluids-couple stress fluid and Jeffery fluid-within a horizontally oriented porous cylinder. The flow domain is divided into two distinct regions: Region I, representing the core, where the couple stress fluid flows, and region II, the outer region, where the Jeffery fluid flows. Boundary and interface conditions include the linear Navier slip condition at the cylinder surface, continuity conditions for velocities and shear stresses, and vanishing couple stress at the fluid-fluid interface. The governing nonlinear partial differential equations, along with the boundary conditions, are first formulated mathematically and then transformed into a dimensionless form. Analytical solutions for velocities, wall shear stress, and total flow rate are derived by solving the non-dimensional equations using a direct method. The impact of various flow parameters on velocity in both regions is illustrated graphically and discussed.

FM10-PA0198

Micropolar Fluid Flow with Zero Mass Flux of Nano particles at Stretching Surface

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This study presents a comprehensive investigation of mixed convection flow and heat transfer characteristics of a micropolar fluid in the presence of a porous medium and heat absorption effects. The governing mathematical model is developed along with appropriate boundary conditions. Two key mechanisms—Brownian motion and thermophoresis—are incorporated into the energy and concentration equations, which are coupled with the momentum equation. By introducing suitable similarity transformations, the system of governing partial differential equations for momentum, energy, angular momentum and concentration is reduced to a set of nonlinear ordinary differential equations. These equations are numerically solved using the bvp4c function in MATLAB, which employs a collocation method based on the three-point Lobatto IIIa formula, a type of finite difference approach. The results are presented for various emerging parameters. It is observed that the skin friction coefficient decreases with increasing Hartmann and Eckert numbers. Furthermore, bar graph analyses reveal a decreasing trend in the Nusselt and Sherwood numbers with increasing Brownian motion and thermophoresis parameters.

FM11-PA0019

Dispersion of settling particles in open channel turbulent flow

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This work investigates the transient dispersion of settling particles in open channel turbulent flow taking the effect of turbulent mixing into consideration. The behaviour of concentration distribution in all time regimes has been examined using Aris's method of moments(1956) and Edgeworth series(Chatwin,1970) numerically. The effect of skewness and kurtosis has been incorporated in the analysis to study the non-Gaussian behaviour of concentration distribution at earlier times. The results indicates that the longitudinal dispersion coefficient increases for a range of values of settling velocity from 0 to 3, then it decreases but with a high dispersion at earlier times due to the velocity gradient and constant settling velocity before being settled at the bed layer and forming a bed layer of particles that are removed from the dispersion process thus resulting upstream behaviour.

FM11-PA0024

Stokes theory for gravity-capillary waves on finite depth currents with uniform vorticity

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In this study, a new set of Stokes wave solutions, incorporating the influence of a linear shear current, is derived using a classical expansion procedure. This paper considers two-dimensional surface gravity-capillary waves moving steadily on arbitrary water depth on shear flows. The chief results are

- The wave velocity depends strongly on the magnitude of the vorticity and the depth uniform current
- To find the effect of both co-flowing and counter-flowing currents on the wave profiles using the third-order approximation.

FM11-PA0025

Nonlinear periodic gravity waves in arbitrary water depth on flows of linear shear currents

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A third-order classical Stokes theory for steady periodic waves on linear shear currents in a fluid of arbitrary depth is derived by using the perturbation method. The linear shear currents are supposed to be a linear combination of shear flow and depth uniform current. The key features of this study are

- Several surface profiles for periodic gravity waves are found and the effect of shear currents on these profiles is shown to be significant, and
- The phase velocity is dependent on the linear shear currents.

The results in the deep-water limit are also deduced and described.

FM13-PA0018

Thermoelastitic Modeling of Memory based Space-fractional ordered Hollow Cylinder

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Studying how heat behaves in hollow cylindrical structures that are affected by space fractional ordered derivatives is a new concept that can be useful in fields like mechanical, thermodynamic, and aeronautical engineering design. However, previous studies have mostly overlooked how time delay settings combined with memory-dependent derivatives (MDD) affect temperature and stress distributions in these systems. To fill this gap, this study incorporates MDD to capture memory effects in heat conduction and presents a unique mathematical model for a semi-infinite hollow cylinder exposed to a predefined jump function at its bottom surface. The incorporation of time delay factors into the MDD framework, which provides a more accurate depiction of heat and stress reactions, is innovative. Using the Laplace, Hankel, and Fourier transform techniques, analytical solutions are located in the Laplace domain. The final findings are then obtained using numerical inversion. The model uses copper material parameters for numerical analysis and assumes convective boundary conditions on the curved surfaces of the cylinder. The main contributions are creating accurate formulas for temperature, displacement, and stress patterns, and showing how much time delays affect these factors. The findings indicate thatalthough displacement and radial stress alter as time delay parameters rise, temperature and angular stress decrease, with the maximum strains occurring at certain axial and radial positions. These discoveries advance our knowledge of memory-dependent thermoelasticity and provide important new information for building sturdy cylindrical structures for high-temperature applications like industrial equipment and spacecraft.

FM13-PA0039

Hydrodynamic analysis of the offshore monopile structure fitted with a conical breakwater

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Offshore monopile structures, widely employed in wind farms and marine platforms such as oil rigs, bridge piers, and other similar structures. These monopile foundations are regularly exposed to intense wave-induced forces that can compromise their structural stability and service life. To reduce these hydrodynamic loads and increase the longevity of the foundation, various compound structure design is proposed in the literature. However, in most of those studies, the breakwater was proposed to be a porous plate or a porous circular cylinder encircling the monopile foundation. It is a well-known fact that the wave load is much higher near the free surface and decreases towards the bottom. Hence, a truncated conical breakwater—whose radius varies along the vertical axis—may serve as a better alternative to the circular cylinder. The tapered geometry of the conical design may offer the potential for improved wave scattering and energy dissipation by altering the flow pattern more gradually, which may result in enhanced performance in reducing wave loads on the monopile. This motivates us to consider the proposed problem and perform CFD analysis using STAR-CCM+ to study how the conical breakwater serves as a better design than the circular breakwater. We will carry out an in-depth numerical analysis to examine and assess the hydrodynamic behavior of monopile

structures and compare the study with the existing analytical results available in the literature for the circular cylinder breakwater.

FM13-PA0042

Computational Study of Chemotherapeutic Drug Delivery Enhanced by Electroporation for Tumour Treatment

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In this study, we present a mathematical model describing drug delivery into tumour tissues with the application of electroporation. Electroporation involves the applica- tion of an external electric field to permeabilize the cell membrane, thereby facilitating the transport of drug molecules from the extracellular space into the intracellular com- partment. The model considers six chemotherapeutic drugs: fluorouracil, carmustine, cisplatin, methotrexate, doxorubicin, and paclitaxel for potential application in brain tumour treatment. A system of differential equations is formulated to represent the underlying physical processes, incorporating a mass transport coefficient expressed as a function of pore density to characterize mass flow within the tissue domain. The govern- ing equations are solved numerically using the finite difference method with a suitable numerical scheme. Through numerical solution, we have identified the electroporation parameters that minimize unwanted cell damage, allowing us to determine the most suitable drug among the six chemotherapeutic agents used for brain tumor treatment. The numerical results are analyzed through a graphical representation. It is observed that fluorouracil is the appropriate choice of drug for the treatment of brain tumours. The proposed model could be useful for identifying suitable drugs for application in pharmaceutical and clinical sciences.

FM13-PA0050

Numerical simulation for the fractional prey-predator model with infection by Fractional Variational Iteration Method

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Fractional order prey-predator model is solved approximately using the Fractional Variational Iteration Method (FVIM). We employ parameter estimation techniques for identifying the critical parameter in the model. Numerical methods are developed for solving the model equations. Graphs are generated from the results.

FM13-PA0104

Physics-Informed Neural Network for Canonical One-Dimensional Viscous Flows with Slip and No-Slip Boundary Conditions

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This study investigates the application of Physics-Informed Neural Networks (PINNs) to benchmark one-dimensional viscous flows under both no-slip and Navier slip boundary conditions. Unlike traditional numerical methods, PINNs offer a mesh-free solution strategy by embedding the governing equations and boundary conditions into the loss function of a deep neural network. Four classical flow configurations Plane Couette, Plane Poiseuille, Couette-Poiseuille, and Hagen- Poiseuille are selected due to their availability of closed-form analytical solutions, enabling rigorous validation of the network's accuracy. Each simulation is trained using soft constraints until the total loss drops below 10^4 , typically within 1500–2000 epochs. The PINN predictions are then compared against analytical results for both dimensional and nondimensional velocity profiles. The study explores variations in slip length and asymmetry in boundary conditions, demonstrating the network's ability to capture flow behavior across all configurations. The findings support the feasibility of PINNs as accurate and flexible tools for modeling viscous flows, offering a foundation for future extensions to more complex geometries and boundary-layer-dominated systems.

FM13-PA0113

Contaminant Transport with variable first-order attachment of Microplastic Production

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In this paper, we have described the convective contaminant transport with variable first- order attachment of microplastic production through a homogeneous finite aquifer. We have considered aquifer under contamination due to variable microplastic concentration with sinusoidally. This work develops an analytical model to predict microplastic contaminant concentrations arising from time-dependent production within transient groundwater flow through a homogeneous finite aquifer. The analytical solution is derived using the parameter expansion method and the direct eigenfunction expansion technique, applying suitable initial and boundary conditions. We have calculated desirable effects of main parameters that are involved in first-order attachment of microplastic production coefficient in liquid phase with respect to distance of the aquifer and time by surface and contour plotting. By the interpretations of all graphs, we have concluded many physical remarks that are very important for society and healthy environment. These findings emphasize that dispersion plays a critical role in groundwater transport, where lower leads to localized accumulation, while higher promotes wider contaminant migration. The results have direct implications for groundwater quality management, highlighting the greater vulnerability of aquifers with higher dispersion to rapid contaminant spread.

FM13-PA0133

Stability and Heat Transfer Analysis for Rayleigh-Benard Convection Under Dual Frequency Gravity Modulation in Micropolar Fluids

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This study investigates the effect of double-frequency gravity modulation on Rayleigh–Benard convection in micropolar fluids using both linear and nonlinear stability analyses. We consider sixteen combinations of modulations, which include sinusoidal and non-sinusoidal waveforms(square, sawtooth, triangular) and compare the onset of convection and heat transfer. The findings offer valuable insights into how dual-frequency modulations affect convective stability thresholds and heat flux in micropolar fluids. The no modulation and single-frequency modulation case are obtained as limiting cases of the general model.

FM13-PA0138

Model-based functionality analysis of tri-hybrid nanofluids in a monocrystalline photovoltaic panel mounted on horizontal single-axis solar trackers

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The performance investigation of nanofluid as a coolant in the cooling of a monocrystalline solar panel affixed to a horizontal single-axis solar tracker was the main focus of the study.The ternary hybrid nanofluid employed in this study consists of nanoparticles such as GO (Graphene Oxide), MWCNT (Multi-walled carbon nanotube), and TiO_2 (Titanium Dioxide) with H_2O (Water) as a base fluid. The mathematical model considered here incorporates the combination of physical parameters such as the magnetic field, thermal radiation, porosity, viscous dissipation, and Joule heating, which will play a crucial role in heat transport phenomena. The obtained partial differential equations are transformed into a system of ordinary differential equations using the similarity transformations and then solved numerically using MATLAB bvp4c solver. The outcomes of the present study demonstrate proportionality with earlier findings in the absence of particular parameters.

FM13-PA0140

Convergence and Stability of Fractional Thermoelastic Models in Hemispherical Solids With Convective Heat Transfer

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This article presents an application of fractional thermoelasticity to a hemispherical solid subjected to convective heat flux on its curved boundary and arbitrary temperature conditions on its plane surface. A fractional order heat conduction equation is formulated in a spherical coordinate system and solved using separation of variables in conjunction with Legendre polynomial expansion. The analytical solution of the temperature distribution is expressed in the Laplace domain and inverted into the time domain in terms of the Mittag–Leffler function, highlighting the role of the fractional order parameter in controlling the rate of thermal relaxation. The thermoelastic response is further investigated using Goodier's thermoelastic displacement potential and Boussinesq's harmonic functions. The influence of the fractional order parameter on temperature and stress fields is examined, and convergence of the series solution is discussed to ensure stability and boundedness. As limiting cases, the results reduce to those of classical and generalized thermoelasticity theories, validating the present approach.

FM13-PA0185

Magnetoconvection and Joule Heating Effects on Ternary Hybrid Nanofluid Flow in a Semi-Permeable Channel with Melting Surface

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This research investigates the characteristics of heat transfer and fluid flow in a ternary hybrid nanofluid, which consists of copper, aluminium oxide, titanium oxide, and water as the base fluid, within a semi-permeable channel. The system includes a permeable top wall under injection conditions and a melting bottom surface. The study considers the effects of magnetoconvection and Joule heating on thermal and fluid flows. The Differential Transformation Method (DTM) is employed to solve the dimensionless governing equations with appropriate initial and boundary conditions. A thorough parametric analysis is performed to evaluate the influence of key parameters, such as the Eckert number, Reynolds number, Hartmann number, nanoparticle volume fraction, skin friction coefficient, and Nusselt number. The findings reveal that a higher Eckert number enhances temperature distribution due to the increased conversion of kinetic energy into thermal energy. The melting condition at the bottom surface alters the thermal boundary layer, promoting effective heat dissipation. Furthermore, Joule heating significantly affects transport properties, enhancing energy transfer efficiency. These results highlight the potential of ternary hybrid nanofluids in advanced thermal management and energy storage applications, demonstrating their ability to improve heat transfer performance.

FM13-PA0197

Modeling the Influence of Deformable Surface Roughness on Non-MHD Convection in Partially Heated Nanofluid Layers

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This study investigates the convective behavior of a non-magnetohydrodynamic (non-MHD) nanofluid subjected to partial heating under the influence of deformable surface roughness. The analysis focuses on the combined effects of heat flux variations, surface deformability, and nanoparticle concentration on the thermal and flow fields. The governing partial differential equations (PDEs) for mass, momentum, and energy are formulated based on the boundary layer approximations and solved using numerical methods. A comparative analysis is performed for different surface roughness parameters and nanoparticle volume fractions. The results reveal that deformable roughness significantly alters the thermal boundary layer thickness and enhances convective heat transfer when surface deformation aligns with the flow direction. The study offers insight into energy transport mechanisms in engineered systems such as micro-heat exchangers, thermal storage units, and biomedical flow devices.

FM14-PA0034

Thermodynamic Properties of Statistical Associating Molecular fluids

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The development of analytical expression for strongly homogeneous associating homogeneous fluids has proven to be difficult problems that have recently a great deal of attention. An exact statistical- mechanical treatment of homogeneous chain molecules is difficult owing to the large number of internal degree of freedom. A number of studies have been directed at the study of the relatively hard-sphere homogeneous associating chain molecules.

SM2-PA0006

Analysis of large deformation in beams by element free Galerkin method

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In the analysis of structural beams undergoing large deformations, accurate modelling of geometric nonlinearities is essential for reliable prediction of structural response. The current paper couples element free Galerkin method with updated Lagrangian formulation for modeling nonlinear bending behavior in slender beams. All kinematic variables are expressed with respect to the current configuration, allowing efficient and accurate tracking of geometric nonlinearity as structural deformations increase. Element free Galerkin method is an efficient meshfree technique that eliminates mesh distortion issues and provides a smooth approximation of field variables through moving least squares (MLS) interpolation. Mathematical models developed in the current work are coded in MATLAB to solve different large deformation problems. The accuracy and fidelity of developed codes have been established by solving few bench mark problems whose results are available in open literature. Several numerical problems, involving large deformations in structural beams, have been considered for analysis to demonstrate the applicability and efficiency of EFGM is solving large deformations in engineering components. Updated Lagrangian approach demonstrates excellent agreement with analytical solutions in the linear regime (at lower loads). However, as loading increases and geometric nonlinearity becomes significant, the numerical results begin to diverge from classical analytical predictions. This divergence occurs because the analytical solution is derived under linear assumptions, including Hooke's law and small deformation theory, which fail to capture the nonlinear behavior that arises under large loads and displacements.

SM2-PA0007

Total lagrangian approach based element free Galerkin method for columns

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Traditional finite element methods faces severe mesh distortion issues while modeling large deformations in columns. Meshfree methods provide a strong numerical framework for investigating large deformations occurring during buckling of columns. The current paper invokes total Lagrangian formulation within element free Galerkin method for modeling bucking behavior in columns. Displacements, stresses and strains are expressed with respect to initial undeformed configuration. Deformation gradient has been used to map data from one configuration to another. Element free Galerkin method, because of its meshfree nature, eliminates mesh distortion and provides a smooth approximation of displacement fields through moving least squares (MLS) interpolation. Mathematical models developed in the current work are programmed in MATLAB to investigate large deformations in columns. The accuracy and fidelity of MATLAB codes has been established by solving few bench mark problems whose results are available in open literature. Several numerical problems, involving large deformations in structural columns, have been solved to demonstrate the applicability and efficiency of EFGM is solving large deformations in structural columns.

SM2-PA0015

Thermoelastic modeling of plate structure employing memory-dependent derivatives and a circular laser beam as a moving heat source for plate structures

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The heat transfer equation in the light of the circular laser beam moving heat source with uniform distribution is constructed in this study utilizing memory-dependent derivatives (MDD) to investigate the thermoelastic effects in a thin rectangular plate construction with a thermal bending force. The desired solution of the heat transfer equation (HTE) is obtained by applying the Laplace transformation for memory derivatives and the Fourier transform technique with regard to spatial variables. Furthermore, the resulting stresses and moments are utilized to evaluate the impact of thermal stress on the plate. The computational study considers a plate with copper-based material properties, and all of the temperature, deflection, and stress function results are graphically displayed for different time-delay parameters, different kernel function selections, laser-moving heat sources at different laser powers, and scan speeds.

SM2-PA0023

Battle of isoparametric elements: IGA vs FEM

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The widespread adoption of the finite element method (FEM) for approximating a wide range of partial differential equations (PDEs) over complex domains can be attributed to its strong mathematical foundation and straightforward implementation. Among the various types of basis functions employed in FEM, higher-order curved Lagrange elements comprising C^0 piecewise polynomials are often regarded as the optimal choice for solving second-order PDEs. These elements provide a favorable balance between accuracy and ease of implementation when compared to more sophisticated basis functions such as Hermite and non-uniform rational B-splines (NURBS), which possess higher-order continuity. Isogeometric analysis (IGA), on the other hand, leverages NURBS basis functions for both geometric representation and PDE approximation. Although IGA is often claimed to exhibit superior convergence behavior compared to standard FEM, this study rigorously evaluates that claim by considering the classical plate with a circular hole (Kirsch problem) as a benchmark problem and performing a systematic convergence study under successive h-refinements using various basis functions. The resulting observations provide insights that contribute to the ongoing discussion regarding the comparative performance of IGA and FEM.

SM2-PA0077

Single-Element Damage Identification in Functionally Graded Material Plates Using the Whale Optimization Algorithm

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This study introduces a novel methodology for identifying single-element damage in Functionally Graded Material (FGM) plates using the Whale Optimization Algorithm (WOA). Detecting localized damage in these non-homogeneous structures presents a significant challenge. The problem is formulated as an inverse optimization task, where the WOA minimizes the discrepancy between measured and computed Frequency Response Functions (FRFs) to determine damage location and severity. The FGM plate is modeled using the First-Order Shear Deformation Theory (FSDT) with eight-noded quadrilateral finite elements, accurately capturing its mechanical behavior, while damage is represented as a localized stiffness reduction. Numerical simulations across various damage severities, locations, and boundary conditions validate the proposed framework. The results demonstrate the method's robust convergence, high detection accuracy, and computational efficiency. This WOA-based approach is a promising candidate for real-time structural health monitoring (SHM) applications in critical aerospace, marine, and mechanical engineering structures.

SM2-PA0086

System of Biot and Cattaneo heat energy equations in the context of Caputo time fractional derivatives

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Hyperbolic linear theory of heat propagation has been established in the framework of the Caputo time fractional derivative of order $0 < \alpha \leq 1$ in axisymmetric case. The hyperbolic time fractional heat conduction problem in an infinite solid medium which surrounds an infinitely long cylindrical surface has been studied. A time-dependent temperature on the boundary surface has been prescribed. In the Laplace domain, the analytical solution of the problem is obtained for a stationary boundary condition. The Gaver-Stehfest technique was employed to numerically perform time domain inversions of the Laplace transforms, which satisfied Kuznetsov's convergence theorem. The physical behavior of the temperature distribution has been graphically represented for different fractional orders. Due to the presence of thermal relaxation time τ_0 , the solution describes finite speed of the wave propagation for the temperature field in the geometry under consideration.

SM2-PA0087

A Novel Approach to Solving Time Fractional Advection Dispersion Equations Using Triple Laplace Transform in Conjunction with the Adomian Decomposition Method

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This paper presents a novel analytical method for solving Time-fractional Advection–dispersion equations (TFADEs) by integrating the Triple Laplace Transform (TLT) with the Adomian Decomposition Method (ADM). Time-fractional partial differential equations are widely used to model complex transport phenomena that exhibit memory and hereditary properties, especially in Engineering, solid mechanics, biomedical sciences, environmental modeling and physics. The proposed method transforms the original fractional model into an algebraic form using Triple Laplace transform (TLT). The resulting equation is then solved using the Adomian decomposition technique, allowing the construction of a rapidly convergent series solution. Illustrative examples are provided to demonstrate the accuracy and efficiency of the method. The results validate that the Triple Laplace Transform Adomian Decomposition Method (TLTADM) approach is a powerful and flexible tool for solving a broad class of time-fractional transport models. Compared to purely numerical approaches, the TLTADM framework maintains analytical transparency while capturing the complex behavior of fractional order systems in two spatial dimensions. We examined the impact of the fractional order parameter. Moreover, 2D and 3D graphs representing the solutions for some values of fractional order parameter have been displayed using the MATLAB software.

SM2-PA0171

Effectiveness of Equivalent Strut Models for Seismic Analysis of Masonry Infilled RC Frames with Openings

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ThiS study explores the field of structural engineering regarding details about the interaction between the reinforced frames and the masonry infill walls. Even though the infill walls are defined as non-structural members, decades of research and investigations have shown that the infill walls influence the stiffness, strength, and lateral load resistance of the structure. The Equivalent Diagonal Strut method is a simplified macro modelling technique developed to represent the in-plane behavior of masonry infill that includes Brittle failure, anisotropic, and non-linear behavior in framed structures.

SM4-PA0021

A Study on Memory Effects in a Nonlocal Generalized Thermoelastic Problem Using Atangana–Baleanu Fractional Derivative and Memory-Dependent Derivative

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The present investigation focuses on studying the memory effect under thermal shock in a homogeneous nonlocal thermoelastic medium. Both the memory-dependent derivative and the Atangana-Baleanu fractional derivative have been incorporated into the heat flux relation of the dual phase lag model of generalized thermoelasticity theory. The solution methodology employs the integral transform technique by applying Laplace and Fourier transforms to the governing equations using suitable potential functions. Numerical inversion methods are used for the computations. The model incorporates three different memory kernel functions and the Atangana-Baleanu fractional derivative, with results compared accordingly. The effect of nonlocality is explored for two different generalized thermoelastic models.

SM4-PA0022

Generalized thermoelasticity in an infinite medium with cylindrical cavity using eigenvalue approach

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This work introduces a mathematical framework to investigate the thermal and elastic behavior of an unbounded isotropic medium with a cylindrical cavity subjected to a continuous line heat source. The analysis is carried out using the Dual Phase Lag model within generalized thermoelasticity under traction-free and ramp-type thermal conditions. The governing equations are solved in the Laplace domain, converted into a vector-matrix form, and then inverted to the time domain using Stehfest's technique. Graphical results highlight the influence of key physical parameters and phase lags.

SM4-PA0164

A simple dynamical system for modeling a tip link

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In this paper we begin building a simple dynamical model of the tip link, a protein which connects the stereocilia in the hair cells of the cochlea. When a sound wave reaches the cochlea, the hair bundle, which is a bundle of stereocilia, is deflected. The shear creates tension in the tip link and this tension is communicated to a transduction channel, whose opening allows an influx of ions which cause the release of neurotransmitters that excite the relevant nerve fibers. One of the principal requirements of auditory transduction is high speed, due to the high frequencies of sound. One of the goals of the model is to study how fast a mechanical signal can propagate along a tip link. The model is built trying to recreate the experimental figures in pulling experiments done with optical tweezers on one of the two proteins that compose the tip link, Protocadherin 15. In these figures the extension grows non linearly with force and the system presents jumps in extension which correspond to unfolding events in the protein. The model begins as a chain of masses and non linear springs and is slowly modified to capture the different biological behaviors.

SM5-PA0065

Automated Detection of Vegetation Encroachment in Brick Masonry Battlements of Darbhanga Fort Using YOLOv8

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Vegetation growth on the surface of aging masonry structures poses a significant threat to their structural durability and long-term preservation. In the present study, a deep learning-based approach using the YOLOv8 architecture has been employed to identify and localize such damage manifestations on a heritage building. A subset of a publicly available image dataset, originally curated and published by Singh and Maity (2025) via Mendeley data repository, has been utilized for training the model. The Darbhanga Fort in Bihar, India—constructed primarily with brick masonry—serves as the focal site for this investigation due to its visible deterioration, including widespread vegetation growth attributed to prolonged neglect. The YOLOv8 model has been trained and evaluated using a dataset comprising $2,520$ images—including 5% background images—spanning training, validation, and testing splits, along with one video used for testing. The model's performance has been assessed using metrics such as mean average precision (mAP), precision, recall, F1score, and confusion matrix. The results demonstrate high accuracy, with the model achieving a peak $mAP\_0.5$ of 99.5%, $mAP\_0.5:0.95$ of 95.52%, precision of 99.69%, recall of 99.85%, and F1-score of 99.77%. These findings affirm the model's robustness in detecting and precisely localizing vegetation-related damage on historic masonry surfaces, supporting its potential application in rapid visual screening for structural health assessment.

SM6-PA0009

Elasto-Plastic Crack Growth in Titanium Alloys by Extended Finite Element Method

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Extended finite element method has been used to investigate elasto-plastic fatigue crack growth in titanium alloys. Titanium and its alloys have shown significant potential as an engineering material because of its high specific strength and excellent corrosion resistance. Titanium alloys have found wide applications in various domains including aerospace, biomedical, automobiles and power generating industries. Titanium alloys have played a significant role in producing next-generation engines due to their superior structural properties leading to lower fuel consumption and costs. The current work invokes partition of unity method within extended finite element method to incorporate crack tip enrichment functions for modelling the behavior of cracks in engineering components. Level set method has been employed to represent internal interfaces present in the domain. Extended finite element method models the cracks present in engineering components independent of the mesh chosen for analysis, due to which the requirement of conformal meshing and mesh adaption does not arise during simulation. Isotropic hardening coupled with Ramberg-Osgood model has been used to model elasto-plastic behavior of titanium alloys. Mathematical models developed in the current research have been coded in MATLAB to solve different crack growth problems. The results obtained in the current study have been compared with the analytical solutions available in literature. Various numerical problems on elasto-plastic crack growth in titanium alloys have been presented to demonstrate the potential of extended finite element method in modelling elasto-plastic crack growth in titanium alloys.

SM6-PA0010

Estimation of Crack Tip Plastic Zones in Cobalt Chromium Alloys by XFEM

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The present study utilizes the Extended Finite Element Method (XFEM) to estimate the size of the crack tip plastic zones that form ahead of cracks in cobalt-chromium (Co–Cr) alloys. These alloys are extensively used in orthopedic implants due to their excellent biocompatibility and mechanical performance. Three cobalt chromium alloys which have found wide applications as orthopedic implants include Co–28Cr–6Mo, Co–20Cr–15W–10Ni and Co–35Ni–20Cr–10Mo alloys. Co–28Cr–6Mo alloy may be cast (ASTM F75), forged (ASTM F799) or wrought (ASTM F1537). Co–20Cr–15W–10Ni is wrought (ASTM F90) and Co–35Ni–20Cr–10Mo is wrought (ASTM F562) or forged (ASTM 961). XFEM invokes partition of unity method to incorporate crack tip enrichment functions for modelling the discontinuities produced by crack interfaces. Level set method has been used for the accurate and efficient representation of internal interfaces in the domain. XFEM models all types of discontinuities (independent of the mesh), thus eliminating mesh adaptation and conformal meshing. Mathematical models developed in the current work are coded in MATLAB to solve different numerical problems. Several numerical problems, involving behaviour of cracks in Co-Cr alloys to predict the extent of crack tip plastic zones have been demonstrated to establish the fidelity and applicability of XFEM.

SM6-PA0014

A review on fatigue crack growth behaviour of Inconel 600, 617 & 625 with focus on loading, overloading and temperature,

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The failures of material occur when repeated or fluctuating stresses are below their ultimate tensile strength, but are sufficient to induce cracks and promote their growth. These cracks can eventually lead to catastrophic failure, even if the material has not reached its breaking point in a single load cycle. Fatigue leads to failure through damage accumulation under cyclic loading conditions. Current paper is a review article that focuses on time-dependent damage, primarily in structural members, emphasizing the degradation mechanism associated with fatigue in Inconel Alloy. Given the importance and widespread application of nickel-based superalloys such as Inconel 600, 617, and 625 in various engineering fields, it is crucial to investigate the mechanisms of fatigue crack growth in these materials especially when operating under high temperatures and corrosive environments. Although titanium and nickel alloys are commonly used in aerospace applications, they still face challenges such as temperatures rise, oxidation, stiffness reduction, and thermal fatigue occur. In this article, the structural behaviour associated with fatigue failure such as dislocation interactions, crack initiation, crack propagation, fatigue strength, and fatigue life are explored in the context of FCG in superalloys. The reduction in stress precipitates and stress relaxation (SR), attributed to modifications in the dislocation structure, also contributes to fatigue behaviour. Additionally, the article highlights findings to demonstrate fatigue life with multiple overloads. Furthermore, the review article with fatigue life prediction models for such metallic and non-metallic materials with the Pari's model. All these insights not only to enhance our understanding of fatigue behaviour but also offer guidance for improving the durability and performance of materials which in demanding engineering more applications.

SM6-PA0055

Flexibility of Circular Shaft with Open Inclined Edge Crack: Application to Frequency Determination

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Crack is a physical discontinuity present in the form of a flaw a continuum. It can occur in materials such as hot rolled materials like shafts due to manufacturing flaws or it can get created during service under the action of external loads due to improper service environment. The cracks present in material can be surface or sub-surface cracks. Further, it can be a longitudinal or transversely orientated. It may also be oriented in a plane inclined to the longitudinal axis. In this work, some studies for estimation of flexibility of a shaft having an edge crack inclined at an angle to its axis. The ultimate aim of obtaining the flexibility due to presence of crack is to calculate natural frequencies of the shaft in the presence of the crack. Flexibility calculations are carried using fracture mechanics approach. Strain Energy Release Rate (SERR) due to a generalized loading is calculated to arrive at the equation of compliance coefficients. A complete stiffness matrix for generalized loading is presented along with the definitions of all non-zero compliance coefficients. The compliance matrix can be inverted to obtain the stiffness matrix. The stiffness coefficients are employed in the calculations of natural frequencies of the shaft with an open inclined edge crack.

SM6-PA0068

Damage identification in linear and nonlinear structural systems using physics informed neural network with dimensionless formulation

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Conventional physics-based and data driven models for structural damage detection often suffer from limitations in generalization, convergence stability, and computational efficiency. Physics-Informed Neural Networks (PINNs), which integrate governing equations with datadriven learning offer a promising alternative by combining the strengths of both methodologies. This study proposes PINNs with dimensionless formulation for damage identification in linear and nonlinear systems, where damage is introduced by simultaneously reducing stiffness and increasing damping. The dynamic equations are reformulated in a dimensionless form, and displacement measurements data are used to formulate the loss function. Comparative analysis between the dimensional and dimensionless formulations on a single-degree-of-freedom (SDOF) cubic nonlinear system demonstrates significant improvements in convergence and numerical stability, which is validated with the help of eigenvalues, various losses, and damage parameters. The proposed approach is further validated on a three-degree-of-freedom shear building model subjected to sinusoidal excitation. The methodology has strong potential for robust, data-efficient, and physically consistent structural health monitoring applications.

SM7-PA0069

Machine learning model for design of elastomeric self-healing composite systems

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Self-healing polymers have gained significant research attention over the past few decades due to their ability to enhance the durability and life of polymeric materials. In extrinsic self-healing systems, a healing fluid is stored within microchannels which are embedded in the polymer matrix. However, such systems often face challenges related to the limited spread of the healing fluid within the damaged region and the inability to supply sufficient fluid for repeated damage-healing cycles. Moreover, fluid flow behavior through these channels is complex and is influenced by the properties of matrix and fluid, channel geometry, and applied loading. In this work, an extrinsic self-healing elastomer composite is proposed in which the healing fluid is stored in cylindrical channels in a compressible elastomeric matrix. An initial compression is applied to matrix to pressurize the fluid stored in the channels. When a cut occurs, this pressurized fluid starts to flow out and repairs the damage. The fluid flow parameters are estimated in terms of elastomer and fluid properties, composite's geometrical properties, and initial compression through semi-analytical approach. Numerical simulations are performed in COMSOL multiphysics software to validate theoretical results. A machine learning model is employed to determine the system parameters for desired performance characteristics. The ML model can be used to design self-healing elastomer composites based on elastomer and fluid properties, number of cuts that should be healed, etc.

SM7-PA0121

Multiscale Homogenization of Composite Materials: An R-based Computational Framework

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Composite materials exhibit highly anisotropic behavior due to their heterogeneous microstructure comprising fibers, matrix, and interfaces. Predicting effective engineering properties requires robust homogenization methods that bridge microscale fiber–matrix interactions with macroscale laminate performance. This paper develops a computational framework for multiscale homogenization of fiber-reinforced composites using R. Distinct from conventional MATLAB/Python implementations, this framework leverages the statistical and visualization strengths of R to provide an open-source platform for composite mechanics. The methodology integrates analytical micromechanics models (Rule of Mixtures, Halpin–Tsai, Mori–Tanaka, Self-Consistent schemes) with Classical Laminate Theory (CLT). Stochastic homogenization using Monte Carlo simulations is introduced to account for fiber distribution uncertainties. Parametric studies demonstrate the predictive accuracy of the framework against benchmark experimental data, with validated case studies on glass/epoxy and carbon/epoxy laminates. Results confirm that R-based homogenization yields less than 5% error compared to reported experimental data, demonstrating computational efficiency and extensibility. The novelty lies in the integration of traditional micromechanics with stochastic simulations in R, enabling reproducible, transparent, and pedagogical exploration of multiscale composite mechanics.

SM7-PA0186

Bond–Slip and Crack Width Model for Continuously Reinforced Concrete Pavement with Steel and Bamboo Rebar

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The central objective of this work is to quantify the link between bond–slip behavior and crack width using a mechanics-based formulation grounded in laboratory investigation. Pullout tests on steel and treated bamboo are used to extract bond–slip characteristics. These are then incorporated in a two-point boundary-value framework solved by a shooting method, with parameters calibrated using Gauss–Newton optimization. The outcome is a predictive tool for slip evolution, strain localization, and crack width determination under stabilized cracking conditions.

SM11-PA0016

Effect of step bottom and a vertical wall on hydroelastic analysis in semi-infinite domain

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Scattering of oblique water wave by a floating flexible plate, which is placed in front of a vertical wall, is investigated in the presence of a finite step bottom topography. Using potential theory, the physical problem is modeled as a boundary value problem, which is solved using the eigenfunction expansion method. The velocity potential is derived in terms of infinite Fourier series. Using mode-matching at the interface and edge conditions (free, simply supported, and clamped) at the edges of the plate, hydroelastic response of the floating plate is studied.

SM11-PA0029

Pranav P, Amit Kumar Rahul, Manoj Kumar Singh Love-Type Wave Propagation in a Heterogeneous Viscoelastic Fiber- Reinforced Medium Over a Transversely Isotropic Half-Space with Initial Stress and Sliding Interface

Pranav P, Amit Kumar Rahul, Manoj Kumar Singh **Love-Type Wave Propagation in a Heterogeneous Viscoelastic Fiber- Reinforced Medium Over a Transversely Isotropic Half-Space with Initial Stress and Sliding Interface**

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This study reveals the dispersive and damping behaviour of Love-type surface waves in a layered structure consisting of an initially stressed Voigt type viscoelastic fiber reinforced medium and an initially stressed transversely isotropic heterogeneous half space. The interface between two media is taken as a sliding interface. The vertical non-homogeneity is modelled as a linear function that varies with depth in the half-space and as an exponential function in the upper medium. To calculate the displacement components for each medium analytically, partial differential equations can be simplified to ordinary differential equations. The removal of random constants and the application of appropriate boundary conditions can result in a relationship that accounts for both dispersion and damping in Love-type waves. With MATHEMATICA software, dispersion and displacement were analyzed graphically. Our model's validity has been examined in particular situations and matched with the conventional Love wave equation. Investigating wave propagation across imperfectly bonded geological strata is the main goal of sliding interfaces in Love wave models. This is crucial for subsurface characterization, site response analysis, and earthquake engineering.

SM11-PA0041

Propagation of Distortional Waves in Micro-Morphic Media

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In this Paper the Problems was studied in Micro polar theory discussed. It is observed that in some addition to the wave corresponding to classical .There are Three additional waves are found and they also dispersive .in this case of distortion waves. The same number of additional waves is found .Due to the some absence of the values of micro isotropic and micro elastic constants.

SM11-PA0098

Modelling of MHD Hybrid Nanofluid Peristaltic Flow with Thermal Radiation and Shape Factor Effects in Asymmetric Channels: Implications for Coolant Systems

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Hybrid nanofluids exhibit improved thermal conductivity and heat transfer capabilities, rendering them suitable for use in electronics, industrial cooling, and biomedical applications. This research examines the peristaltic flow of a hybrid nanofluid ($(Al_2O_3 - Cu$, *ethylene glycol*) within an asymmetric microchannel subjected to an inclined magnetic field. Ethylene glycol serves as a base fluid owing to its superior anti-freezing characteristics. Factors including thermal radiation, nanoparticle morphology, heat source, viscous dissipation, buoyancy force, Hall current, and electroosmosis are integrated. The Poisson–Boltzmann equation is linearised using the Debye–Hückel method, and the governing equations are simplified through lubrication theory. The non-linear system is addressed through the application of the homotopy perturbation method. The results pertaining to velocity, temperature, pressure rise, and streamlines are presented graphically. An increase in the volume fraction of copper nanoparticles enhances heat transfer efficiency. Lamina-shaped nanoparticles demonstrate enhanced thermal performance. Velocity is positively correlated with magnetic inclination and Hall effect parameters, while it exhibits a negative correlation with an increased Hartmann number. Thermal radiation decreases bolus size and reduces pressure rise.

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