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Sanjoy K. Ghoshal · Arun K. Samantaray ·
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Editors

Recent Advances in Industrial Machines and Mechanisms

Select Proceedings of IPRoMM 2022

Springer

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Preface

This book presents a collection of selected papers presented at the "2nd International and 14th National Conference on Industrial Problems on Machines and Mechanisms (IPRoMM 2022)", held during 22–23 December at the Indian Institute of Technology (ISM) Dhanbad, Jharkhand, India.

It was the invention of machines, more specifically the water and steam-powered machines and engines that heralded the beginning of the industrial revolution. Since then, mechanisms and machines have been integral parts of industrial development. As we embrace the paradigms of Industry 4.0, the mechanisms community face greater challenges, having to venture into relatively uncharted territories to solve problems which hitherto were not known to exist. Therefore, it is extremely important for the researchers and practitioners in this field to come together to discuss these problems towards finding collaborative solutions. IPRoMM 2022 was a successful step in this direction.

Recognising the need for industry–academia interactions, Association for Machines and Mechanisms (AMM) started a workshop, under the title of "Industrial Problems on Machines and Mechanisms", in 1986. The first of these biennial workshops was held at Ahmedabad Textile Industry's Research Association (ATIRA), with Mr. Ratna Prabhu at the helm of the organisation. The choice of the venue reflected the focal point of these workshops at that time, namely the problems associated with the textile industries. Over the years, these workshops grew significantly in participation, as well as the diversity of topics of deliberation. Eventually, IPRoMM was recognised as an international conference, with the first of the new series being titled the "1st International and 13th National Conference on Industrial Problems on Machines and Mechanisms", which was held at the Birla Institute of Technology and Science (BITS) Pilani, Hyderabad Campus, in 2020.

This year, the conference drew 168 contributions from a wide variety of topics, including multi-body dynamics and mechanical vibrations, robotics and control, advanced manufacturing processes, fault detection and structural health monitoring, composites and advanced materials, biomedical engineering and biomechanics, thermal and thermo-fluidic analysis, soft computing techniques, AI/ML, and IoT. Based on initial desk review and single-blind peer reviews involving 194 reviewers,

77 papers were selected for oral presentation, while 12 were presented in the form of posters. Finally, after another round of quality assessment, 67 papers were included in this book.

The editors are greatly obliged to the authors for their contributions and the reviewers for their efforts towards ensuring the quality of the papers. They also thank IIT (ISM) for hosting this event and AMM for their guidance and support throughout the organisation process. Special thanks are due to the sponsors of the event for their liberal support. Last but not least, the editors acknowledge with thanks the efforts of the editorial team at Springer for bringing out this book in a timely manner.

Dhanbad, India — Sanjoy K. Ghoshal
Kharagpur, India — Arun K. Samantaray
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About the Editors

Sanjoy K. Ghoshal is a full professor at the Department of Mechanical Engineering, Indian Institute of Technology, Dhanbad, and in-charge of dynamics of machinery laboratory in mechanical engineering department of IIT (ISM), Dhanbad. He did his undergraduation in 1996 from Jadavpur University (JU), Kolkata, and then served three different industries such as ESAB India, Texmaco, and Kesoram Industries as a maintenance engineer till the year 2001. Thereafter, he received master's degree in machine design specialization from the same University (JU) in 2003 and Ph.D. degree from Indian Institute of Technology Kharagpur, in 2007. He joined Indian Institute of Technology, Dhanbad, in the year 2007 as an assistant professor, where he teaches courses like engineering mechanics, solid mechanics, kinematics of machines, dynamics of machinery, mechanical vibration, and mechatronics in undergraduate level and automation and control, simulation of dynamical systems in postgraduate level. Apart from that he has also taken some lectures on executive development programs on power hydraulics. He has authored many journal articles and one chapter. His current research interests are system modeling, simulation and control, fault diagnosis, automation, condition monitoring, and fluid power. Currently, he is serving as an Associate Editor in the journal, *Sadhana.*

Arun K. Samantaray is a full professor in the mechanical engineering department of IIT Kharagpur since 2014. He received undergraduate mechanical engineering degree in 1989 from CET Bhubaneswar and master's and Ph.D. degrees from IIT Kharagpur in 1991 and 1996, respectively. He worked as a project manager at HighTech consultants from 1996 to 2000 and as a CNRS researcher in France from 2001 to 2004. He joined IIT Kharagpur in 2004. His research interests are systems and control, fault diagnosis and prognosis, industrial automation, nonlinear mechanics, legged and soft robotics, rotor dynamics, and road and rail vehicle dynamics. He teaches engineering mechanics, systems and control, modeling and simulation of dynamical systems, and modern control theory. He has been a consultant to Mitsubishi Hitachi, Tata Motors, DRDO, Mahindra, SAIL, etc. He was involved in the design of CryoArm of the 2nd space vehicle launch pad of ISRO, blade dampers for Kaveri aircraft rotor, and indigenous high-speed railway bogie of Indian Railways. He is the author of commercial

multi-energy domain modeling software Symbols. He has authored three text books, two of which are published by Springer and one by Taylor and Francis. Currently, he is an associate editor of *ASME Journal of Dynamic Systems, Measurement and Control*, and *Springer Journal of Vibration Engineering & Technologies.*

Sandipan Bandyopadhyay is an Associate Professor at the Department of Engineering Design, Indian Institute of Technology Madras. He received his bachelor's degree in Mechanical Engineering from Jadavpur University, Kolkata, in the year 1998, and his master's as well as doctoral degrees from the Indian Institute of Science, Bangalore, in the years 2000 and 2006, respectively, both in the discipline of Mechanical Engineering. He also obtained an M.S. degree in Mechanical Engineering and Applied Mechanics from the University of Pennsylvania, Philadelphia, in the year 2001. He has worked as a Researcher in the India Science Lab, General Motors R&D, during 2005–07. In 2007 he joined IIT Madras, where he teaches courses on mechanical design, mechanisms, and robotics. His research interests include Theoretical and Computational Kinematics, Parallel Manipulators, Design of Socially Relevant Products, and Symbolic Computations. He has served as the Secretary of the Association for Machines and Mechanisms during 2008–13, and is the Vice President of the organisation since 2021. He also represents India in the IFToMM Technical Committees on Computational Kinematics as well as Robotics and Mechatronics. He serves as an Associate Editor in the journals *Mechanism and Machine Theory*, *Sadhana*, and *Robotica.*

Computational Analysis on the Three-Dimensionality of Turbulent Duct-Flow Subsequent to In-Plane Double Bends

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(IPROMM 2022)

Arka Banerjee, Sayantan Sengupta, Nawes Qamar & Shantanu Pramanik

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Abstract

We present a computational study of Prandtl's secondary flow of the first kind in the presence of turbulence within a 90° in-plane double bend fitted between two straight ducts. Most of the previous papers available in the literature demonstrate the gross flow behaviours due to out-of-plane double bends. We, however, focus on capturing the local flow behaviours in an in-plane double bend and the progressive development of the flow downstream of the bend. We capture a pair of Dean vortices located downstream of the double bend. We trace the motion of higher velocity fluid particles within the vortices by in-plane velocity vectors directed from the pipe core towards the bend's outer side due to an unbalanced centrifugal force of the skewed flow. Our solutions nicely capture the decay of the in-plane flow (or secondary flow) and concurrent re-establishment of primary flow downstream of the bend. For engineering analyses, we introduce a new parameter called enhancement ratio (ε), a measure of the increase of the fluid velocity while passing through the bend. ε decreases with increasing both Reynolds numbers (Re) and curvature ratio ($\overline{R}_c$). It is realized that the reduction of ε is related to the corresponding fall in non-dimensional pressure loss.

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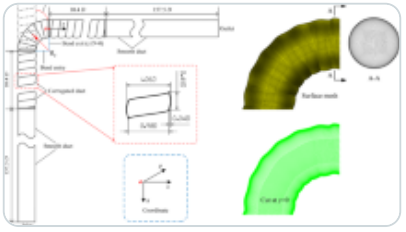

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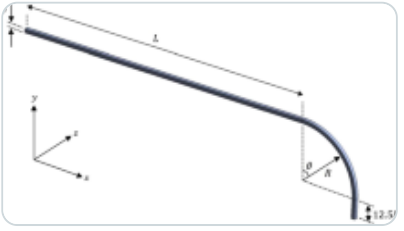

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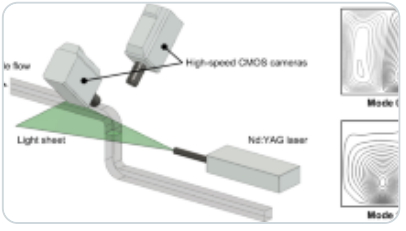

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