ADVISORY BOARD MEMBERS

**Dr. Reji Mathai (Chairman)**  
Director – ARAI  
The Automotive Research Association of India, Pune – Maharashtra, India

**Dr. S.S.V. Ramakumar**  
Director (R&D) and Board Member  
Indian Oil Corporation, Faridabad, India

**Mr Rajendra Petkar**  
President / Chief Technology Officer  
Tata Motors Limited, Pune – Maharashtra, India

**Prof. Anil Sahasrabudhe**  
Chairman – NETF  
Nelson Mandela Marg, Vasant Kunj, New Delhi

**Mr Arindam Lahiri**  
Chief Executive Officer  
Automotive Skills Development Council (ASDC), New Delhi, India

**Dr N. T. Rao**  
Vice Chancellor  
Chandigarh University, Mohali, Punjab, India

**Dr Jabez Dhinagar**  
Senior Vice President – Vehicle Engineering  
Ola Electric, 17th Main, 100 Feet Road, Koramangala, Bengaluru, Karnataka

**Dr Ramesh, A.**  
Institute Chair Professor  
Indian Institute of Technology-Madras, Chennai, India

**Prof. Anindya Deb**  
Professor  
Indian Institute of Science (IISc), Bangalore – Karnataka, India

**Dr Anuradda Ganesh**  
Chief Technical Advisor and Director  
Cummins Technologies India Pvt Ltd., Pune & Emeritus Professor, IIT-B, Mumbai – Maharashtra, India

Registered Address  
The Automotive Research Association of India (ARAI)  
Survey No. 102, Vetal Hill, off Paud Road, Kothrud, Pune-411038, Maharashtra, India.  
Publisher Contact: (020)-3023-1130, Email: dhande.dts@araiindia.com  
Editor Contact: (020)-3023-1434, Email: thipse.edl@araiindia.com

Disclaimer: The publisher, editor(s), or any editorial or advisory board members are not responsible for the accuracy of the content, author statements, expressed opinions, or data in this journal. The authors are solely responsible for the contents published in the paper.
EDITORIAL BOARD MEMBERS

- Dr. Abhijeet Marathe – General Manager - Automotive Research Association of India, Pune
- Dr. Akella Sharma – Vice President - Automotive Sector - Mahindra & Mahindra Limited, Chennai
- Dr. Amala Justus Selvam – Professor - Vel Tech University, Chennai
- Dr. Arun Jaura – Chief Technology Officer - Hero MotoCorp, Jaipur
- Dr. B. Ashok – Associate Professor - VIT University, Vellore
- Dr. B. S. Kothavale – Professor - Dr Vishwanath Karad MIT World Peace University, Pune
- Dr. Ganesh Kakandikar – Professor - Dr. Vishwanath Karad MIT World Peace University, Pune
- Dr. K. C. Vora – Emeritus Professor - College of Engineering Pune (CoEP), Pune
- Dr. M. Suresh – Assistant Professor - Karunya Institute of Technology and Sciences, Coimbatore
- Dr. Mohan Godse – Proprietor - U 2 I, Pune
- Dr. Mohd Rafiq B. Agrewale – Manager - Automotive Research Association of India, Pune
- Dr. Nagesh H. Walke – Sr. Deputy Director - Automotive Research Association of India, Pune
- Dr. P A Lakshminarayanan – Former - Technical Advisor - Simpson & Co. Ltd., Chennai
- Dr. P. P. Chattaraj – Additional Director - National Automotive Testing and R&D Infrastructure Project (NATRiP), Pithampur
- Dr. P. R. Pawar – Deputy Director - Automotive Research Association of India, Pune
- Dr. P.K. Ajeet Babu – Manager - Automotive Research Association of India, Pune
- Dr. R Basargekar – Technical Director - APPL Industries, Pune
- Dr. Rashmi R – Dean & Associate Professor - Padmabhooshan Vasantdada Patil Institute of Technology (PVPIT), Pune
- Dr. Ravindra Utgikar – Vice President - Praj Industries Ltd., Pune
- Dr. Sanjay A Patil – General Manager - Automotive Research Association of India, Pune
- Dr. S R Marathe – Consultant - Engineering Consultant, Pune
- Dr. S.A. Mohan Krishna – Associate Professor - Vidyavradhaka College of Engineering, Mysuru
- Dr. Sanjay Arole – Director - Automotive Materials & Manufacturing Engineering Services, Pune
- Dr. Sanjay D. Yadav – Professor - Rajarambapu Institute of Technology, Sangli
- Dr. Sarit Kumar Das – Institute Chair Professor - Indian Institute of Technology-Madras, Tamil Nadu
- Dr. Satyam Sahay – John Deere Fellow - John Deere Technology Centre India, Pune
- Dr. Senthil Muthu Kumar Thiagamani – Associate Professor - Kalasalingam Academy of Research and Education, TamilNadu
- Dr. Sharada Vikram Chougule – Professor - Finolex Academy of Management and Technology, Ratnagiri
- Dr. Shivprakash Barve – Professor - Dr. Vishwanath Karad MIT World Peace University, Pune
- Dr. Simhachalam D. Juttu – General Manager - Automotive Research Association of India, Pune
- Dr. Srinivas Gunti – Head - Talent Development, General Manager - Tata Passenger Electric Mobility Limited, Pune
- Dr. Sundarapandian Vaidyanathan – Professor - Vel-Tech University, Chennai
- Dr. Sushil S. Ramdasi – Deputy Director - Automotive Research Association of India, Pune
- Dr. Vijay Narkhede – Senior Manager (R&D) - Süd-Chemie India, Gujarat
- Dr. Y.K. Bhateshvar – Faculty - Automotive Research Association of India, Pune
EDITORIAL BOARD MEMBERS (Cont.)

- Dr. Yogesh Aghav – Head-Advanced Technologies - Kirloskar Oil Engines Limited, Pune
- Mr. A. A. Gaikwad – General Manager - Automotive Research Association of India, Pune
- Mr. Ashwin Subramanian – AGM-e mobility propulsion systems - Stellantis, PCA Motors Pvt. Ltd., Chennai
- Mr. Atul Pol – Program Manager - Tata Technologies, Pune
- Mr. Ayush Maheshwari – Researcher - Akar International, Singapore
- Mr. Devendra Mandke – Technical Specialist - JOHN DEERE INDIA PRIVATE LIMITED, Pune
- Mr. Mahadevan Pichandi – Head-Vehicle Engineering - Mahindra Electric Mobility Limited, Bangalore
- Mr. Mahesh Masurkar – Chief Manager - John Deere India Pvt Ltd., Pune
- Mr. Moqtik Bawase – General Manager - Automotive Research Association of India, Pune
- Mr. Pradeep Chandrasekaran – Associate Director - Ola Electric Mobility Pvt. Ltd., Bangalore
- Mr. Prakash, V. Sardesai – Head, Application Engg & Business Development - Sud-chemie-India-Pvt Ltd., Gujarat
- Mr. Prashant Mahale – Asst. General Manager - Fiat Chrysler, Mumbai
- Mr. R M Cursetji – Head-Technology Department - Sud-Chemie India Pvt. Ltd., Gujarat
- Mr. Rahul Mahajan – Deputy Director - Automotive Research Association of India, Pune
- Mr. S. B. Sonawane – Manager - Automotive Research Association of India, Pune
- Mr. Sakthivel V – Chief General Manager - IndianOil Corporation Limited, Chennai
- Mr. Sanjay Deshpande – Vice President - Mahindra & Mahindra, Nasik
- Mr. Srinivasan Raju – Consultant - Automotive Consultant, Pune
- Mr. Swarupanand Sewalkar – Sr. Technology Lead - JOHN DEERE INDIA PRIVATE LIMITED, Pune
- Mr. T.C. Kamath – Deputy General Manager - Design Standards MRF Limited, Chennai
- Mr. Umesh Sawant – Chief Operating Officer - Pi Green Innovations Pvt. Ltd., Pune
- Mr. Vikram A. Tandon – General Manager - Automotive Research Association of India, Pune
- Mr. Vinay Mundada – Consultant - Engineering Consultant, Pune
- Mr. Vinit Jawale – Systems Engineering Leader - JOHN DEERE INDIA PRIVATE LIMITED, Pune
- Mr. Yogesh Thipse – General Manager - Automotive Research Association of India, Pune
- Mr. Z. A. Mujawar – Consultant - Engineering Consultant, Pune
- Mrs. Beena Sandeep Limkar – Assistant Professor - Savitribai Phule Pune University, Pune
- Mrs. Swati Athavale – Consultant - Engineering Consultant - Pune
- Ms. Jyoti Kirve – Deputy Director - Automotive Research Association of India, Pune
CONTENTS

Editorial
Dr. Samraj J Dhinagar

Research Papers

- Study on Application of AI Controllers for Speed Control of Motors
  Ketan Kalke and Dr Bhumeshwar Patle ................................................................. 635

- Assessment of M15 Fuel on BS IV 2 and 3-wheeler
  Mohammad I Jamadar, Sandeep D Rairikar, Shailesh B. Sonawane, Prasanna S. Sutar, Debjyoti
  Bandyopadhyay and Dr. S S Thipse ........................................................................ 647

- Vibration Analysis of an On-board Charger Assembly for Electrical Mobility
  Shantaram Jadhav, Shantanu Kalurkar and Srikanth T.S. ............................................. 658

- Functional Safety for Automatic Emergency Braking based on ISO 26262
  Ananda Adhikari, Aspak Saban, Shirish Bohora and Viranchi Shastri ........................ 666

- Performance Emission and Combustion Characteristics of Ethanol
  Hydrogen Blends at MBT Spark Timing on Multi-cylinder SI Engine
  Dr. Pravin T. Nitnaware and Dr. J G Suryawanshi ................................................... 686

- Study of Effective Powertrain Sizing for Electric Vehicles
  Siddharth R Gandhi and Abhijeet Chavan .................................................................. 695

- Failure Analysis and Product Improvement for Hypoid Gearset of Rear Axle
  Prasanna Venkatesan R, Sundarayya V and Yoganand R D ........................................... 708

- Micromobility Vehicles in India: Urban Commute Analysis with Users’ Perspective
  Madhuvanti Parikkar and Upendra Dani ....................................................................... 714

- Studying Modern Formula 1 Front wing at High Cornering Speeds
  P. Nimje and R. Kakde ............................................................................................... 722

Technical Paper

- Design and Development of Indigenous EV Motor Test Rig for
  Small Capacity Motor Testing
  Sreekumar. U ........................................................................................................... 756

Technical Report

- Growing Automotive Intake Manifold Market Key Trends and Future Prospects
  Sarah Johnson ............................................................................................................. 760

Editor-in-Chief: Dr S.S. Thipse
ARAI is placed at the center of critical juncture where the entire automotive industry is evolving from conventional combustion engine centered to a software centered smart mobility Industry. ARAI Journal of Mobility Technology captures this essence of transition very clearly. The readers will indeed get a glimpse of these technologies that are built in India and across global institutions and organizations.

As I recollect my memories of walking through the mist-covered hilltop centre of ARAI back in the 1990s for calibration of the smoke meter which was the only measuring equipment used to check and control the visible pollutants from diesel engines. Today’s ARAI has morphed itself into an institution where every modern aspect of these software-driven automotive products are created, assessed and regulated to create a sustainable future.

Any nation's progress purely relies on the utilization of its full potential. Our capability to create products and services that fulfil the aspiration and needs of our consumers. We are the home to the software industry that designs software module or software packages that runs in machines today be it consumer appliances, automobiles, aircraft, banks, security systems, defence equipment and many more where software is an integral part of a product.

Crystallization of ideas and products which helps individuals to move or for the general public to move in large numbers within our growing cities and in between cities is very well encompassed in this technical journal which helps researchers and engineers to visualize different products for the mobility industry.

As a nation having the largest pool of young, qualified and highly capable engineers, the education system that propels the youth into a capable engineer with skills across multiple engineering domains is the fuel for the growth of both the component and vehicle industries. This human capital combined with the core research into components like sensors, actuators, magnetics, multiple cell chemistries, fast acting low-loss switches getting enabled through the latest communication technologies is the strength of our ecosystem to create software-defined automobiles of the future. This Journal from ARAI places a critical role in all these areas.

The partnership between components and product creators in the automotive industry is in a transition phase through which Industry is undergoing will definitely witness a sea change in its capabilities to support and create next-gen mobility products. To identify, inform and eliminate the risk of failure on the part, every mobility product of today and in future has a vast amount of electronics and software inbuilt to effectively use such
products to its fullest potential. These components will configure and change over a period of time inside these intelligent products to optimize the product performance over its lifetime.

This journal of mobility technology and the authors of various articles herein bring great insight into every technical aspect and align leaders in the mission of creating software-centred autonomous and semi-autonomous products.

Wishing all success to the editorial team for bringing this together and happy reading to all the readers.

---------------------------------------------****-------------------------------------------
ANNUAL SUBSCRIPTION RATES
Subscribers will receive four print copies annually as well as immediate access to the online journal, including full online access to all current and back articles.

A) Degree Offering College / University: Annual subscription cost INR 5000 / USD 100
B) Corporate / Individual / R&D Institute / Government Institute: Annual subscription cost INR 8000 / USD 200

Individual Subscriptions: Individual subscriptions require login to access subscription content.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Format</th>
<th>Duration</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Subscription for Indian Citizens</td>
<td>Print+Online</td>
<td>1 year</td>
<td>8000.00 (INR)</td>
</tr>
<tr>
<td>Individual Subscription for Non-Indian Citizens</td>
<td>Print+Online</td>
<td>1 year</td>
<td>200.00 (USD)</td>
</tr>
</tbody>
</table>

Institutional Subscriptions: Institutional subscriptions do not require login. The user's domain and/or IP address are used to provide access to subscription content.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Format</th>
<th>Duration</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree Offering College/University</td>
<td>Print+Online</td>
<td>1 year</td>
<td>5000.00 (INR)</td>
</tr>
<tr>
<td>Corporate/R&amp;D Institute/ Government Institute</td>
<td>Print+Online</td>
<td>1 year</td>
<td>8000.00 (INR)</td>
</tr>
<tr>
<td>Degree Offering College/University-For Foreign Entity</td>
<td>Print+Online</td>
<td>1 year</td>
<td>100.00 (USD)</td>
</tr>
<tr>
<td>Corporate/R&amp;D Institute/ Government Institute - Foreign Entity</td>
<td>Online</td>
<td>1 year</td>
<td>200.00 (USD)</td>
</tr>
</tbody>
</table>

CONTACT

Mr. Nikunjesh Shah
Subscription and Marketing Head
4-4-309/306, Sultan Bazar,
Bank Street Hyd-500095
Mob: +91-8374105220
Email: nikunjesh.shah@bspbooks.net
Website https://araijournal.com/index.php/arai/index

DISTRIBUTOR OFFICE
BSP Books Pvt. Ltd.,
4-4-309/316, Giriraj Lane, Sultan Bazar,
Hyderabad 500 095, Telangana.
SUBSCRIPTION INFORMATION

Here is payment instruction for your reference

Cheque/DD:
Please send the US dollar cheque from outside India and INR cheque from India:
Payable to “BSP Books Pvt. Ltd.”
Drawn on the Hyderabad branch

Credit Card:
We accept Visa or MasterCard/Online (Paypal)

Wire transfer: (RTGS, IMPS and NEFT transactions)
Complete Bank Account No. 041005005619
Beneficiary Name: BSP Books Pvt. Ltd.
Bank & Branch Name: ICICI Bank, Abids Branch, Hyderabad
IFSC RTGS Code: ICIC0000410

Payment detail:
Ch/DD No.
Date of Ch/DD
Amount paid INR/USD
  1.  Advance payment required by Demand Draft payable to BSP Books Pvt. Ltd.
      payable at Hyderabad
  2.  Cancellation is not allowed except for duplicate payments.
  3.  Agents are allowed a 10% discount.
  4.  Claim must be made within six months from the issue date.

Note: Please kindly add bank charge at your side if you pay by cheque or wire transfer.