

**Dr. K.R. Nemade: Cutting-Edge Progress In Tandem Solar Cell Innovation**

ISBN: 978-93-88901-74-1

# RESEARCH TRENDS IN SCIENCE AND TECHNOLOGY VOLUME III

EDITORS

DR. ALOK RANJAN SAHU  
MR. BASANT DESHWAL  
DR. NARAYAN GAONKAR  
DR. SANJAY SINGH



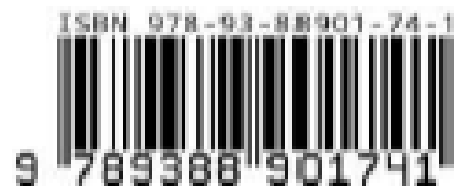
BHUMI PUBLISHING, INDIA



FIRST EDITION: JULY 2023

*First Edition: July, 2023*

*ISBN: 978-93-88901-74-1*



© Copyright reserved by the Editor

Publication, Distribution and Promotion Rights reserved by Bhumi Publishing, Nigave Khalasa, Kolhapur

Despite every effort, there may still be chances for some errors and omissions to have crept in inadvertently.

No part of this publication may be reproduced in any form or by any means, electronically, mechanically, by photocopying, recording or otherwise, without the prior permission of the publishers.

The views and results expressed in various articles are those of the authors and not of editors or publisher of the book.

Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: [www.bhumipublishing.com](http://www.bhumipublishing.com)

E-mail: [bhumipublishing@gmail.com](mailto:bhumipublishing@gmail.com)

Book Available online at:

<https://www.bhumipublishing.com/book/>



## TABLE OF CONTENT

Sr. No.	Book Chapter and Author(s)	Page No.
1.	<b>APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN BIOTECHNOLOGY</b> Bindu Rajaguru, Meenakshi Johri and Bhakti Gavhane	1 - 12
2.	<b>TRANSMISSION EMBEDDED COST ALLOCATION USING PROPORTIONAL NUCLEOLUS METHOD IN A LIBERALIZED ELECTRICITY MARKET</b> Murali Matcha, Siddheswar Kar and Neha Verma	13 - 32
3.	<b>SOCIAL WELFARE MAXIMIZATION IN A RESTRUCTURED POWER SYSTEM USING BAT ALGORITHM</b> Murali Matcha, Siddheswar Kar and Neha Verma	33 - 53
4.	<b>REVIEW ON APPLICATION PROGRAMMING INTERFACES FOR INTERNET PROTOCOL</b> Sumit Chopra, Lovedeep Kaur, Anchal Nayyar and Gagandeep Singh	54 - 63
5.	<b>PROCESS MANAGEMENT IN OPERATING SYSTEM</b> Sumit Chopra, Diksha Rani, Rajesh Sharma and Simranjot Kaur	64 - 71
6.	<b>INTRODUCTION TO SENSORS</b> M. W. Bhade	72 - 75
7.	<b>PROTEIN ENGINEERING FOR PRODUCTION OF INDUSTRIAL IMPORTANT ENZYMES</b> Kirti Yadav, Neeraj K. Aggarwal and Awtar Singh	76 - 83
8.	<b>BIOMATERIALS</b> D. R. Nagapure	84 - 102
9.	<b>A REVIEW OF THE INTERPRETATION OF DUALITY IN DIFFERENTIABLE AND NON-DIFFERENTIABLE MATHEMATICAL PROGRAMMING</b> Ram Naresh Singh, Shailendra D. Deo and Ajay Kumar Sharma	103 - 108
10.	<b>CELLULAR COMMUNICATION IN BREAST CANCER</b> Juily R. Atitkar	109 - 117
11.	<b>CUTTING-EDGE PROGRESS IN TANDEM SOLAR CELL INNOVATION</b> Kailash Nemade	118 - 123

## **CUTTING-EDGE PROGRESS IN TANDEM SOLAR CELL INNOVATION**

**Kailash Nemade**

Department of Physics,

Indira Mahavidyalaya, Kalamb Dist. Yavatmal 445401, Maharashtra, India

Corresponding author E-mail: [krnemade@gmail.com](mailto:krnemade@gmail.com)

### **Abstract:**

The demand for efficient and sustainable energy sources has spurred remarkable advancements in photovoltaic technology, particularly in the field of tandem solar cells. This research paper delves into the cutting-edge progress made in tandem solar cell innovation, exploring the latest developments, breakthroughs, and challenges in this rapidly evolving domain. Tandem solar cells, also known as multi-junction solar cells, offer the potential to surpass the efficiency limitations of traditional single-junction cells by stacking multiple sub-cells, each optimized for a specific portion of the solar spectrum. This chapter comprehensively reviews the state-of-the-art materials, design strategies, and fabrication techniques employed in tandem solar cell architectures. By critically evaluating the progress and prospects of tandem solar cell innovation, this research paper offers valuable insights into the future direction of photovoltaic technology. The synthesis of recent developments and emerging trends serves as a guide for researchers, engineers, and policymakers seeking to accelerate the deployment of high-efficiency solar energy solutions and drive the transition towards a sustainable energy landscape.

**Keywords:** Energy Conservation; Tandem Cell; Solar Cell

### **Introduction:**

Energy conservation is a crucial and pressing need in today's world due to a myriad of reasons that encompass environmental, economic, and social dimensions. As global energy demand continues to rise, it is imperative that we adopt strategies to conserve energy and utilize it more efficiently. First and foremost, environmental concerns are at the forefront of the energy conservation movement. The excessive consumption of non-renewable energy sources, such as fossil fuels, leads to detrimental effects on the planet. Burning fossil fuels releases greenhouse gases into the atmosphere, contributing to climate change, air pollution, and the depletion of natural resources. By conserving energy, we can reduce our carbon footprint and mitigate the impact of climate change, thus preserving a habitable planet for future generations.

Economic factors also play a significant role in the necessity of energy conservation. Energy production and distribution require substantial financial investments, and high demand can strain energy infrastructure. By conserving energy, we can alleviate the pressure on energy grids, reduce the need for expensive infrastructure upgrades, and ultimately lower energy costs for consumers. Moreover, energy efficiency measures in industries and households can lead to substantial cost savings over time, enhancing economic stability and resilience [1].

## About Editors



Dr. Alok Ranjan Sahu serves as an Assistant Professor in Botany at Vikash Degree College, Bargarh, Odisha. He received M.Sc., M.Phil. (Life Science) and Ph.D. in Biotechnology from the School of Life Sciences, Sambalpur University, Odisha, India. He has published more than 45 research papers in National and International Journals and Books. He also has obtained three National Patents and filed one Patents to his credit. He is the sole author of two books and co-author of four books. He is a Fellow and Life member of Six reputed International and National Academic Societies. He is a Reviewer and Editorial Board Member of more than 30 numbers of National and International Journals, including Biology, Genes, Biomolecules, Sustainability, BAPT, JAPS, JABB, etc. For his outstanding research contribution, he was awarded Research Excellence Award-2023, Academic Excellence Award (Botany/ Plant Biotechnology)-2022, Young Achiever Award-2022, Outstanding Scientist Award-2022, Best Faculty Award-2021, Young Plant Breeder Award-2021, Best Researcher Award-2020, Young Scientist Award-2014, Best Poster Presentation Award-2013. His current areas of research interest are Plant Molecular Biology & Genome mapping, Medicinal Plant Conservation, Natural products & therapeutics.



Mr. Basant Deshwal born on 24 June 1996 in Hirnoda village at Jaipur district of Rajasthan, India. He completed his bachelor's degree in agriculture from Agriculture University, Jodhpur in 2019. Following year, he cleared ICAR-JRF and joined Masters at Division of Nematology, IARI, New Delhi. After M.Sc., by 2022 he joined the same division for pursuing Ph.D. He has many research papers, book chapter and popular articles in reputed journals. He has also qualified the ICAR-NET.



Dr. Narayan Gaonkar is presently serving as Assistant Professor of Physics at University College of Science, a constituent college of Tumkur University, Tumkur, Karnataka. He obtained his Master's degree in Physics from Karnatak University, Dharwad in 2009 with gold medals and cleared CSIR-NET in 2010. He is awarded with Ph.D. degree from Tumkur University, Tumkur in 2023. His theoretical research work has resulted in 14 journal publications and a book chapter. He has attended more than 20 international/national conferences to present the research findings. He has jointly authored 03 books on undergraduate physics.



Dr. Sanjay Singh is presently working as assistant professor and head, department of Physics at Chintamani College of Arts and Science, Gondpipri, Dist. Chandrapur. He has more than Ten-year teaching experience. He has done experience at University College (KUK-Haryana) and Shyam Lal College, University of Delhi (DU). During the last twelve year of research experience, he has published 19 research papers in national and international reputed journals. He has presented many research papers in national and international seminar and conference.

