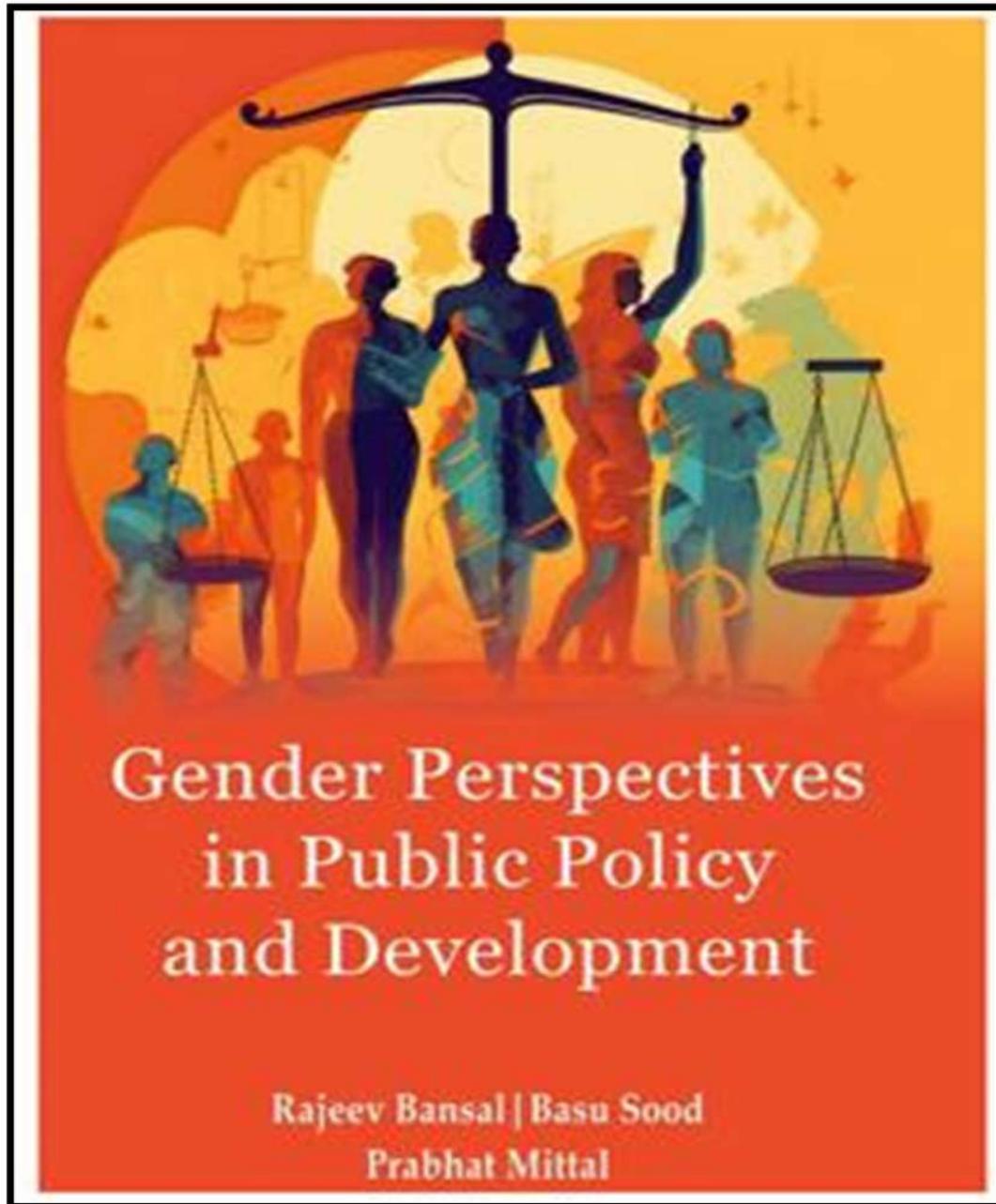


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2.	Ms. Nisha Kumari	History	01(Chapter In Book)
3.	Dr. Arvind Paul	Geography	01(Book)
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5.	Dr. Reenu devi	Geography	01 (Book)
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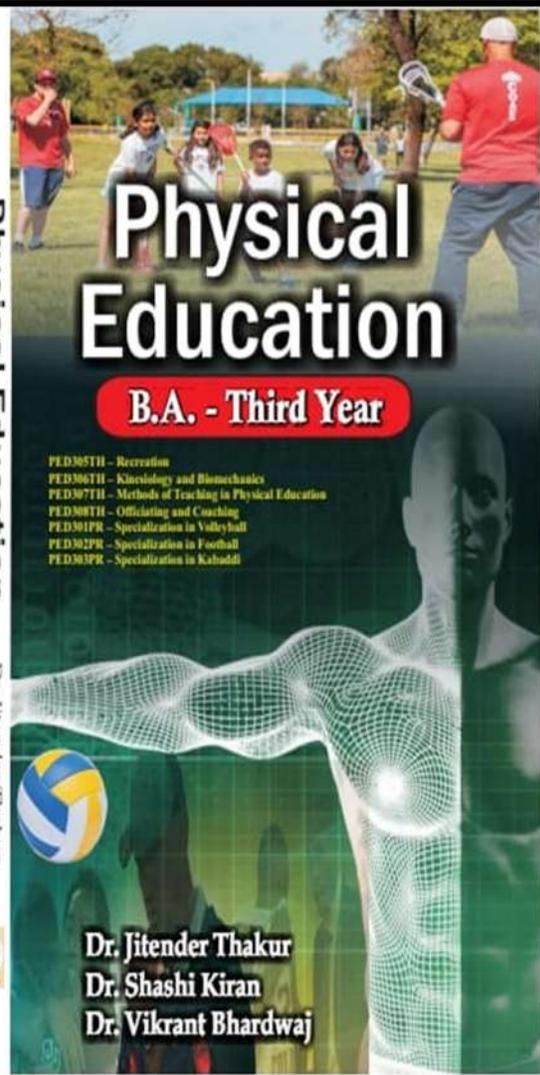
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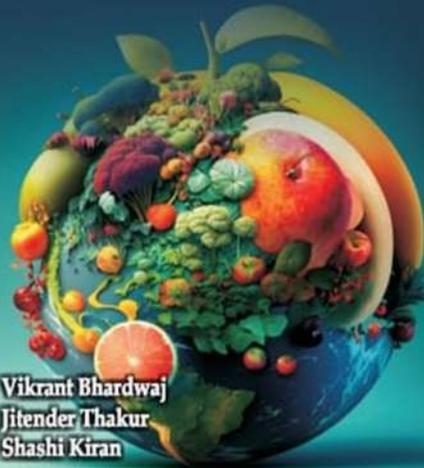
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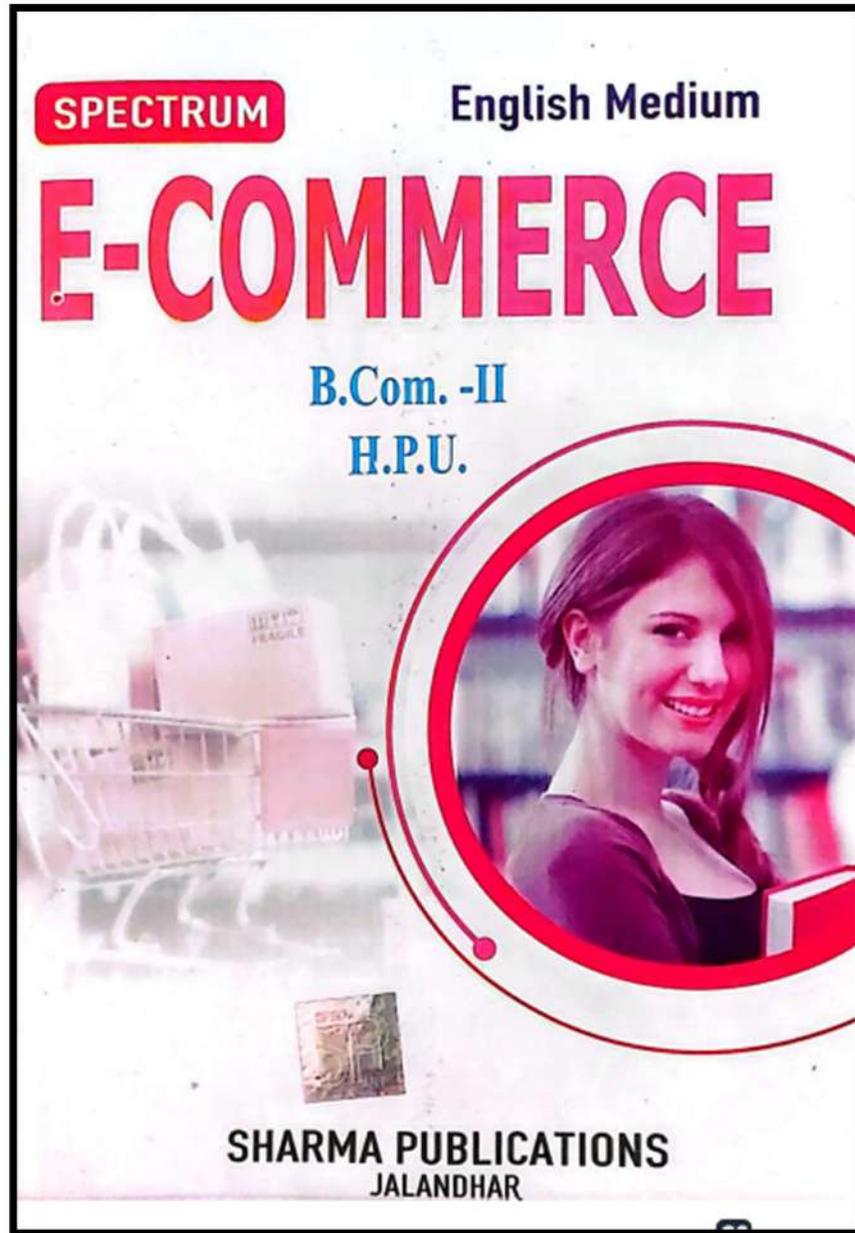
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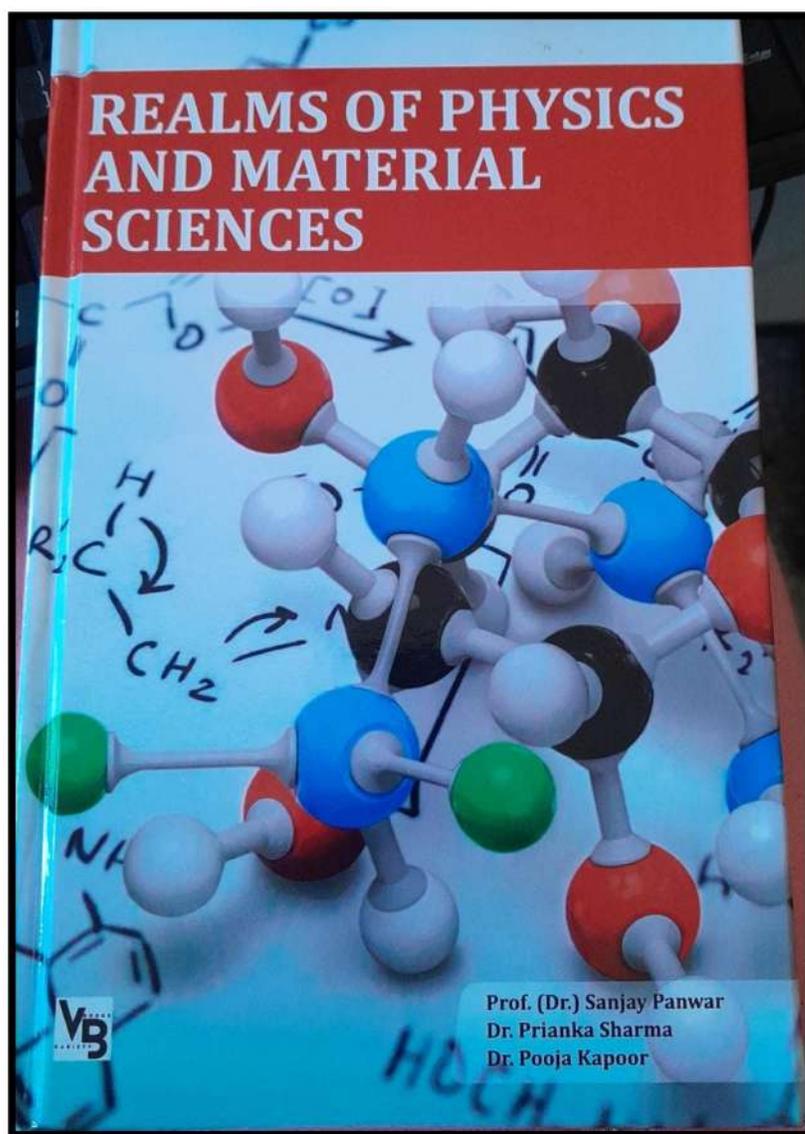
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## Preface

This book is based on advancements in materials science to combat with the global challenges of rising energy needs and environmental degradation together with the development of novel materials for sustainable future. It focuses on how nanotechnology holds the promise of revolutionizing environmental conservation efforts, paving the way for resilient and ecologically balanced future.

The increasing demand of energy emphasize on the use of hydrogen to meet the needs of modern times and how carbon-based nanomaterials like graphene, silicene, h-BN, etc., and metal perovskites can be promising hydrogen storage materials. Green energy harvesting and storage techniques provide solutions to the emerging global problems and building a better tomorrow. The role of non-centrosymmetric crystals towards renewable and green energy harvesting is explained. The properties of cadmium oxide and barium titanate are discussed and how these properties make them useful for biomedical, energy storage, environmental and photo-catalytic applications. The excellent properties of steel and how they can be tuned for high-strength applications are also covered.

Lastly, the book presents the two-dimensional layered materials as potent candidates for converting waste heat into usable electrical energy, offering a solution to the energy crisis. Overall the book provides an insight into the advancements of materials and their excellent applications in various fields towards building a better tomorrow.

—Editors

  
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## Progress of Piezoelectric Materials: The Past, Present and Future

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### Abstract

In modern society, energy is the main engine of economic development. As per Global Energy production and consumption report Jan, 2024, it is stated that Global energy consumption continues to grow, but it does seem to be slowing — averaging around 1% to 2% per year. Governments and scientists in many countries have been making efforts to find eco-friendly "green energy". Piezoelectric technology is generating one such type of energy. The piezoelectric effect was discovered by two French physicists brothers Pierre and Paul in 1880. When pressure is applied on piezoelectric materials, typically non-centrosymmetric crystal generates voltage between two end faces and hence electric field gets produced. These non-centrosymmetric crystals have important physical properties due to which they are getting attention. These crystals have demonstrated significant promise in biomaterials and biomedical applications due to their ability to interface with biological systems and stimulate cellular responses. Eventually, they are energy harvesters by transforming mechanical energy from human movement into electrical energy for implantable technology. This technology can be applied on a large scale like roads, railway stations, and footpath of crowded areas. In civil engineering, piezoelectric materials are used in energy harvesting not only in superstructures but also in substructures, control strategies, the creation of composite materials with cement mortar, and structural health monitoring (SHM) systems. Piezoelectric materials are widely used because they can be employed as either actuators or sensors due to their piezoelectric effect and vice versa. The efficiency of piezoelectric material in converting electrical energy to mechanical energy and the other way around is measured by the electro-mechanical coupling factor,  $k$ . Due to its substantial coupling coefficient and higher energy generation,

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