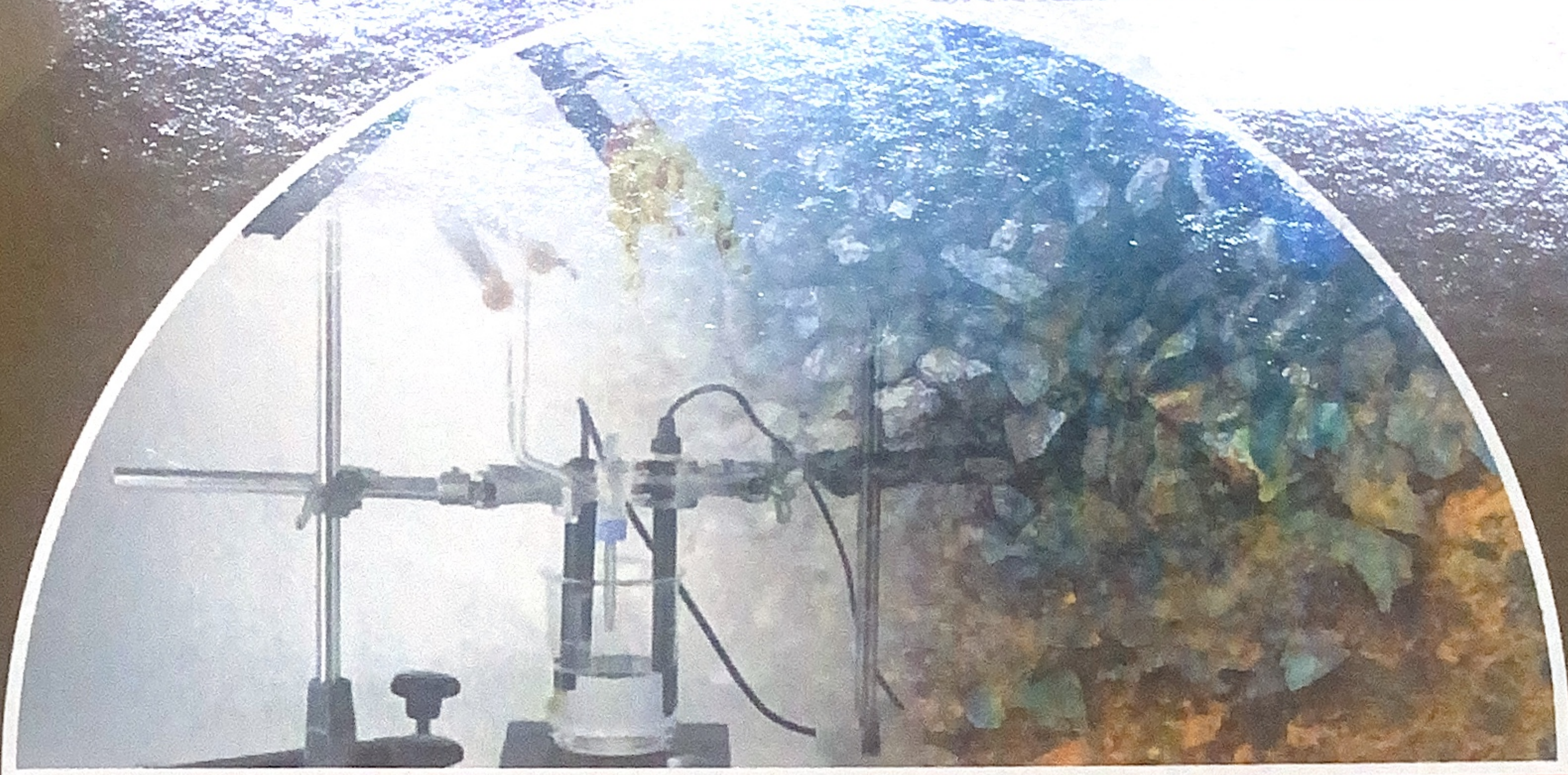

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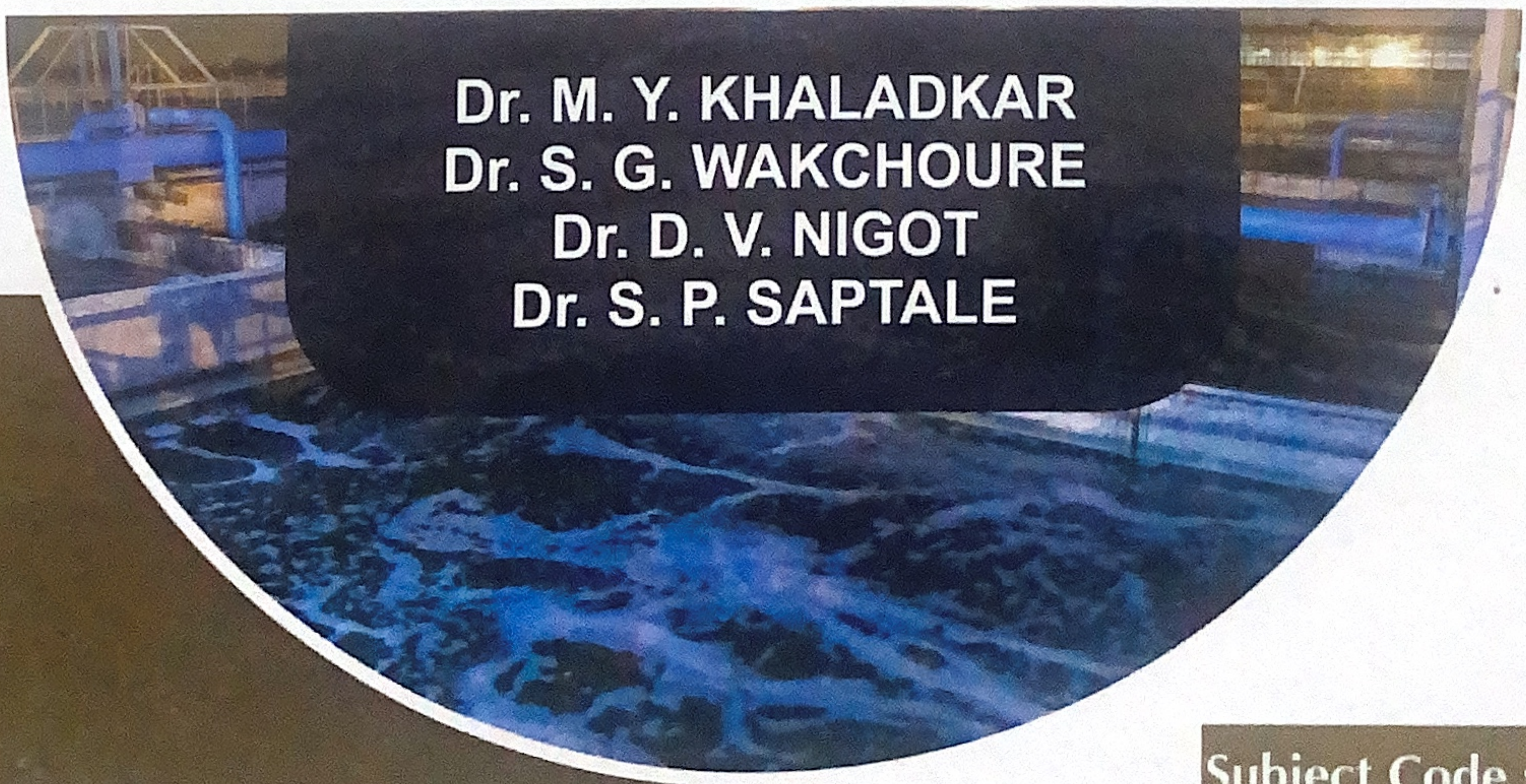

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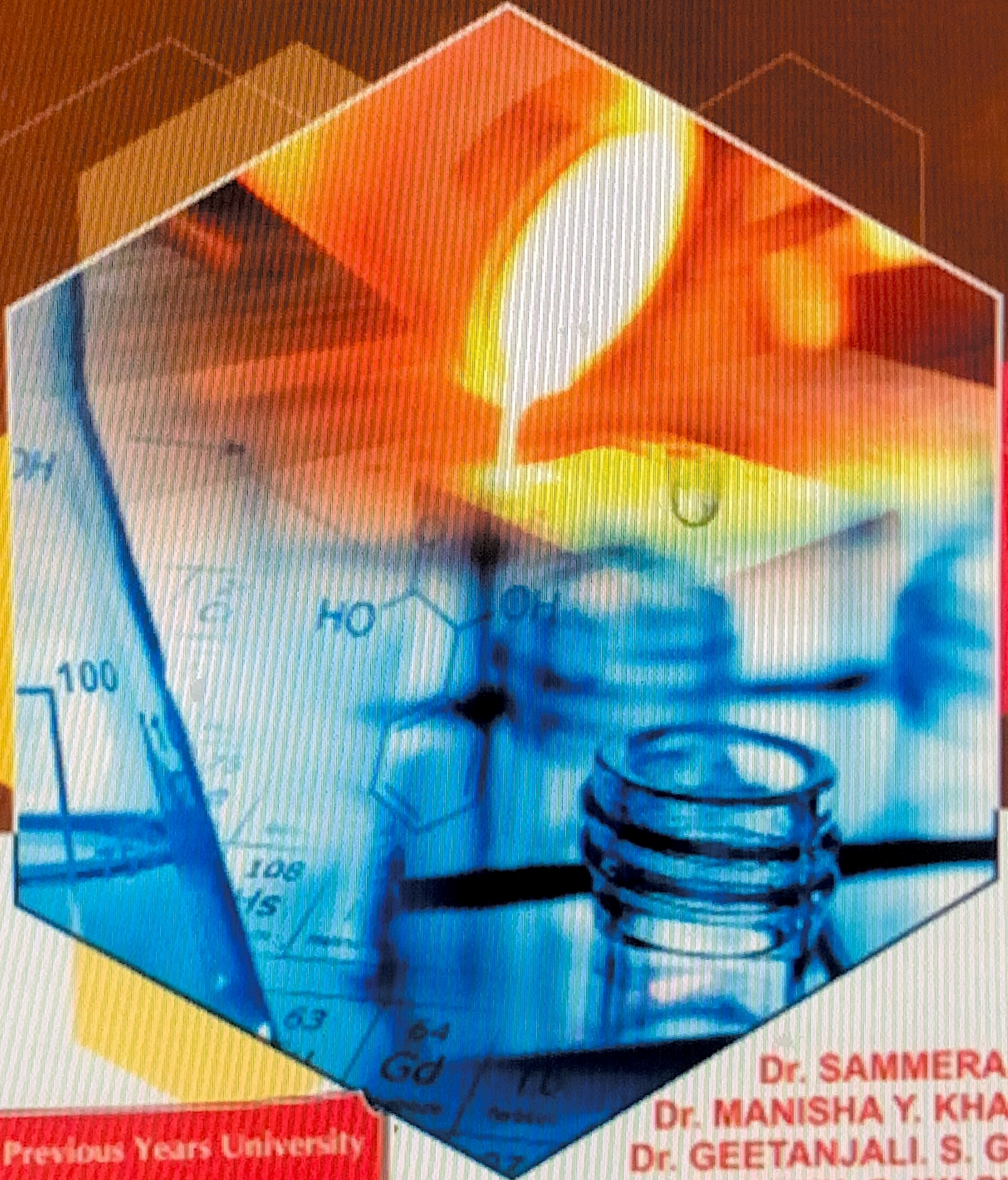

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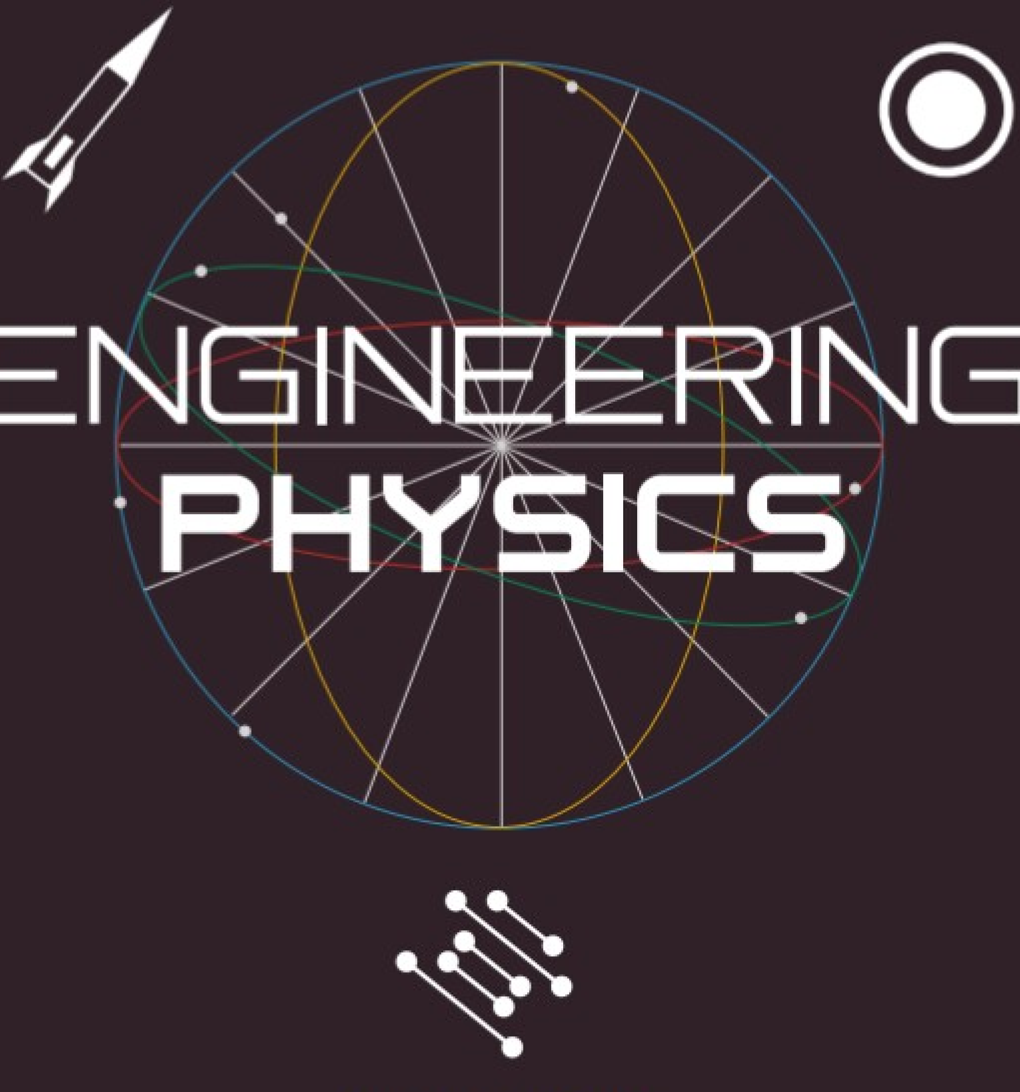

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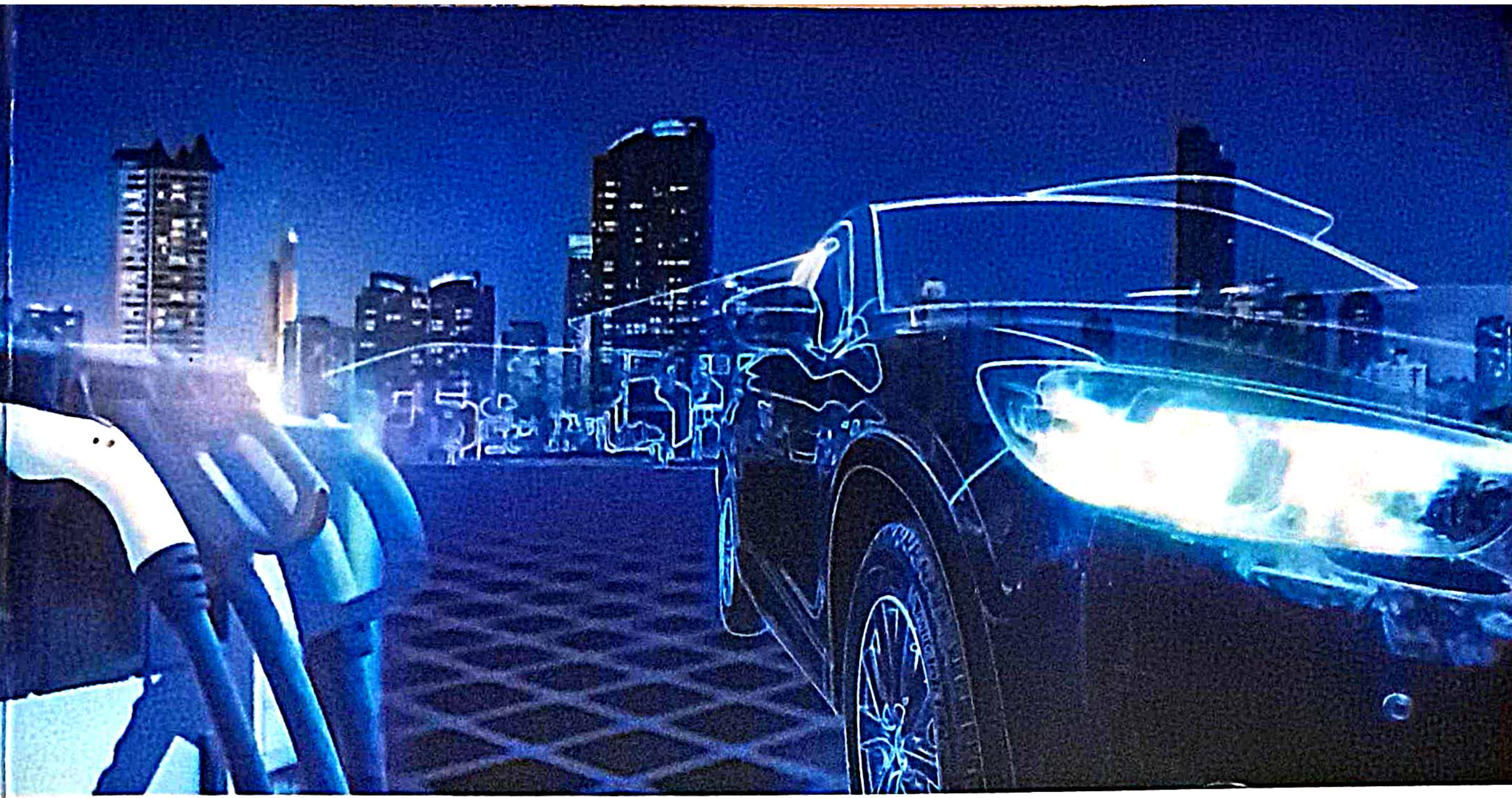

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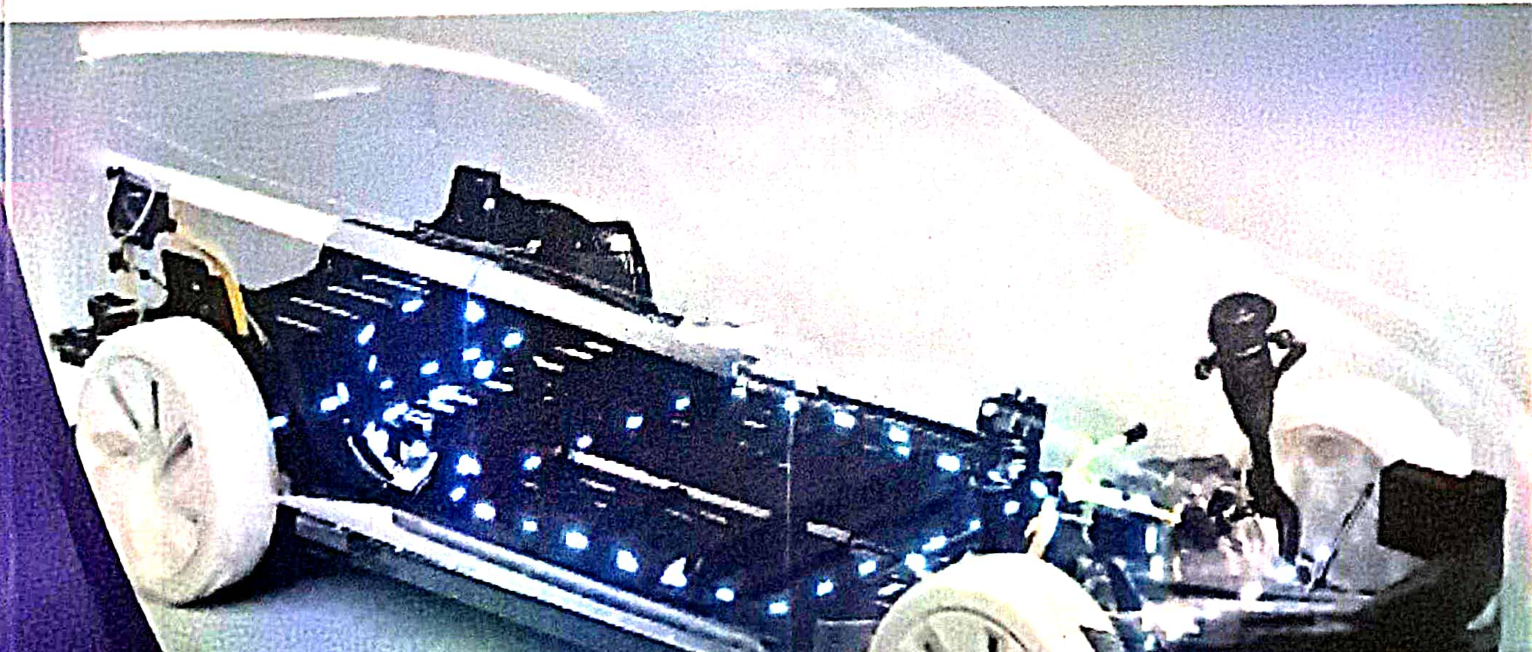

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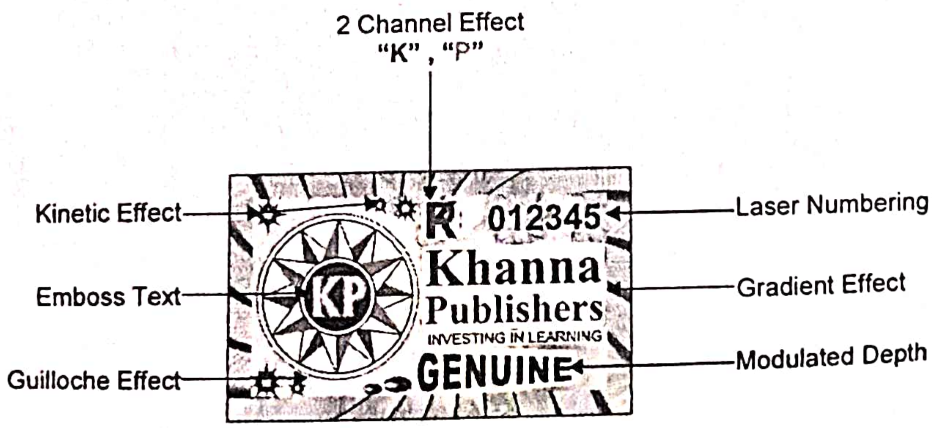

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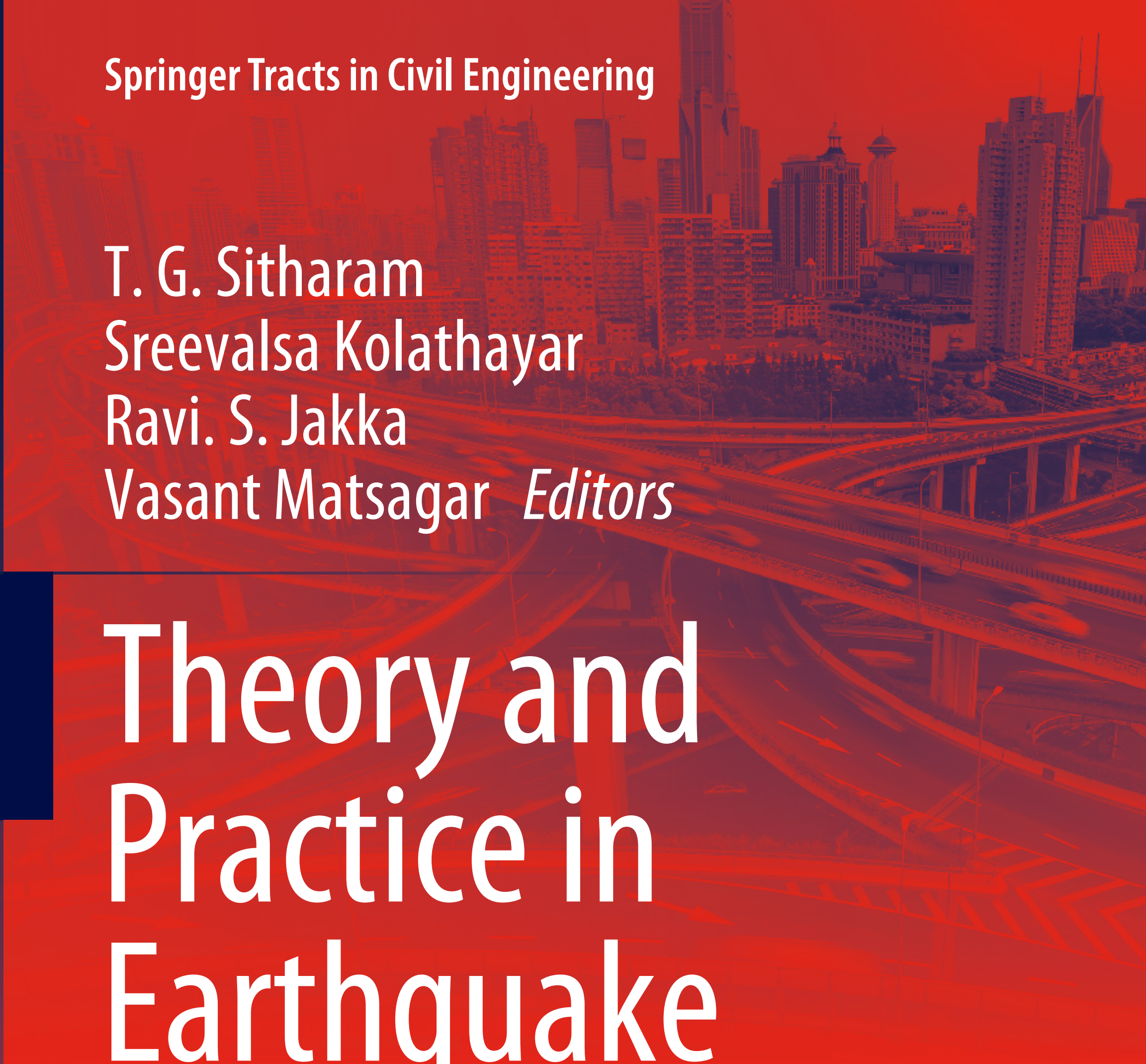

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Preface

The editors are pleased to present this text to the readers on theory and practice in earthquake engineering and technology. Extensive research work is conducted on earthquake engineering and allied areas across the world, quite naturally because of its relevance to the life safety of people. In the present text, the authors have provided a broad spectrum of research works carried out under several disciplines and sub-disciplines of earthquake engineering and technology, from theory to practice, starting from the rudiments thereof. Matsagar (2022) has initiated the discussion on earthquake engineering and technology by setting the tone of the deliberations within this text. Under the overarching umbrella of earthquake engineering and technology, systematic categorization of various disciplines and sub-disciplines has been made, while introducing them, some ongoing research works have also been presented in this opening chapter. The subsequent chapters cover several aspects of geology, seismo-tectonics, regional seismology, geotechnical earthquake engineering, soil-structure interaction, structural engineering, and dynamic response control of structures.

Application of site response studies in seismic hazard microzonation and ground characterization has been presented by Shukla (2022) in the next chapter. In engineering seismology, site response study helps in modeling the effects of the near surface layers of soil on earthquake ground motions, which is an important requirement in seismic hazard microzonation. Ground response studies carried out world over have been reviewed herein, and the discussion is then made in the Indian context.

Ravi-Kiran and Jakka (2022) have presented seismic design of shallow foundations giving the conceptual principles and design methodologies. They have as well deliberated on the current Indian practices, in the framework of codes. Foundation design for structures that are resilient under seismic activities poses several challenges to a geotechnical earthquake engineer owing to the complexities involved in the dynamic soil-structure interaction (SSI) problems. A geotechnical engineer is required to design foundation addressing all such complexities and yet provide design adequately safe under the anticipated forces. Such design procedure for shallow foundations, in particular, has been dealt with in this chapter.

During an earthquake event, adjacent structures may collide with each other, which is called seismic pounding, generating high impact forces in the structural members. Such seismic-induced pounding of structures and its mitigation through some connecting links have been proposed by Dey-Ghosh and Aviral-Kumar (2022). The authors have recommended to relook the current provisions of maintaining adequate gap between adjacent buildings and bridge girder in order to preclude possibility of seismic pounding, else connecting links in the form of energy absorbing dampers have been recommended.

Soil-Structure Interaction (SSI) plays a crucial role in evaluating seismic response of structures, which cannot be overlooked, especially when the underlying soil is flexible. The influence of the nonlinear SSI on yielding of pile embedded in stratified soil has been discussed in detail by Bhattacharjee and Borthakur (2022). Estimating yield moment of a pile embedded in stratified soil by conducting static pushover analysis has been shown in this chapter by modeling the pile-soil system in the open source simulation tool, OpenSees.

When soil loses its shear strength under the earthquake-induced dynamic excitation due to increased pore water pressure soil liquefaction is considered to have occurred. Satyam and Priyadarsini (2022) have fittingly discussed development of liquefaction susceptibility maps for Vishakhapatnam City in India that would be useful in the infrastructure development projects in future. The hazard maps developed based on the liquefaction severity and potential indexes are projected to help solving engineering problems in the considered study area.

Several earthquake response modification and control techniques and devices have been invented of late. One among such dynamic response control methods is seismic base isolation of structures. Base isolation systems are also proven effective for seismic response control of masonry dome (Kakade et al., 2022). The authors have adequately shown the effectiveness of the base isolation system employed in dynamic response control of masonry dome when subjected to earthquake base excitation. Especially, development of tensile stresses in the masonry dome has shown to be reduced advantageously.

With new developments in knowledge and knowhow, rapid changes are being made in the codes and standards. Such changes mandate reassessment of structures on new scale, parameters, or norms, and subsequently adopting measures to make them code compliant. Sarmah et al. (2022) have presented a method for rapid retrofitting of reinforced concrete (RC) columns using iron-based shape memory alloy, Fe-SMA to achieve enhanced seismic performance. This new technique helps in seismic retrofitting of RC columns by winding of thermally prestressed and actively controlled, Fe-SMA strips around the columns.

Considerable research contributions have been made at the Indian Institute of Technology (IIT) Roorkee in developing earthquake early warning system. Relevance of earthquake early warning system in India has been deliberated by Ashok-Kumar et al. (2022), especially emphasizing the need for addressing the blind zone region within 100 km radius from the epicenter. Nonetheless, research efforts are further required to be taken in making the earthquake early warning system more reliable and advancing/increasing the time for making the prediction, even in the near source regions. Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), and Neural Network (NN) techniques are finding their enormous applications in the earthquake early warning system to this effect, after such a pilot project has been completed at IIT Roorkee.

Local authorities require guidance on city planning, earthquake risk mitigation, and response actions taken after occurrence of an earthquake. After an occurrence of unfortunate earthquake estimating the loss incurred is also required, which is a daunting task. How to carry out such estimation of losses has been presented by Meslem et al. (2022), who have taken an example on earthquake loss information system developed for the North-Eastern City of Guwahati, Capital of Assam in India. The procedure laid down in this chapter can suitably be applied for a city before/after occurrences of earthquake.

Occurrence of earthquakes is unpredictable in terms of time and intensity in different regions. However, for important mega-projects, such as river-valley projects, estimation of probable intensity of earthquakes at the proposed site or location is quite essential. To this effect, a Probabilistic Seismic Hazard Analysis (PSHA) for hydropower project sites in the Himalayan Region has been carried out and presented by Srivastav and Satyam (2022) in their chapter. With an aim to quantify the rate of exceeding certain specified earthquake ground motion level at a specific project site, the PSHA technique has been employed for three chosen hydropower project sites located in Uttarakhand, Himachal Pradesh, and Jammu and Kashmir in India, which will be helpful in generating a site-specific seismic hazard map.

In heavy industries and structures, the structure-equipment-piping interactions are important considerations under the earthquake excitation (Reddy, 2022). Failures are likely to occur not only in the parent (host) structure but also either in equipment or in the piping systems, which sometimes are categorized as lifeline structures. The forces induced in the structure, equipment, and piping depend upon how they are interacting with each other. It is notable that such dynamic interactions vary largely based on whether the secondary structures are acceleration-sensitive or displacement-sensitive. Thereby, seismic designs of the primary and secondary structures are greatly influenced by the structure-equipment-piping interactions, as discussed in this chapter.

Advanced seismic design approaches are being adopted in modern design codes and standards. In this context, the Performance-Based Seismic Design (PBSD) of Reinforced Concrete (RC) structures discussed by Gwalani and Singh (2022) becomes highly relevant. In the near future, the Bureau of Indian Standards (BIS) is anticipated to publish standard guidelines on the PBSD of code-compliant reinforced concrete buildings. Hence, this chapter, describing the concept of the PBSD and how to apply it in earthquake-resistant design of buildings, appropriately illustrating the Nonlinear Static Analysis (NSA) and Nonlinear Time History Analysis (NLTHA) methods, is very timely and useful to the structural designers.

Borah et al. (2022) have carried out a comparative analysis of the Standard Spectral Ratio (SSR) and Horizontal to Vertical Spectral Ratio (HVSR) methods for site response analysis. They have concluded that the SSR method provides a more accurate and conservative estimate of site amplification response as compared to the HVSR, which therefore can suitably be adopted for the seismically active North-Eastern Regions in India.

It is indeed pleasing to see that a wide variety of topics have been dealt with in these chapters of the book. We feel that these contributed chapters in this book have elaboratively highlighted tenets of theory and practice in earthquake engineering and technology aptly. Therefore, we believe that the latest developments in earthquake engineering and allied disciplines presented through these 14 chapters will prove to be highly informative to the readers and pave ways for further research.

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Prof. Dr. T. G. Sitharam is the Director of Indian Institute of Technology Guwahati, Assam since July 2019. He is a member of the Science and Engineering Research Board (SERB), Established through an Act of Parliament: SERB Act 2008, Department of Science & Technology, Government of India. He is a Senior Professor in the Department of Civil Engineering, Indian Institute of Science (IISc), Bangalore, and served IISc for more than 27 years. He was Chairman of the Board of Governors at IIT Guwahati during 2019–2020 for more than a year. He was the former Chairman, Research Council, CSIR- CBRI (Central Building Research Institute, Roorkee). He is holding the position of Director (additional charge) of Central Institute of Technology, Kokrajhar, Assam (A Deemed to be University), since May 2021. Over the last 35 years, he has carried out research and development in the area of geotechnical and infrastructure engineering, seismic microzonation and soil dynamics, Geotechnical earthquake engineering and has developed innovative technologies in the area of earth sciences, leading to about 500 technical papers, 20 books with Google scholar H-index of 47 and I-10 index 137 with more than 7175 citations. He has guided 40 Ph.D. students and 35 Master's Students. He was listed in the world's top 2% of scientists for the most-cited research scientists in various disciplines by Stanford University in 2020. His name appeared again in the top 2% of scientists IN Elsevier by Stanford University in 2021. His broad area of research falls into Geotechnical Infrastructure engineering, earth sciences, hydrology, seismology, and natural hazards. He has carried out Seismic microzonation of many urban centers in India and he is an authority on seismic microzonation and site effects. Presently, he is the President of the Indian Society of Earthquake Technology and he was the chairman of the 7th International conference on recent advances in geotechnical earthquake engineering and soil dynamics held in July 2021. He is the chief editor of the International Journal of Geotechnical Earthquake Engineering, (IJGEE), PA, USA since 2010. He is the Editor-in-chief, Springer Transactions in Civil and Environmental Engg series, Book Series, Singapore. He is the Fellow of ASCE, Fellow