ENGINEERING PHYSICS

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Engineering Physics

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FOREWORD

It gives me immense pleasure to see the present textbook on "Engineering Physics" which covers almost the entire syllabus taught at undergraduate level at different engineering colleges and institutions throughout India. I complement the authors and appreciate their efforts in bringing out this book written in a very simple language. The text is comprehensive and the explanation of topics is commendable. I understand that this book carries all the elements required for a good presentation.

I have been a student of IIT Kharagpur and later on taught at IIT Delhi. Being a part of the IIT system, I recognise that the rigorous and enriching teaching experience at IITs originating from the interaction with the best engineering students and their strong feedback results in continuous evolution and refinement of the teachers. This spirit is reflected in the comprehensive and in-depth handling of important topics in a very simple manner in this book. I am happy to note that this textbook has been penned down by IITian and hope that it would serve to be a good textbook on the subject. Since this book also covers advanced topics, it will be an important learning resource for the teachers, and those students who wish to develop research skills and pursue higher studies. I hope that the book is well received in the academic world.

Prem Vrat

Professor Prem Vrat
Vice-Chancellor, U.P. Technical University, Lucknow
Founder Director, IIT Roorkee

PREFACE

Physics is a mandatory subject for all engineering students, where almost all the important elements of the subject are covered. Finally, these evolve as different branches of the engineering course. The book entitled Engineering Physics has been written keeping in mind the need of undergraduate students from various engineering and science colleges of all Indian universities. It caters to the complete syllabus for both–Physics-I and Physics-II papers in the first year Engineering Physics course.

The aim of writing this book has been to present the material in a concise and very simple way so that even weak students can grasp the fundamentals. In view of this, every chapter starts with a simple introduction and then related topics are covered with a detailed description along with the help of figures. Particularly the solved problems (compiled from University Question Papers) are at the end of each chapter. These problems are not merely numerical; many of them focus on reasoning and require thoughtful analysis. Finally, the chapters carry unsolved questions based on which the students would be able to test their knowledge as to what they have acquired after going through various chapters. A chapter-end summary and list of important formulae will be helpful to students for a quick review during examinations. The rich pedagogy consists of solved examples (450), objective-type questions (230), short-answer questions (224) and practice problems (617). The manuscript has been formulated in such a way that students shall grasp the subject easily and save their time as well. Since the complete syllabus is covered in a single book, it would be highly convenient to both.

The manuscript contains 22 chapters which have been prepared as per the syllabus taught in various colleges and institutions. In particular, the manuscript discusses optics, lasers, holography, fibre optics, waves, acoustics of buildings, electromagnetism, theory of relativity, nuclear physics, solid state physics, quantum physics, magnetic properties of solids, superconductivity, photoconductivity and photovoltaic, X-rays and nanophysics in a systematic manner. We have discussed advanced topics such as laser cooling, Bose-Einstein condensation, scanning electron microscope (SEM), scanning tunnelling microscope (STM), controlled fusion including plasma, Lawson criterion, inertial confinement fusion (ICF), plasma based accelerators, namely, plasma wake field accelerator, plasma beat wave accelerator, laser wake field accelerator and self-modulated laser wake field accelerator, and nanophysics with special emphasis on properties of nanoparticles, carbon nanotubes, synthesis of nanoparticles and applications of nanotechnology. These will be of interest to the teachers who are involved in teaching postgraduate courses at the universities and the students who opt for higher studies and research as their career. Moreover, a series of review questions and problems at the end of each chapter together with the solved questions would serve as a question bank for the students preparing for various competitive examinations. They will get an opportunity to learn the subject and test their knowledge on the same platform.

The structuring of the book provides in-depth coverage of all topics. **Chapter 1** discusses Interference. **Chapter 2** is on Diffraction. **Chapter 3** is devoted to Polarization. Coherence and Lasers are described in **Chapter 4**. **Chapter 5** discusses Fibre Optics and its Applications, while Electron Optics is dealt with in **Chapter 6**. **Chapter 7** describes Waves and Oscillations. **Chapter 8** is on Sound Waves and Acoustics. **Chapter 9** is on Dielectrics. Electromagnetic Wave Propagation is described in **Chapter 10**. **Chapter 11** discusses the Theory of Relativity.

Chapter 12 is devoted to Nuclear Physics. Crystal Structure is described in **Chapter 13**. **Chapter 14** deals with the Development of Quantum Physics, while **Chapter 15** is on Quantum Mechanics. **Chapter 16** discusses Free Electron Theory. Band Theory of Solids is explained in **Chapter 17**. **Chapter 18** describes the Magnetic Properties of Solids. **Chapter 19** is on Superconductivity. **Chapter 20** explains X-rays in detail while **Chapter 21** is on Photoconductivity and Photovoltaics. Finally, **Chapter 22** discusses Nanophysics in great detail. The manuscript has been organised such that it provides a link between different topics of a chapter. In order to make it simpler, all the necessary mathematical steps have been given and the physical feature of the mathematical expressions is discussed as and when required.

The exhaustive OLC supplements of the book can be accessed at http://www.mhhe.com/malik/ep and contain the following:

For Instructors

- Solution Manual
- Chapter-wise PowerPoint slides with diagrams and notes for effective lecture presentations

For Students

- A sample chapter
- Link to reference material
- Solved Model Question Paper
- Answers to objective type questions given in the book.

We would like to thank the entire team of Tata McGrawHill Education specifically Vibha Mahajan, Shalini Jha, Tina Jajoriya, Dipika Dey, Sohini Mukherji, Priyanka Negi and Baldev Raj for bringing out this book in a very short time span. The reviewers of the book also deserve a special mention for taking out time to review the book. Their names are given below.

A K Jain	*IIT Roorkee*
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Prerna Garg	*Meerut Institute of Technology, Uttar Pradesh*
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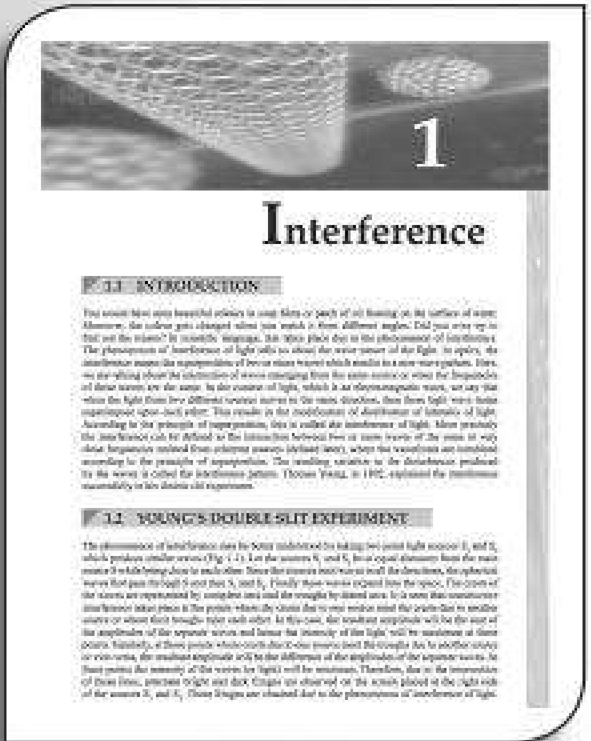
WALKTHROUGH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Interference

1.1 INTRODUCTION

1.2 YOUNG'S DOUBLE SLIT EXPERIMENT

Introduction

Each chapter begins with an Introduction that gives a brief summary of the background and contents of the chapter.

Sections and Sub-sections

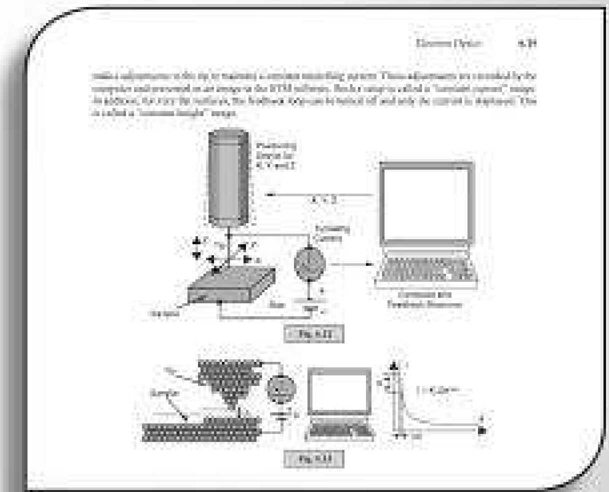
Each chapter has been neatly divided into relevant sections and sub-sections so that the text material is presented in a logical progression of concepts and ideas.


2.2 Engineering Physics

2.3 DIFFERENCE BETWEEN DIFFRACTION AND INTERFERENCE

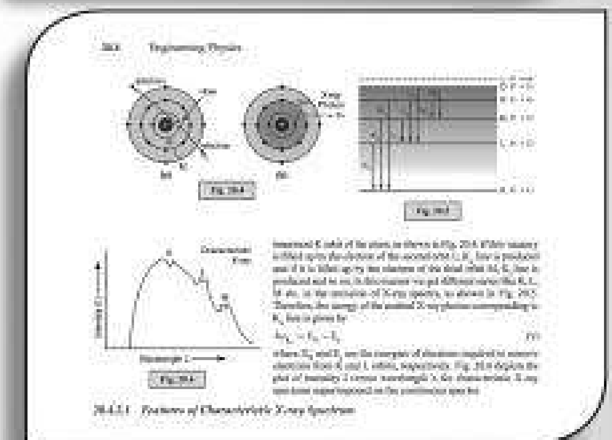
2.4 TYPES OF DIFFRACTION

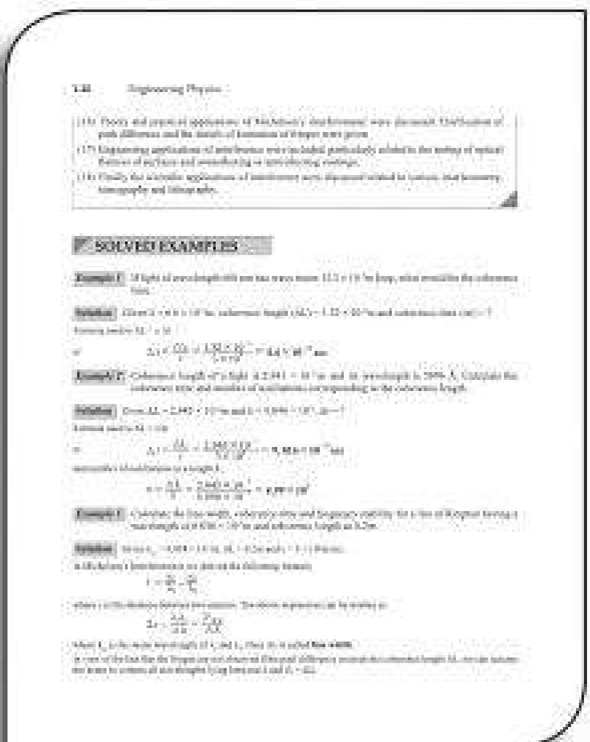
2.4.1 Fraunhofer Diffraction



Illustrations

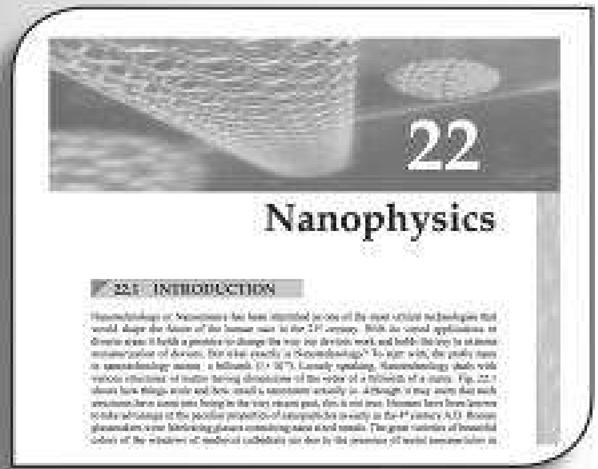
Illustrations are an important tool in the presentation of text material. The reader of the text would come across ample number of diagrams/illustrations provided in each chapter to effectively discuss the concepts of engineering physics.





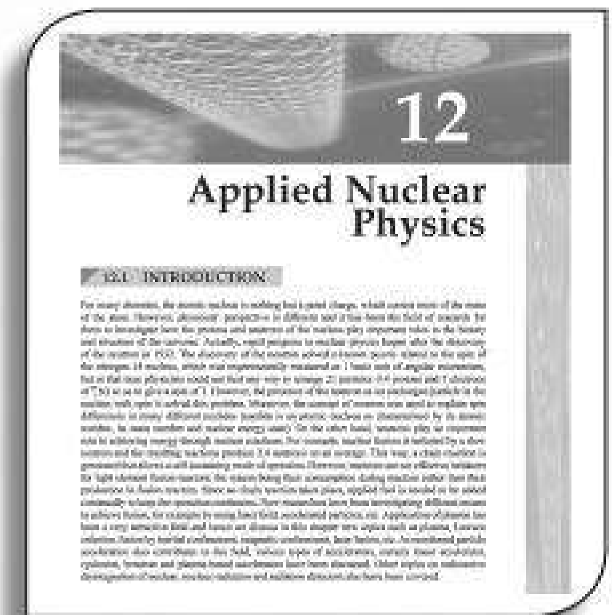
Solved Examples

Solved Examples (450) are provided in sufficient number in each chapter and at appropriate locations, to aid in understanding of the text material.



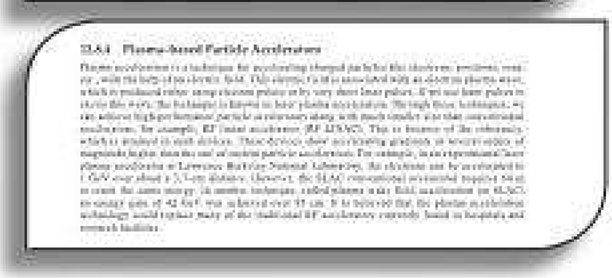
Advanced Topics

Advanced Topics like Nanophysics, an essential part of the syllabus, are covered extensively.



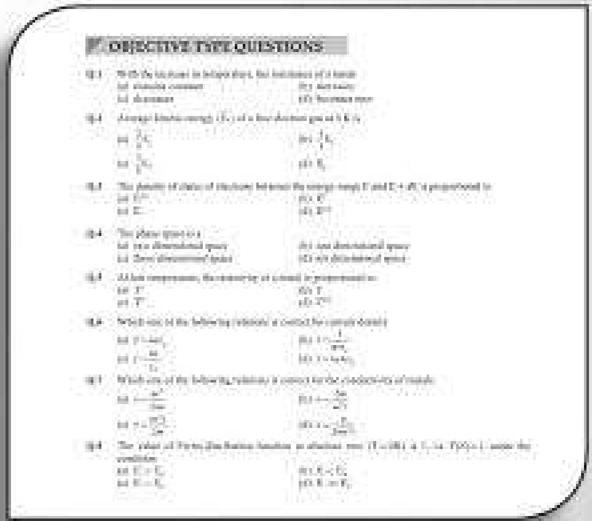
Applications

Applications like Controlled Fusion Reaction, Particle Accelerators (Basics of Plasma) are explained in detail with relevant topics.



Summary

A bulleted summary gives the essence of each important topic discussed in the chapter for a quick recap.



OBJECTIVE-TYPE QUESTIONS

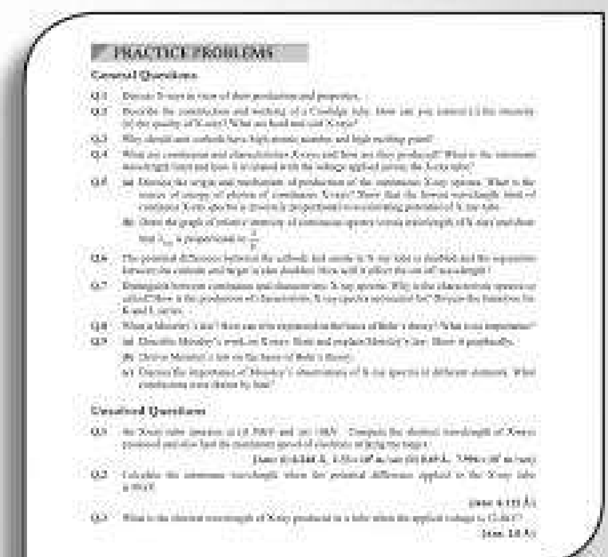
Objective-type questions

Objective-type questions enable the user to have a clear comprehension of the subject matter. Answers to all the objective questions are provided in the online learning centre of the book.

SHORT-ANSWER QUESTIONS

Questions

A set of (850) questions are given as exercise to the students. Further divided into Short-answer Questions and Long-Answer Questions and are very helpful to teachers in setting class work, assignments, quizzes and examinations. In some chapters, numerical problems with answers, under the heading 'Unsolved Questions', are also given. Readers can assess their knowledge by answering the objective-type questions and short-answer questions given at the end of the book.



PRACTICE PROBLEMS

General Questions

Unsolved Questions

Practice Problems

Practice problems, in the category of general and unsolved questions provide an opportunity to students to reinforce his or her learning and gain confidence.

Roadmap to the Model Syllabus

Interference, Diffraction, Polarisation

Chapter 1: Interference
Chapter 2: Diffraction
Chapter 3: Polarisation
Chapter 20: X-Rays

Superconductivity

Chapter 19: Superconductivity

Super Conducting Materials

Chapter 21: Photoconductivity and Photovoltaics

Relativistic Mechanics

Chapter 11: Theory of Relativity

Solid State Physics

Chapter 17: Band theory of Solids
Chapter 18: Magnetic Properties of Solids

Sound Waves

Chapter 7: Waves and Oscillations

Electricity and Magnetism

Chapter 10: Electromagnetic Wave Propagation

Dielectric and Magnetic Properties of Materials

Chapter 9: Dielectrics

Electromagnetics, Electrostatics & Electrodynamics

Quantum Physics

Acoustics

Oscillations

Ultrasonic

Crystal Physics

Lasers

Optical, Wave Optics, Geometrical Optics, Electron Optics, Fibre Optics

Nuclear Physics

Nano Physics