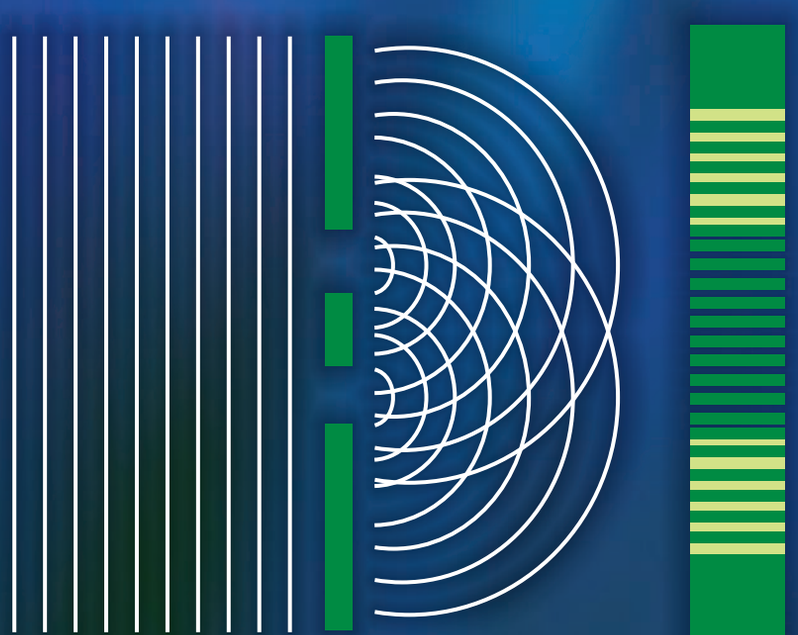
Eastern Economy Edition

Second Edition

Engineering Physics



PHI

G.S. Raghuvanshi

ENGINEERING PHYSICS

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SECOND EDITION

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To

My Wife ***Sushila Raghuvanshi***

whose patience and dedication

energized me to write this book

CONTENTS

PREFACE

The core subject, Physics, provides the foundation on which the elegant building (so to speak), Engineering and Technology, is built. In today's fast-growing technology, the time available for Physics is meagre, particularly in Rajasthan Technical University (RTU), Kota. Therefore, the course on Engineering Physics has been designed so as to avoid repetition of what is taught in earlier classes up to Class XII and to provide the necessary background for developing engineering subjects. This book specifically addresses this problem. Preliminaries are provided in an easy-to-understand language at the beginning of each chapter. This enables the students to revise the topics gradually and understand the fundamentals. Engineering aspects of the topics are emphasized at the end of each chapter.

Engineers and technologists are known for problem solving. To strengthen this faculty, a large number of solved and unsolved problems and questions are included in each chapter. To make the book students friendly, all the questions and numerical problems asked in the last several years at various university examinations have been added.

To cater to the needs of the students of universities other than RTU, Appendices are provided to supplement the topics which are not dealt with in the main text.

The *second edition* adds two new chapters on namely *dielectrics* and *electromagnetism*. In addition, it also contains a topic on band theory of solids. As usual these chapters have a large number of solved and unsolved problems. The inclusion of these chapters further increases the usefulness of the book in universities other than RTU too. Many new examples have been added in each chapter and errors have been removed.

The book is also suitable for the B.Sc. courses in optics and modern physics of all Indian universities.

I do not claim any originality for the contents of a book of this kind. I acknowledge my indebtedness to a large number of books and articles which I have consulted in the preparation of the manuscript. Thanks are due to Dr. Anil Pathak, Dr. Anil Kumar, Dr. Sunil Jain, all of University College of Engineering, RTU, Dr. Y.C. Bhatt and Dr. K.C. Swami, MNIT Jaipur; and to Sh. M.S. Dhaka, Engineering College, Bikaner.

Finally, I wish to thank the Publishers, PHI Learning, for bringing the book in excellent form, particularly to Mr. K.C. Devasia who, along with the production team, has meticulously processed the manuscript.

I do hope that the book would be very useful to all engineering students for whom it is intended. I would welcome constructive suggestions and comments from students and teachers for further improvement of the book.

G.S. Raghuvanshi

CHAPTER

1 INTERFERENCE OF LIGHT

CONTENTS

1.1 INTRODUCTION

1.1.1 General Properties of Wave Motion

A propagating disturbance is a wave. The wave disturbance for physical waves is generally periodic. Therefore, the disturbance that varies periodically with both distance and time, remains continuous and finite, represents a wave. It can be represented by sine or cosine functions,

$$\psi = a \sin(\omega t - kx + \phi_o) \tag{1.1}$$

The maximum disturbance $\psi_{max} = a$ is called *amplitude* of the wave and the argument of sine or cosine function is called *phase* of the wave, ϕ,

$$\phi = \omega t - kx + \phi_o \tag{1.2}$$

where ϕ_o is initial phase and ω is angular frequency. Equation (1.1) is general equation of a one-dimensional wave. If ψ is mechanical say pressure, it is sound wave. If ψ is electric or magnetic field, it is an *electromagnetic wave* and if ψ is probability, it is a *matter wave*.

The minimum time after which disturbance repeats itself is called *time period T*. The inverse of T i.e., $1/T$ is referred to as *frequency of the wave*. The minimum distance after travelling which disturbance repeats itself is called *wavelength of the wave*. It is thus obvious, that

$$\frac{\lambda}{T} = v \quad \text{or} \quad v = \nu\lambda \tag{1.3}$$

where v is velocity of the wave and ν is its frequency.

In Eq. (1.1), $k = \dfrac{2\pi}{\lambda}$ is called *wave vector* or *propagation constant*. Thus when wave travels a distance λ, it takes time T and phase changes by 2π. Therefore, the phase difference $\Delta\phi$, the path difference Δx, and the time difference Δt are related as

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{\Delta t}{T} = \nu\Delta t \tag{1.4}$$

Differentiating Eq. (1.1) twice with x and twice with t and dividing equations so obtained, we have

$$\frac{\partial^2\psi}{\partial x^2} \Big/ \frac{\partial^2\psi}{\partial t^2} = \frac{k^2}{\omega^2} = \frac{(2\pi/\lambda)^2}{(2\pi\nu)^2} = \left(\frac{1}{\nu\lambda}\right)^2 = \frac{1}{v^2}$$

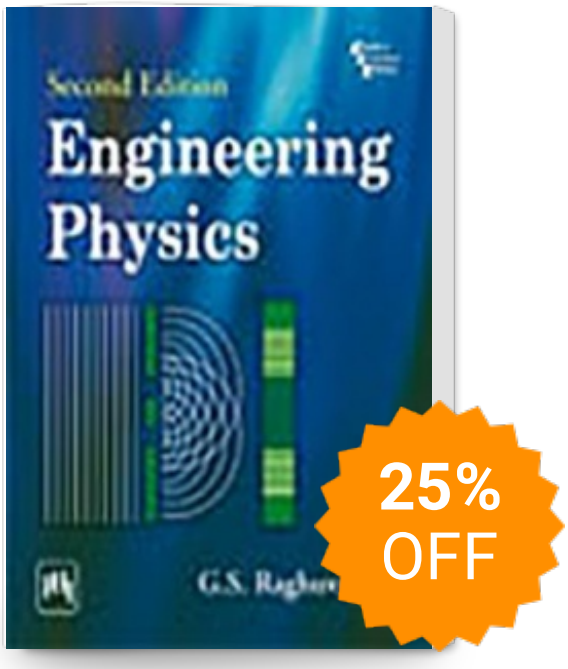
or

$$\frac{\partial^2\psi}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} \tag{1.5}$$

Equation (1.5) is one-dimensional differential equation of a wave and in three dimensions it takes the form

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} = \nabla^2\psi = \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} \tag{1.6}$$

Engineering Physics



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