14th Edition

ENGINEERING MECHANICS

STATICS AND DYNAMICS

A. K. TAYAL

UMESH

ENGINEERING MECHANICS: STATICS AND DYNAMICS

Dr. A.K. Tayal

ENGINEERING MECHANICS STATICS AND DYNAMICS

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Preface to the Fourteenth Edition

It gives me a great pleasure to present the Fourteenth Edition of this book on Engineering Mechanics. I express my gratitude for the wide acceptability of the book by the academics as well as student community and it gives me deep sense of satisfaction. In this new edition, a new chapter on 'Shear Force and Bending Moment' has been added. This topic is included to meet the current requirements of some universities.

I again, request for the suggestions and comments for the improvement of the book.

Delhi
January, 2011

Dr. A.K. TAYAL

Preface to the First Edition

Mechanics is essentially a deductive science based on a few fundamental principles and has vectorial character. This book has been written with a view to emphasize the vectorial character of mechanics in such a manner so that the material presented may not require any previous knowledge of mathematics beyond elementary calculus. For this reason, products and derivatives of vectors are not used. A chapter on the 'Review of Vectors and Forces in Space', however, has been included as an appendix to introduce the vector approach of the subject. This chapter can be covered before going on the mechanics of coplanar system of forces.

It is a well recognised fact that the teaching of the first course in a subject should be based on a text book. A systematic, consistent and clear presentation of concepts through explanatory notes and figures and worked out problems are the main requirements of a text book. This book has been written to meet such requirements. Merely stating the principles and explaining the concepts is not enough; these are to be identified as applicable to the various problems which may appear to be strangely different. With this objective, a large number of worked-out problems have been included in this book. In the most worked-out problems, free-body diagrams have been separately drawn with the coordinate axes shown. The equations of equilibrium or of motion, as applicable, have been indicated. Inertia forces have also been clearly identified in a problem. Alternative methods of solution to a number of problems have given or indicated to explain the comparative merits of the concepts and solution procedures involved. In fact, skill through repetition may be as much true here as in occult sciences.

I am grateful to many of my faculty colleagues and numerous students at Delhi College of Engineering, Delhi (now Deemed University) who have contributed significantly by way of constructive and useful discussions. The patience of the family members and the encouragement by friends is gratefully acknowledged.

I am also tankful to the publishers who have taken keen interest throughout the preparation of the book.

Despite may best efforts, it is possible that some unintentional errors may have escaped my attention. I would gratefully acknowledge if any of these is pointed out. Also, any suggestions and comments for further improvement of the book would be gratefully received and acknowledged.

Delhi

A. K. TAYAL

Contents

1 CHAPTER Introduction

1.1 ENGINEERING MECHANICS

It is the science which deals with the physical state of rest or motion of bodies under the action of forces. Depending upon the nature of the body involved, it can be further divided into *mechanics of rigid bodies, mechanics of deformable bodies* (also called strength of materials) and the *mechanics of fluids.*

In this book, we shall deal with the mechanics of *rigid bodies.* Rigid bodies are those *bodies which do not deform under the action of applied forces.* The mechanics of rigid bodies is studied in two parts, *statics* and *dynamics. Statics deals with bodies at rest and dynamics with bodies in motion.*

1.2 IDEALIZATION OF BODIES

Matter is made up of atoms and molecules. But the real picture of matter as atoms and molecules is too complex to deal with. So to study the average measurable behaviour of bodies, we assume that *the matter is continuously distributed. Such a description of matter is called a continuum. A continuum can be rigid or deformable depending upon the assumptions we make.*

Rigid Body. The physical bodies deform, although slightly, under the action of loads or external forces. But in many situations this deformation is negligibly small to affect the results. So, the assumption of a rigid body shall mean that the body does not deform or the distance between any two points of the body does not change under the action of a applied force.

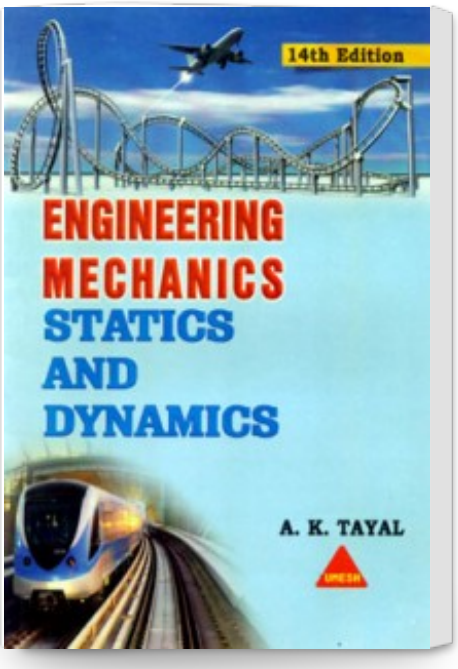
Particle. It is defined as an object whose mass is concentrated at a point. This assumption is made when the size of a body is negligible and is irrelevant to the description of the motion of the body.

1.3 BASIC CONCEPTS

The study of mechanics involves the concepts of *space, time, mass* and *force.*

(*i*) Concept of space is essential to fix the position of a point. To fully define the position of a point in space we shall need to define some frame of reference and coordinate system.

Engineering Mechanics Statics and Dynamics



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