ELEMENTARY STATICS OF TWO AND THREE DIMENSIONS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649097739

Elementary statics of two and three dimensions by R. J. A. Barnard

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

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MACMILLAN AND CO., LIMITED
LONDON · BOMBAY · CALCUTTA · MADRAS
MELBOURNE

THE MACMILLAN COMPANY
NEW YORK · BOSTON · CHICAGO
DALLAS · SAN FRANCISCO

THE MACMILLAN CO. OF CANADA, LTD.
TORONTO

ELEMENTARY STATICS

OF TWO AND THREE DIMENSIONS

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MACMILLAN AND CO., LIMITED
ST. MARTIN'S STREET, LONDON
1921

PREFACE

THE reception of my *Elementary Dynamics* has encouraged me to write a *Statics* of a similar standard of difficulty, and I have followed the same principles as in that book.

With reference to the contents I may mention the following:

(i) The introduction of examples on friction early, in dealing with forces at a point.

(ii) The insertion of a chapter on Shearing Stress and Bending Moments.

(iii) The use of the methods of the elementary differential calculus in the chapter on Virtual Work, and of the integral calculus for finding the centres of mass of a number of geometrical areas and volumes.

(iv) Three-Dimensional Statics are dealt with more fully than usual.

(v) A chapter on Vectors in Space, including vector products, has been included.

It is hoped that the last-named chapter, with the chapter on vectors in my *Dynamics*, will make a satisfactory introduction to Vector Algebra and its applications.

As in my *Dynamics*, a number of the more difficult examples come from papers set at the Melbourne University. Nearly all the others have been constructed by myself for the book or for my classes.

R. J. A. BARNARD.

DUNTROON,
March, 1921.

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CHAPTER I.

FOUNDATIONS OF MECHANICS.

BEFORE dealing specially with Statics as one branch of Mechanics, it is necessary to refer to the fundamental ideas about Force, and these are most easily obtained from a consideration of dynamical questions.

It will be sufficient to give a short summary of these ideas, referring for fuller development to my book on *Elementary Dynamics*, Chapter III.

1. Position, Relative Motion and Rest.

The position of a point is generally measured by its distances from points, or lines, or planes fixed to the earth. If these distances change, it is said to be in motion relative to the earth; if the distances do not change it is at rest relative to the earth. When it is at rest relative to the earth it is usually said simply to be at rest.

2. Force.

Force is generally defined as any action that alters or tends to alter a body's state of motion; but two or more forces acting on a body may balance one another's effects in such a way that the body remains at rest.

Statics is that branch of mechanics which deals with the relations between forces acting on a body at rest.

A body is said to be **Rigid** if its shape and size are unaffected by forces acting on it. While no such body actually exists in nature, the alterations in solids are small and will be neglected throughout this book, except where changes are specially mentioned, such as in the springs and strings of the next paragraphs.

In simple experiments a force may be applied to a body by attaching a spring or string to it, and pulling the spring or string. The effect of the force depends both on the strength and the direction of the pull. Hence a force requires both magnitude and direction to denote it fully, and can be consequently represented by a straight line whose length represents the magnitude of the force according to some scale, and whose direction is the direction of the force.

If the force is exerted by the medium of a spiral spring (spring balance), the extension of the spring can be taken as a measure of the force. For, if we take weights which balance on an ordinary balance, and hang them successively to a spring balance, we find that they elongate the spring balance to the same amount; and that if different weights are hung on, the elongation will be very nearly proportional to the weight, and even if the elongation is not exactly proportional to the weight, the balance may still be graduated to shew various forces by marking the positions taken by the pointer for given weights hung on the balance.

Spring balances thus graduated, and of comparatively small stiffness, so that a weight of a few ounces produces an easily observed elongation, may be used for simple demonstrations of fundamental results in statics.

3. Action and Reaction.

A force acting on a body is always due to the presence of a second body influencing it, and a force never acts on one body without an equal force acting in the opposite direction