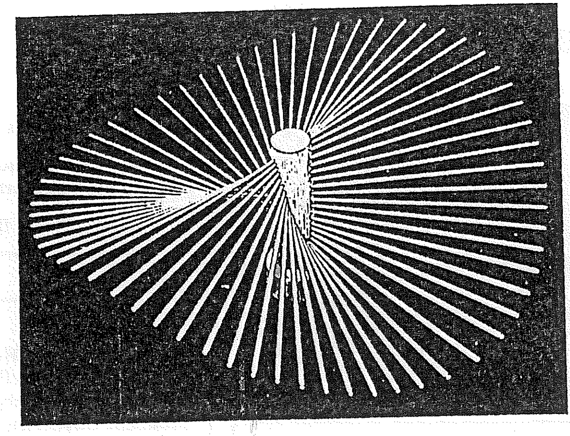

Ball's cylindroid: a model for screw motions

The work for which he is chiefly remembered, his classic researches on screw motions, was developed over more than thirty years in a series of important communications, contributed in great part to the Royal Irish Academy from 1871. He developed a powerful geometrical method to treat the problem of small movements in rigid dynamics, investigating in particular the behaviour of rigid bodies having different degrees of freedom. In the case where there are two degrees of freedom, he demonstrated that the cylindroid shown in the figure represents the cubic surface locus of the screw axis for all possible twists. Thereafter, he took a special interest in exploring the detailed properties of this kind of surface. In the course of his investigations he made independent discovery of certain theorems concerned with the theory of linear complexes in line geometry, a topic which, in his day, was only in its infancy, and he is now ranked among the leaders of nineteenth century mathematics for his contributions to the geometry of motion and force.

Of genial temperament, he was an outstanding public lecturer and his popular works on astronomy (thirteen volumes published between 1877 and 1908), including *The Story of the Heavens* and a university textbook *A Treatise on Spherical Astronomy*, enjoyed a considerable vogue.

Further reading:
W. Valentine Ball (ed.): *Reminiscences and Letters of Sir Robert Ball*, Cassell and Co. Ltd, London, 1915.
Sir Robert S. Ball: *A Treatise on the Theory of Screws*, Cambridge University Press, 1900.
O. Henrici: *The Theory of Screws*, Nature No. 1076, 42, 127-132, 1890. (Review of 'Theoretische Mechanik Starrer System' by H. Gravelius, published Berlin, Reimer, 1889, an important German treatise based mainly on Ball's work.)

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BOOK REVIEWS

"MEASURE AND INTEGRATION FOR USE"

By *H.R. Pitt, FRS*

Published by *Clarendon Press*, Oxford, 1985. Stg £9.95.
ISBN 0-19-853608-9

Integration is an essential tool for doing mathematics, yet its teaching leaves much to be desired. We are told that the Lebesgue integral is 'too heard' and any analyst knows that the Riemann theory has poor manipulative properties. One solution is that of Henstock*; but prejudice against such simplicity seems too strong. The only other solution is to teach Lebesgue's integral.

This book goes some way towards convincing me that this is possible and desirable. Indeed the main difficulty is that the treatment stays too close to the Riemann integral, presumably so that the reader feels secure. The author sets out to show that the Lebesgue integral is not so difficult to learn, and is of such importance in applications that it simply cannot be ignored. He concentrates on the applications of the theory; notably to harmonic analysis and to probability theory where its ubiquity is most impressive. The point is that one uses the Lebesgue integral for its economy, for its structural integrity and because it unifies.

The book is divided into two parts. The first concerns the theory of integration. Formulated initially in an abstract setting, it focuses mainly on reaching the main results needed to integrate in Euclidean space. There is little digression on measure theoretic pathology. An irritating feature is the constant comparison with the Riemann integral, but this is mostly excusable on cultural grounds. In fact he takes care to answer many of the questions I remember worrying about

* R. Henstock: *Theory of Integration*, Butterworths, 1963

when I first studied the Lebesgue theory; such as integrability of continuous functions, that it generalises the Riemann integral, the appropriate fundamental theorem of calculus etc. The second part introduces the applications and attempts to convince the reader that the Lebesgue integral is the natural tool for tackling certain basic problems.

I have several reservations. One is that the book is basically concerned with measures on R^k, which leads to a fundamental loss of clarity in the section on probability theory since path space has infinite dimension. Another difficulty is that there are no exercises. This is a major drawback in a book of this type. I also noted several throwaway remarks where whole subject areas are surveyed in a few lines. For example there are some comments on filtering theory whose value to the beginner is doubtful. Against this I would commend the inclusion of proofs of Heisenberg's inequality, the Riemann-Lebesgue lemma, the individual ergodic theorem, and Liapounoff's theorem.

Do we need another book on integration? The answer is surely no, but books like this are transitional and are to be welcomed. The difficulty lies with a prejudice which retains the Riemann integral as a first year undergraduate essential. In my opinion this can no longer be justified.

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"WORKED EXAMPLES IN MATHEMATICS FOR SCIENTISTS AND ENGINEERS"

By *G. Stephenson*

Published by *Longman*, 1985, Stg £4.95. ISBN 0-582-44684-8

I must confess immediately that I find it difficult to warm to any book aimed at students - whatever its stated objective - which contains no exercises. Students need to be encouraged to be active, not passive, and a collection of worked examples, however well - chosen or elegantly solved (as they generally are in this text), is unlikely to do this. The author sees a need for a book such as this because "lecture courses usually tend to concentrate ... on the theory rather than examples". This may be so, but a quick perusal of standard and popular mathematics textbooks would tend to suggest that the necessity of providing an adequate number of worked examples is well recognised by most lecturers. What we do not always provide, however, are examples relevant to the interests of our listeners, and the book under review is certainly open to criticism in this regard: despite being aimed at scientists and engineers I failed to find even a token reference to an electrical circuit or to Boyle's Law.

Turning to the content of the book, the chapter headings run from "Functions", "Inequalities", "Limits", through "Partial differentiation", "Matrix algebra", "Ordinary differential equations" to "Contour integration", "Fourier transforms" and "Calculus of variations", and the author's purpose is to cover "most of the topics met in ancillary mathematics courses". As well as the worked examples, the book also contains occasional and brief (very brief) synopses of basic results. Most of the examples in the book are a little harder than the general run of examples encountered in standard texts and a number of them have been taken from examination papers set for courses at Imperial College (London University). The text and solutions are always concise, sometimes indeed too concise: