# CALCULUS, WITH A KEY TO THE SOLUTION OF DIFFERENTIAL EQUATIONS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649571826

Elements of the Integral Calculus, With a Key to the Solution of Differential Equations by William Elwood Byerly

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd. Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

www.triestepublishing.com

# WILLIAM ELWOOD BYERLY

# CALCULUS, WITH A KEY TO THE SOLUTION OF DIFFERENTIAL EQUATIONS



# ELEMENTS

 $\overline{\phantom{a}}$ 

OF THE

# INTEGRAL CALCULUS,

WITH A

KEY TO THE SOLUTION OF DIFFERENTIAL EQUATIONS.

BY

WILLIAM ELWOOD BYERLY, Ph.D.,
PROFESSOR OF NATMEMATICS IN HABYARD UNIVERSITY.

BOSTON:
PUBLISHED BY GINN, HEATH, & CO.
1881.

#### PREFACE.

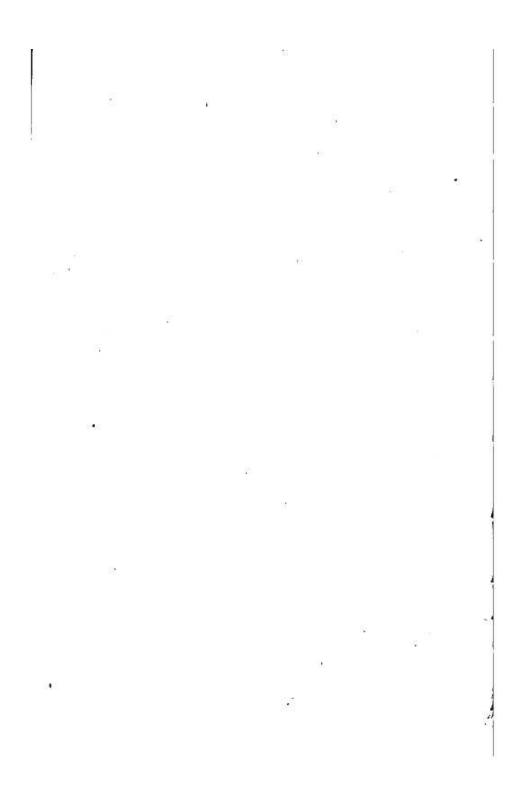
The following volume is a sequel to my treatise on the Differential Calculus, and, like that, is written as a text-book. The last chapter, however, a Key to the Solution of Differential Equations, may prove of service to working mathematicians.

I have used freely the works of Bertrand, Benjamin Peirce, Todhunter, and Boole; and I am much indebted to Professor J. M. Peirce for criticisms and suggestions.

I refer constantly to my work on the Differential Calculus as Volume I.; and for the sake of convenience I have added Chapter V. of that book, which treats of Integration, as an appendix to the present volume.

W. E. BYERLY.

CAMBRIDGE, 1891.



## ANALYTICAL TABLE OF CONTENTS.

### CHAPTER I.

	SYMBOLE OF OPERATION.
Artic	
	Functional symbols regarded as symbols of operation 1
	Compound function; compound operation 1
3.	Commutative or relatively free operations
4.	Distributive or linear operations
5.	The compounds of distributive operations are distributive 2
6.	Symbolic exponents
7.	The law of indices
8.	The interpretation of a zero exponent
9.	The interpretation of a negative exponent
10.	When operations are commutative and distributive, the sym-
	bols which represent them may be combined as if they were
	algebraic quantitles
	CHAPTER II.
	· IMAGINARIES.
11.	Usual definition of an imaginary. Imaginaries first forced upon
	our attention in connection with quadratic equations 5
12.	Treatment of imaginaries purely arbitrary and conventional 6
13.	$\sqrt{-1}$ defined as a symbol of operation
14.	The rules in accordance with which the symbol $\sqrt{-1}$ is used.
(Balli	$\sqrt{-1}$ distributive and commutative with symbols of quantity.
15.	Interpretation of powers of $\sqrt{-1}$ ,
	Imaginary roots of a quadratic
	Typical form of an imaginary
	Geometrical representation of an imaginary. Reals and pure
	imaginaries. An interpretation of the operation $\sqrt{-1}$ 8
19.	The sum, the product, and the quotient of two imaginaries,
320,0	$a+b\sqrt{-1}$ and $c+d\sqrt{-1}$ , are imaginaries of the typical
	form

Artic	ris. Pa	ge.
20.	Second typical form $r(\cos \phi + \sqrt{-1}\sin \phi)$ . Modulus and argu-	
01	ment. Examples	10
21.		
00		11
		12
23.		18
24.		13
25.		14
26.	살 것들은 그렇게 이 가는 것 같아 가장 하는 것을 보는 것이 없었다. 얼마나 이 사람들이 아니는 것을 살아 있다면 보다 하는데 이 사람들이 아니다.	14
27.	·	15
28.	Transcendental functions of an imaginary variable best defined	17
29,	- '프랑프'(1997) (1997) (1997) (1997) - '프로그 프로그램 (1997) (1997) - 프로그램 (1997) - 프로그램 (1997) - 프로그램 (1997) - 프로그램 (1997)	17
00		17 18
30. 31.	Exponential functions of an imaginary. Definition of es where	10
31.		19
32.	[] B. 19 [ 10] [	20
33.	Logarithmic functions of an imaginary. Definition of log z,	eU.
00.	Log s a periodic function. Example	91
34.	Trigonometric functions of an imaginary. Definition of sin s	41
34.		22
35.		••
80.	tal formulas of Trigonometry hold for imaginaries as well as	
	for reals. Examples	99
36.	Differentiation of Functions of Imaginary Variables. The de-	92
	rivative of a function of an imaginary is in general indetermi-	
	nate	94
37.	In differentiating, we may treat the $\sqrt{-1}$ like a constant factor.	H.Z.
357.0	Example. Two forms of the differential of the independent	
		24
38.		25
39.		26
40.	- ''''' '' ''' '' '' '' '' ''' '' ''' '	26
41.		26
42.	Formulas for direct integration (I., Art. 74) hold when z is	
		27
43.		27
44.		28
45.	[P. H.	28
46.	Anti-hyperbolic functions. Examples	28
47.		
48		

#### TABLE OF CONTENTS.

### CHAPTER III.

	GENERAL METHODS OF INTEGRATING.	
Artic		LEGIL.
49.	Integral regarded as the inverse of a differential	32
50.	If $fx$ is any function whatever of $x$ , $fx.dx$ has an integral, and	
2.5	but one, except for the presence of an arbitrary constant	32
51.	A definite integral contains no arbitrary constant, and is a func- tion of the values between which the sum is taken. Exam-	
	ples	
	Definite integral of a discontinuous function	
	Formulas for direct integration	
	Integration by substitution. Examples	36
55.	Integration by parts. Examples. Miscellaneous examples in	
	integration	37
	CHAPTER IV.	
	RATIONAL PRACTIONS.	
***	Terrenation of a matical strategic with a training to	
30.	Integration of a rational algebraic polynomial. Rational frac-	
***	tions, proper and improper	40
57.	Every proper rational fraction can be reduced to a sum of sim-	
	pler fractions with constant numerators	40
98.	Determination of the numerators of the partial fractions by indirect methods. Examples	42
59.	Direct determination of the numerators of the partial fractions	
60.	Iilustrative examples	45
	Illustrative example	
	Integration of the partial fractions	
	Treatment of imaginary values which may occur in the partial	OR III
	fractions. Examples	49
	•	
	CHAPTER V.	
	REDUCTION FORMULAS.	
64.	Formulas for raising or lowering the exponents in the form	222
		52
65,	Consideration of special cases. Examples	54

#### CHAPTER VL

	IRRATIONAL FORMS.	
Arti	cie. Pag	çe
	Integration of the form $f(x, \sqrt[4]{a+bx})dx$ . Examples	
67.	Integration of the form $f(x, \sqrt[n]{c + \sqrt[n]{a + bx}})dx$ . Examples 5	7
68.	Integration of the form $f(x, \sqrt{a+bx+ex^2})dx$	7
	Illustrative example. Examples	
70.	Integration of the form $f\left(x, \sqrt[n]{\frac{ax+b}{lx+m}}\right)dx$ . Example 6	1
71.	Application of the Reduction Formulas of Chapter V. to irra-	
	나는 사람들은 아이들 마음을 하는 것이 되었다. 그 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은 사람들은	1
72.	A function rendered irrational through the presence under	
	the radical sign of a polynomial of higher degree than the	
	second cannot ordinarily be integrated. Elliptic Integrals . 6	2
	72	
	CHAPTER VII.	
27	TRANSCENDENTAL FUNCTIONS.	
73.	Use of the method of Integration by Parts. Examples 6	3
		4
75.	Integration of $(\sin^{-1}x)^n dx$ . Examples 6	5
76.	Use of the method of Integration by Substitution 6	B
77.	Integration of $\sin^n x \cos^n x dx$ . Examples 6	7
	CHAPTER VIII.	
	DEFINITE INTEGRALS.	
78.	Computation of a definite integral as the limit of a sum 6	9
	병원들이 병원들이 하면 있었다면 하는데 그리는데 이렇게 하다면 이번을 하지 않아 있다면 하는데 하나 아니라를 하는데 나를 하고 않아 나를 하나 없다면 하는데 되어 되었다. 그 그 사람이 되는 그 사람이 없는데 그리는데 그리는데 그리는데 그리는데 그리는데 그리는데 그리는데 그리	0
	Usual method of obtaining the value of a definite integral.	
	Examples	0
81.	Application of reduction formulas to definite integrals. Ex-	1
82.	그래에는 계속식하게 되고 하지 않는 경식하지만 그런데 되는 그런 레르막은 하이지는 하지만 그 이번에 가를 내려 하지 않는다.	3
	The principal value of the definite integral of a discontinuous	_
(454)	THE STATES OF THE PROPERTY OF	4
84.	Differentiation and integration of a definite integral when the	73