DOCUMENT RESUME

ED 291 607 SE 048 945

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TITLE Multivariate Limits and Continuity: A Survey of Calculus Textbooks.
PUB DATE 9 Feb 88
NOTE 26p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Calculus; *College Mathematics; Functions (Mathematics); Higher Education; *Mathematical Concepts; *Mathematics Curriculum; Mathematics Education; *Textbook Content; Textbook Evaluation; Textbook Research; Textbooks
IDENTIFIERS Mathematics Education Research

ABSTRACT

There has been much recent discussion concerning the content of the standard calculus course for students majoring in mathematics and the sciences. Some of this discussion has focused on the available textbooks. One weakness noted in some of these books involves the definitions of limit and continuity for functions of several variables. A surprising number of the textbooks include exercises or examples which are incorrectly handled within the context of the definitions given. These subjects are surveyed in both current and past textbooks and presented in graphical and tabular form. Some alternatives are suggested. [Appended is a nine-page "Calculus Textbook Data Table" and 229 references.] (Author/PK)

Multivariate Limits and Continuity: A Survey of Calculus Textbooks

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9 February 1988

Abstract. There has been much recent discussion concerning the content of the standard calculus course for students majoring in mathematics and the sciences. Some of this discussion has focused on the available textbooks. One weakness in some of these books involves the definitions of *limit* and *continuity* for functions of several variables. A surprising number of the textbooks include exercises or examples which are incorrectly handled within the context of the definitions given. These subjects will be surveyed in both current and past textbooks and presented in graphical and tabular form. Some alternatives will be suggested.

INTRODUCTION

A number of authors have recently considered the content of the standard calculus course for science majors [8] [19] [140] [159] [167] [187] [225]. For a thought-provoking general discussion of calculus textbooks, see Ungar's review [225].

An interesting oversight that exists in many calculus textbooks was recently brought to our attention when a student asked a question in class. His question concerned an assigned homework exercise involving limits of functions of several variables. The exercise was to evaluate

$$\lim_{(x,y)\to(0,0)} \frac{e^y \sin x}{x}.$$

The student wondered how to arrive at 1, the answer given in the back of the textbook [215]. The definition of *limit* as stated in that textbook is given below:

> The *limit* of f as p approaches p_0 is L if for each $\epsilon > 0$ there exists $\delta > 0$ such that $|f(p) - f(p_0)| < \epsilon$ whenever $0 < |p - p_0| < \delta$.

Notice that this definition requires that f be defined on a deleted neighborhood (open) of the point p_0.

In this particular textbook, nearly half of the homework exercises illustrating limits involve functions which fail to exist throughout a deleted neighborhood of p_0 even though, according to the definition, these functions must be defined on just such a neighborhood. In the homework

exercise given above, the function is not defined for any points on the line $x = 0$. Consequently, each deleted neighborhood of $(0,0)$ contains points where f fails to exist, and thus the limit does not exist.

Browsing through other calculus textbooks on our shelves revealed a surprising number of inconsistencies between the definition of *limit* and the related examples and homework exercises. Similar difficulties involved the concept of ***continuity.***

This prompted us to survey the libraries of several colleges and universities by examining the calculus textbooks intended for science majors and treating functions of several variables in any form. As our review of these 222 books proceeded, we observed a rich variety in the definitions given for the terms *limit* and ***continuity.*** In addition, there is a concomitant variety in the types of examples and homework exercises given to illustrate the various definitions.

In order to present the results of this study in both graphical and tabular form, we have elected to categorize the various textbooks according to the definitions, examples, and homework exercises. In a few cases where the data would not precisely fit into any of the categories, we selected what seemed to be the closest category. We shall now proceed with the analysis of the definitions.

Definitions of Limits and Continuity

It is always a challenge to satisfy simultaneously the two notions of simplicity and completeness. At one extreme, some authors have chosen not to give any definitions of *limit* or ***continuity.*** Others may merely describe one or the other of these concepts in an informal paragraph. On the other hand, many authors attempt greater levels of rigor by using the standard epsilon-delta or the equivalent neighborhood approach.

We begin with the classifications of the textbooks according to the definitions of *limit.* The various category symbols will be used in Figures 1 and 2 and the Calculus Textbook Data Table.

N. No definition is given in these books. In some cases the concept is still used.

I. Limits are described only in an informal paragraph. These books will be grouped into what we will call class **I** (informal).

FA. These books contain an informal presentation in the main body of the text together with a formal definition given in an appendix. This group will be referred to as class **FA** (formal-appendix).

C. Limits in these books are defined in terms of continuity. We shall refer to this group as class **C** (continuity).

F. In these textbooks, the definition is given formally in terms of epsilon and delta or in terms of neighborhoods. For example, "The limit of $f(p)$ as p approaches p_0 is L if given $\epsilon > 0$ there exists $\delta > 0$ where $0 < |p - p_0| < \delta$ implies that $|f(p) - L| < \epsilon$." The definitions used in these books require that f be defined on a deleted neighborhood of p_0. These books form class **F** (formal).

GF. The formal definition is expanded to include functions not defined on a deleted neighborhood of p_0. For example, "The limit of $f(p)$ as p approaches p_0 is L if:

a. for each $\delta > 0$ there exists some point p in the domain of f satisfying $0 < |p - p_0| < \delta$, and

b. given $\epsilon > 0$ there exists $\delta > 0$ where $0 < |p - p_0| < \delta$ and p contained in the domain of f implies that $|f(p) - L| < \epsilon$."

These definitions are more complicated than those found in class **F** books, but they do accommodate more interesting examples. In particular, note that p_0 need only be an accumulation point of the domain of f. We shall call this group of books class **GF** (generalized-formal).

X. The definition is similar to those found in **GF** textbooks but p_0 is allowed to be an isolated point. A typical definition is "the limit of $f(p)$ as p approaches p_0 is L if given $\epsilon > 0$ there exists $\delta > 0$ where $0 < |p - p_0| < \delta$ and p contained in the domain of f imply that $|f(p) - L| < \epsilon$." In this case, f is allowed to exhibit the rather bizarre behavior of having any value as a limit when p is an isolated point in the domain of f. These shall be grouped into class **X**.

Only slight modifications are required to classify the books according to the definitions of *continuity*. One new class is introduced.

N. No definition is given. In some cases the concept is still used.

I. Continuity is described informally in a paragraph.

L. Continuity is defined in terms of a limit.

F. A formal definition is given in terms of epsilon and delta or neighborhoods. The function f must be defined on a neighborhood of p_0 if it is to be continuous at p_0.

GF. These books contain generalized definitions which do not require f to be defined on a neighborhood of p_0. However, p_0 must be contained in and be an accumulation point of the domain of f.

X. The point p_0 could be an isolated point of the domain of f.

Examples and Homework Exercises Involving Limits

We shall now categorize the textbooks according to the examples and homework exercises illustrating limits:

S. These books contain only examples and homework exercises which are the most straightforward. The functions are all defined on a deleted neighborhood of p_0. A typical problem is to show that

$$\lim_{(x,y)\to(1,2)} x^2 + y = 3$$

or that

$$\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$$

does not exist. In the second case, the expected method of solution is to show that the limiting values of the function are different along different paths approaching p_0. We shall call this group of books class **S** (safe).

+. In these class **GF** or **X** books, at least one example or homework exercise involves a function which fails to exist on a curve containing p_0. A typical example is to find

$$\lim_{(x,y)\to(1,1)} \frac{xy^2 - x}{y - 1}.$$

Since these books contain generalized definitions which allow such limits to be investigated, there is no inconsistency. This group will be called class **+**.

?. These books contain at least one example or homework exercise similar to those in the last category except that the expected solutions to the homework exercises are uncertain, and the books are of not class **GF** or **X**. The exercises do not have answers given in the text. In the case of the examples, at least one is misleading (e.g. it may be stated that a limit does not exist since the limiting values are calculated to be different on different paths while no mention is made of the fact the function is not even defined on some paths approaching p_0,. We refer to these as class **?**.

−. In this class of books, at least one example or homework exercise involves a function which fails to exist on a curve containing p_0 and the books are not of class **GF** or **X**. In addition, a solution is offered for the example or for the homework exercise which is incorrect (e.g. a value is given for a limit when that limit is not

defined in the textbook). This group of books will be called class −.

N. No examples or homework exercises are given.

EXAMPLES AND HOMEWORK EXERCISES INVOLVING CONTINUITY

The classifications of textbooks by examples and homework exercises given above need only minor modification when made according to *continuity* rather than *limit.*

S. All examples and homework exercises involve functions defined on a neighborhood of p_0.

+. Some of the examples or homework exercises involve functions not defined on a neighborhood of p_0. These textbooks have generalized definitions which allow continuity at points on the boundary of the domain of the function.

?. Again, some of the examples or homework exercises involve functions not defined on a neighborhood of p_0. However, in order for a function f to be continuous at p_0, these textbooks require that f be defined on a neighborhood of p_0. Consequently, none of these functions are continuous at p_0. In the case of a homework exercise, no solution is given, and there is some uncertainty concerning the expected solution. In the case of textbook examples, the solution given is misleading. The functions illustrated are not continuous at p_0, and this fact is typically shown by considering two paths of approach with two different limiting values, while no mention is made of the fact that f is not defined on a neighborhood of p_0.

−. These books contain definitions and examples or homework exercises similar to those in class ? books. Unfortunately, some of the solutions given in the answer section or examples are incorrect (e.g. a function is said to be continuous at a point even though, according to the definition given in the text, it is not).

N. No examples or homework exercises are given.

TRENDS

Most of the textbooks published before 1950 do not contain any definition of *limit* (see Figure 1). In many cases the authors of these books assume that the student has an intuitive grasp of limits and proceed to define *continuity* in terms of a limit. Most textbooks published in this period contain no examples or homework exercises treating limits

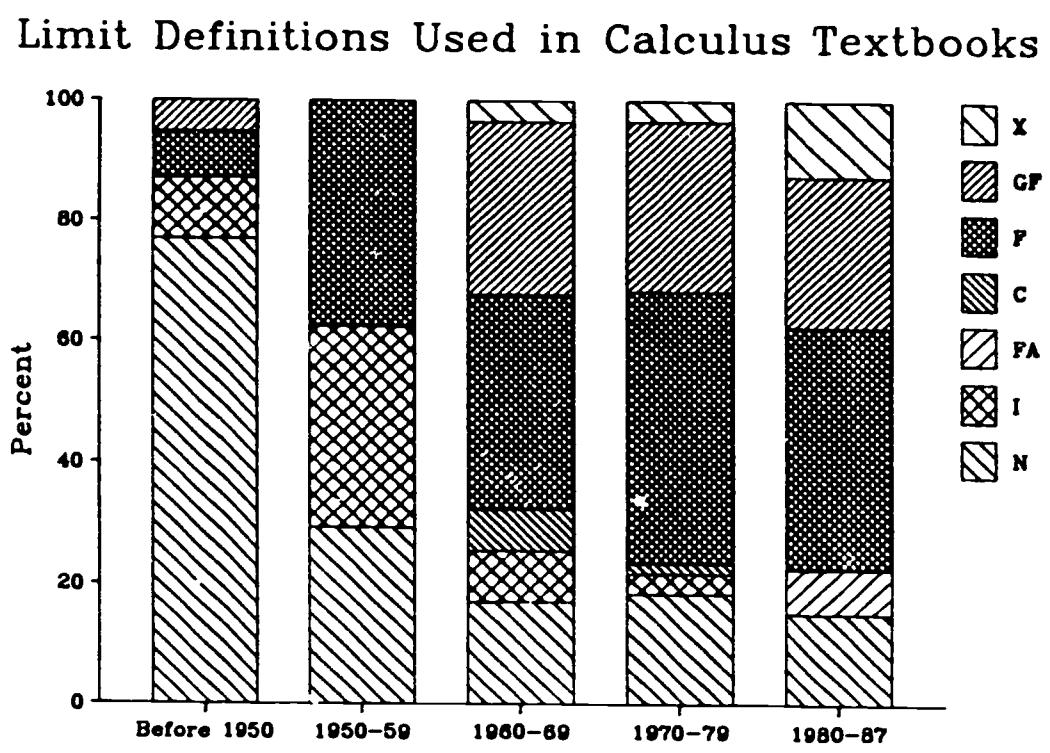

Figure 1

or continuity but rather move rapidly into partial differentiation. Consequently, we found almost no inconsistencies between the definitions and the examples or homework exercises.

Since 1950, increasing attention has been given to limits and continuity. Over 78% of the surveyed calculus textbooks published in the 1970's contained a formal definition of the limit (**C**, **F**, **GF**, or **X**). For the books published during the 1980's, this figure drops to slightly under 78%; however, during this period, some authors elected to treat limits intuitively in the main body of the text and to move the formal definition to an appendix. Formal definitions were found in the appendices of an additional 7.5% of these books.

As the degree of rigor in the definitions increased, more examples and homework exercises were added to the books, and the number of inconsistencies between the definitions and the examples and homework exercises increased as well. While almost no inconsistencies were found prior to 1950, about 22% of the surveyed texts published in the 1970's contained incorrect or misleading examples or homework exercises. For books published in the 1980's, this figure rises to over 37% (see Figure 2).

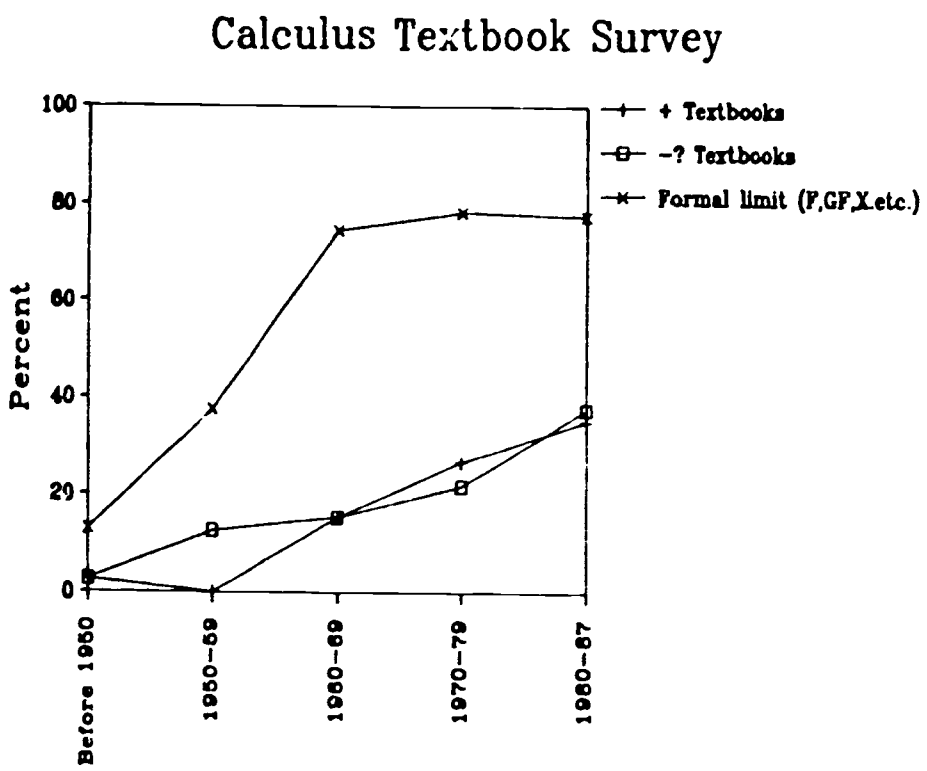

Figure 2

CONCLUSION

Many authors have grappled with the problem of finding the ideal mixture of clarity and generality in the definitions of limit and continuity. Most current textbooks fall into class **F** for limit definitions, class **L** for continuity definitions, and class **S** for examples and homework exercises. Many other current textbooks are of the same classes for the definitions, but move into class **−** for the examples and homework exercises. We feel that this combination places an unreasonable burden on the student, and we suspect that in some cases the authors who use this combination are unaware of the inconsistencies.

Careful authors who wish to give a general definition often use a definition placing the book in class **GF** with more challenging examples or exercises which place the book in the **+** class. This combination includes a definition that is perhaps more difficult for the average student to master, but it also includes very interesting examples and homework exercises for the more capable student.

It appears to us that the best approach for authors who favor an intuitive presentation is to place a formal definition in an appendix and limit both the examples and homework exercises to the straightforward type found in class **S** books.

For a more formal approach, we prefer a book in with an **F**-type definition in the main body of the text coupled with a **GF**-type definition given as a footnote or in an appendix. Most of the exercises should be of the most straightforward type such as those in class **S** books, with perhaps one or two of the more challenging type found in class **+** books. These more demanding exercises should include an indication that they are more difficult and require the extended definition. This combination has the brevity and clarity needed by the average student while at the same time providing more involved exercises for the motivated student.

If the limit concept is presented as suggested above, the idea of continuity is easily handled in terms of limits.

CALCULUS TEXTBOOK DATA TABLE

Column Heading Symbols:

L = Type of limit definition
E = Type of limit examples
H = Type of limit homework exercises
C = Type of continuity definition

Please note that the second **E** and **H** refer to continuity.

Books Published Before 1950 (Sample Size = 39)

Author	Title	Yr	pp.	L	E	H	C	E	H
Bacon	Diff & Int C	42	778	F	N	N	L	N	N
Carmichael & Weaver	The C	27	359	N	N	N	L	N	N
Carmichael, Weaver, & Lopaz	The C, Rev ed	37	400	N	N	N	L	N	N
Caunt	Intro to Inf C	14	588	N	N	N	L	N	N
Cohen	Diff & Int C	25	527	N	N	N	L	N	N
Courant	Diff & Int C, v II	36	672	GF	N	N	GF	S	+
Douglass & Zeldin	C & Its Appl	47	576	N	N	N	L	S	N
Dresden	Intro to the C	40	440	N	N	N	F	N	N
Fine	C	27	459	N	N	N	I	S	N
Gibson	Ele Treat on C	06	549	N	N	N	L	N	N
Granville	Elts of Diff & Int C	04	477	N	N	N	L	N	N
Granville	E of Diff & Int C, Rev	11	478	N	N	N	L	N	N
Granville, Smith, & Longley	Elts of the Diff & Int C	29	527	N	N	N	L	N	N
Granville, Smith, & Longley	Elts of the Diff & Int C, New	34	527	N	N	N	L	N	N
Granville, Smith, & Longley	Elts of the Diff & Int C, Rev	41	567	N	N	N	L	N	N
Granville, Smith, & Longley	Elts of C	46	560	N	N	N	L	N	N
Hulburt	Diff & Int C	12	499	N	N	N	L	N	N

Books Published Before 1950 Cont.									
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Kells	C	43	518	N	N	N	F	N	N
Kells	C, 2nd	49	520	N	N	N	F	N	N
Love	Diff & Int C, Rev	25	386	I	N	N	L	N	N
Love	Diff & Int C, 3rd	34	398	I	N	N	L	N	N
Middlemiss	Diff & Int C	40	426	N	N	N	F	N	N
Middlemiss	Diff & Int C, 2nd	46	505	N	N	N	I	N	N
Miller	C, 2nd	46	432	N	N	N	L	N	N
Morris & Brown	AG & C	37		N	N	S	L	S	S
Murray	Course in Inf C, New	05	456	N	N	N	I	N	N
Nelson, Folley, & Bergman	C	42	366	I	N	N	L	N	N
Osgood	Diff & Int C, Rev	19	477	F	N	N	L	N	N
Phillips	Diff C	16	167	N	N	N	I	N	N
Phillips	AG & C	42	540	N	N	N	F	N	S
Phillips	AG & C, 2nd	46	517	N	N	N	F	N	S
Randolph & Kac	AG & C	46	651	F	?	?	L	N	S
Robbins & Little	C	40	406	N	N	N	I	N	N
Sherwood & Taylor	C	42	517	GF	S	N	L	S	N
Smail	C	49	605	I	N	N	L	N	N
Smith, Salkover, & Justice	C	38	570	N	N	N	L	N	N
Smith, Salkover, & Justice	Unified C	47	544	N	N	N	L	N	N
Snyder & Hutchinson	Diff & Int C	02	327	N	N	N	L	S	N
Townsend & Goodenough	Essentials of C	10	367	N	N	N	L	N	N
Books Published 1950-1959							(Sample Size = 24)		
Ayres	Schaum's O of C	50	232	I	N	N	L	S	N
Bacon	Diff & Int C, 2nd	55	554	F	N	N	L	N	N
Britton	C	56	598	I	–	S	L	S	S

Books Published 1950-1959 Cont.									
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Ferrar	Diff C	56	306	N	N	N	F	S	N
Fort	C	51	572	F	S	N	L	N	N
Franklin	Diff & Int C	53	652	N	N	N	L	N	N
Granville, Smith, & Longley	Elts of the Diff & Int C, New Rev ed	57	567	N	N	N	L	N	N
Hart	C	55	638	F	N	S	L	S	N
Holmes	C & AG	50	426	I	S	?	L	N	N
Johnson & Kiokemeister	C	59	646	F	N	S	L	N	S
Landau	Diff & Int C	50	366	N	N	N	F	S	N
Leighton	C	58	383	I	N	N	L	N	S
Love & Rainville	Diff & Int C, 5th	54	540	I	N	N	L	N	N
Maxwell	An Analy C, v III	54	201	N	N	N	F	S	S
Menger	C — A Mod Appro	55	371	F	N	N	L	N	N
Morrill	C	56	547	F	S	S	L	S	S
Peterson	Elts of C	50	377	N	N	N	L	S	N
Randolph	C	52	493	F	?	?	L	N	S
Sherwood & Taylor	C, 3rd	54	594	I	S	S	L	N	N
Smail	AG & C	53	728	I	N	N	L	N	N
Sprague	C	52	587	F	N	N	L	N	N
Taylor	C w/ AG	59	777	I	S	N	L	S	N
Thomas	C & AG, 2nd	53	833	N	N	N	I	S	S
Wylie	C	53	575	F	S	N	L	S	S
Books Published 1960-1969							(Sample Size = 59)		
Adams & White	AG & C	61	942	F	N	N	L	N	N
Adams & White	AG & C, 2nd	68	988	F	N	N	L	N	N
Agnew	C: AG & C	62	750	F	N	N	L	N	N
Apostle	C, vol II	62	540	GF	N	S	GF	S	+
Apostol	C, vol II, 2nd	69	694	F	N	S	L	S	–
Ayres	Schaum's O of C, 2nd	64	345	F	N	N	L	–	S
Bartle & Tulcea	C	68	736	GF	S	S	L	S	S

Books Published 1960-1969, Cont.									
Author	Title	Yr	pp.	L	E	H	C	E	H
Bell, Blum, Lewis. & Rosenblatt	Mod Univ C w/ Coord G	66	924	GF	N	N	GF	N	S
Bers	C	69	1049	C	S	N	X	S	+
Blum, Bell, Lewis, & Rosenblatt	Mod C Part 2, Prelim ed	65	700	GF	N	N	GF	N	S
Brady & Mansfield	C	60	465	F	S	?	L	S	S
Britton, Kriegh, & Rutland	C & AG	66	1082	F	S	S	L	S	S
Burdette	Intro to AG &C	68	424	N	N	N	F	N	N
Erwe	Diff & Int C	64	504	C	N	N	X	S	N
Fobes & Smyth	C & AG, vol 2	63	461	X	N	N	X	S	+
Ford & Ford	C	63	468	N	N	N	X	+	N
Freidman	Intrinsic C, vol 1	62	334	N	N	N	X	S	N
Fuller & Parker	AG & C	64	631	F	S	N	L	S	S
Goodman	AG & the C	63	778	N	N	N	F	S	N
Goodman	Mod C w/ AG, v II	68	464	GF	S	+	X	S	+
Granville, Smith, & Longley	Elts of the Diff & Int C, New Rev ed	62	567	N	N	N	L	N	N
Johnson & Kiokemeister	C w/ AG, 2nd	60	722	F	N	S	L	N	S
Johnson & Kiokemeister	C w/ AG, 3rd	64	810	C	N	N	F	S	?
Johnson & Kiokemeister	C w/ AG, 4th	69	969	C	N	N	F	S	?
Kline	C: An Intuit Appro	67	427	I	N	N	L	S	S
Lang	A Sec Cour in C	64	254	GF	N	N	L	N	N
Lang	A Comp Cour in C	68	677	GF	N	N	L	N	N
Lang	A Sec Cour in C, 2nd	68	334	GF	N	N	L	N	N
Leithold	The C w/ AG	68	992	GF	S	+	L	S	+

Books Published 1960-1969 Cont.									
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Lightstone	Concepts of C, v II	66	512	GF	S	S	L	N	S
Love & Rainville	Diff & Int C, 6th	62	596	I	N	N	L	N	N
Mainardi & Barkan	C & Its Appl	63	542	N	N	N	L	N	N
Moise	C	67	803	F	N	S	L	S	S
Morrey	Univ C w/AG	62	768	F	N	N	L	N	N
Munroe	Mod Multi-dim C	63	400	F	S	S	L	S	S
Olmsted	C w/ AG, vol II	66	669	GF	S	S	X	S	S
Ostrowski	Diff & Int C	68	639	N	N	N	F	N	N
Pease & Wadsworth	C w/ AG	69	1084	I	N	N	L	S	N
Protter & Morey	Coll C w/ AG	64	911	F	N	N	L	N	N
Protter & Morey	Mod Math Analy & AG	64	800	F	N	N	L	N	N
Protter & Morey	C for Coll Stud	67	730	F	N	N	L	N	N
Purcell	C w/ AG	65	858	GF	S	+	L	S	S
Randolph	C & AG, 2nd	65	637	GF	+	+	L	S	S
Rees & Sparks	Calc w/AG	69	629	I	N	N	F	N	N
Schwartz	AG & C	69	875	F	S	S	L	S	S
Schwartz	C & AG, 2nd	67	1022	F	S	S	L	S	S
Silverman	Mod C & AG	69	1049	F	?	–	L	S	S
Smirnov	Higher M, v I, C	64	556	I	S	N	L	N	N
Smith	C w/ AG	69	926	F	S	S	L	N	N
Stein	C in the Fir 3 Dim	67	627	GF	N	N	L	N	N
Taylor & Wade	University C	62	786	GF	S	S	L	N	N
Thomas	C & AG, 3rd	60	1022	N	N	N	I	S	?
Thomas	C, 2nd	61	863	N	N	N	I	S	?
Thomas	C & AG, 4th	68	830	N	N	N	I	S	?
Thurston	C for Eng & Sci, v 2	63	208	F	N	S	L	N	N
Tierney	C & AG	68	654	GF	S	+	X	S	S
Toralballa	C w/ AG & Lin Alg	67	935	GF	N	N	X	N	N
Wilf	C & Lin Alg	66	422	F	S	N	L	N	S
Youse	C w/ AG	68	425	X	N	N	L	S	N

Books Published 1970-1979									(Sample Size = 60)
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Bartle & Tulcea	Honors C	70	900	GF	S	S	L	S	S
Buck & Wilcox	C of Sev Var	71	343	C	N	N	X	S	+
Chover	The Green Bk of C	72	761	F	N	N	L	N	N
Clarke	C & AG	74	942	GF	S	+	L	S	+
Courant & John	Intro to C & Analy, v II	74	977	GF	+	+	GF	+	+
Curtis	Multivar C	72	436	F	N	N	L	S	S
Fisher & Ziebur	C & AG, 3rd	75	830	F	N	N	L	S	?
Flanders & Price	C w/ AG	78	1055	N	N	N	X	S	S
Flanders, Korfhage, & Price	C	70	986	N	N	N	I	N	N
Flanders, Korfhage, & Price	A 2nd Course in C	74	699	N	N	N	X	S	S
Flanigan & Kazdan	C Two: Lin & Non-Lin Fcns	71	458	I	N	S	X	S	S
Fraleigh	C: A Lin Appro. v I	71	670	GF	S	+	X	N	N
Gillman & McDowell	C	73	674	F	N	N	GF	S	N
Gillman & McDowell	C, 2nd	78	913	F	N	N	L	N	N
Goffman	The C: An Intro	71	437	F	N	–	L	S	S
Goodman	AG & the C, 3rd	74	1052	F	S	?	L	S	S
Greenspan & Benney	C: An Intro to Appl Math	73	795	N	N	N	F	S	S
Grossman	C	77	1158	F	S	–	L	S	–
Hocking	C w/ Lin Alg	70	882	GF	S	+	L	S	+
Johnson, Kiokemeister, & Wolk	J & K's C w/ AG, 5th	74	849	F	S	–	X	S	+
Johnson, Kiokemeister, & Wolk	C w/ AG, 6th	78	781	F	S	–	X	S	+

Books Published 1970-1979 Cont.									
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Kaplan & Lewis	C & Lin Alg, Vol II	71	581	F	N	S	F	S	S
Keisler	Ele C	76	969	N	N	N	F	S	S
Kline	C, 2nd	77	959	I	N	N	L	S	S
Kolman & Trench	Ele Multivar C	71	510	GF	+	+	X	+	+
Lang	C of Sev Var	73	384	N	N	N	I	N	N
Leithold	The C w/ AG, 2nd	72	1080	GF	S	+	L	S	+
Leithold	The C w/ AG, 3rd	76	1118	GF	S	+	L	S	+
Loomis	C	74	1038	N	N	N	I	N	N
Lynch, Ostberg, & Kuller	C w/ Comput Appl	73	975	X	N	S	F	S	S
McAloon & Tromba	C, v I BCD	72		F	S	–	F	S	S
Moise	C, 2nd	72	777	F	N	S	L	N	S
Munem & Foulis	C w/ AG, 2nd	78	1015	F	S	?	L	S	S
Munroe	C	70	772	F	S	S	L	S	S
Osserman	Two-Dim C	77	473	F	N	S	L	S	S
Protter & Morrey	College C w/ AG, 2nd	70	1068	F	N	S	L	N	S
Protter & Morrey	C w/ AG, a 2nd Course	71	680	F	N	S	L	N	S
Protter & Morey	C for Coll Stud, 2nd	73	947	F	N	S	L	N	S
Protter & Morrey	College C w/ AG, 3rd	77	858	F	N	S	L	N	S
Riddle	C & AG, 2nd	74	854	GF	S	S	X	N	N
Rodin	C w/ AG	70	751	GF	N	N	L	S	N
Salas & Hille	C: One & Sev Var	71	811	GF	N	N	L	S	N
Salas & Hille	C: One & Sev Var, 2nd	74	909	GF	N	N	L	S	N
Salas & Hille	C: One & Sev Var, 3rd	78	962	F	N	N	L	S	N
Schwartz	C & AG, 3rd	74	1155	F	S	S	L	S	S
Seeley	C of Sev Var	70	295	F	S	S	F	S	S
Seeley	C of One & Sev Var	73	1030	F	S	S	F	S	S

Books Published 1970-1979 Cont.									
Author	**Title**	**Yr**	**pp.**	**L**	**E**	**H**	**C**	**E**	**H**
Shapiro & Whitney	Elements of C	70	285	X	S	S	L	N	N
Shenk	C & AG	77	90?	F	S	–	L	N	N
Shenk	C & AG, 2nd	79	1021	GF	S	+	L	N	N
Simon	C	67	639	F	N	–	X	S	+
Stein	C & AG	73	1078	N	N	N	I	N	N
Stein	C & AG, 2nd	77	1008	N	N	N	I	N	N
Swokowski	C w/ AG	75	864	F	S	–	L	N	?
Swokowski	C w/ AG, 2nd	79	1101	GF	S	+	L	N	S
Thomas	C & AG, Alt	72	1048	N	N	N	I	S	?
Thomas & Finney	C & AG, 5th	79	975	N	N	–	L	S	?
Tierney	C & AG, 2nd	72	703	GF	+	+	X	S	S
Tierney	C & AG, 3rd	75	733	GF	S	+	X	S	S
Trench & Kolman	Multivar C w/ Lin Alg & Series	72	769	GF	+	+	L	S	+
Books Published From 1980							(Sample Size = 40)		
Anton	C w/ AG	80	1245	F	S	–	L	S	?
Anton	C w/ AG, 2nd	84	1262	F	S	S	L	S	S
Corwin & Szczarba	Multivar C	82	535	N	N	N	X	S	S
Edwards & Penney	C & AG	82	911	GF	S	+	L	N	S
Edwards & Penney	C & AG, 2nd	86	1099	GF	S	+	L	S	S
Ellis & Gulick	C w/ AG, 2nd	82	1039	GF	S	+	L	S	+
Ellis & Gulick	C w/ AG, 3rd	86	1071	GF	S	+	L	S	+
Fraleigh	C w/ AG	80	878	N	N	N	F	N	N
Gillett	C & AG	81	919	N	N	N	L	S	N
Gillett	C & AG, 2nd	84	988	N	N	N	L	S	N
Goodman & Saff	C: Concepts & Calculations	81	1047	FA	S	?	L	S	N
Grossman	C, 2nd	81	1167	F	S	–	L	S	S
Grossman	C 3rd	84	1359	F	S	--	L	S	S
Lang	A 1st Cour in C, 5th	86	741	N	N	N	L	N	N

Books Published From 1980 Cont.									
Author	Title	Yr	pp.	L	E	H	C	E	H
Larson & Hostetler	C w/ AG	82	1000	F	S	–	L	S	S
Larson & Hostetler	C w/ AG, 3rd	86	1206	F	S	–	L	S	S
Larson & Hostetler	C w/ AG, Alt 3rd	86	1220	F	S	–	L	S	S
Leithold	C w/ AG, 4th, Pt II	81	1185	GF	–	+	L	S	+
Leithold	The C w/ AG, 5th	86	1408	GF	S	S	L	S	S
Marsden & Weinstein	C	80	1039	F	–	–	L	N	N
Marsden & Weinstein	C III, 2nd	85	355	F	S	S	L	S	N
Mizrahi & Sullivan	C & AG	82	1132	GF	S	+	L	S	+
Mizrahi & Sullivan	C & AG, 2nd	86	1223	F	S	–	L	S	?
Munem & Foulis	C w/ AG, 2nd	84	1118	F	S	–	L	S	S
Protter & Morey	Intermed C, 2nd	85	658	F	N	S	L	N	S
Purcell & Varberg	C w/ AG, 4th	84	878	F	S	?	GF	+	S
Riddle	C & AG, Alt	84	1130	GF	S	S	X	N	N
Salas, Hille, & Anderson	C: One & Sev Var w/ AG, 5th	86	1244	F	S	?	L	S	N
Shenk	C & AG, 3rd	84	1287	GF	+	+	L	N	N
Shockley	C & AG	82	1211	GF	S	+	L	S	+
Silverman	C w/ AG	85	1071	X	S	+	L	S	+
Simmons	C w/ AG	85	971	N	N	N	I	S	S
Stein	C & AG, 3rd	82	1227	FA	N	N	L	N	N
Stein	C & AG, 4th	87	1081	FA	N	N	L	N	N
Stewart	C	87	1113	X	S	+	L	S	+
Swokowski	C w/ AG, Alt	83	1007	X	S	+	L	S	S
Swokowski	C w/ AG, 3rd	84	1008	X	S	+	L	S	S
Thomas & Finney	C & AG, 6th	84	1164	F	S	–	L	S	S
Trim	C & AG	83	942	X	+	+	L	S	+
Zill	C w/ AG	85	1007	F	–	–	L	S	–

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