

25th ANNUAL AMS SURVEY, 1981

Second Report

**Employment of Mathematical Sciences Doctorates,
Faculty Mobility, Nonacademic Employment,
and Enrollments, Fall 1981**

by Donald C. Rung

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Second Report

A first report of the 1981 Survey appeared in the November 1981 *Notices*, pages 608-634. It included a report of the survey of faculty salaries, a first report of the survey of new 1980-1981 doctorates, and a report on academic salaries over the past two decades. This second report includes an update of the fall 1981 employment status of new doctorates, an analysis of faculty mobility, and a report on fall 1981 enrollments and class sizes.

The 25th Annual AMS Survey was made under the direction of the Society's Committee on Employment and Educational Policy (CEEP), whose members in 1980 were Lida K. Barrett (chairman), Donald C. Rung, Hans Schneider, Robert J. Thompson, Barnet M. Weinstock and William P. Ziemer. A Data Subcommittee of CEEP, consisting of Lida K. Barrett, Susan J. Devlin (consultant), Lincoln K. Durst, Wendell H. Fleming, Arthur P. Mattuck and Donald C. Rung (chairman), designed the questionnaires with which the data were collected. The committee is grateful to members of the AMS staff, especially Marcia C. Almeida and Peggy Reynolds, for the diligence and efficiency with which the data were collected and compiled. Comments or suggestions regarding this program may be directed to the subcommittee.

Employment of Mathematical Sciences Doctorates, Faculty Mobility, Nonacademic Employment and Enrollments, Fall 1981

by Donald C. Rung

This report is one in a series of annual reports on employment patterns, enrollment and class size in the mathematical sciences. It begins with an update of the fall 1981 employment status of new 1980-1981 doctorates, followed by an analysis of trends in the academic job market based upon the 1981 AMS Survey of faculty mobility. Finally it compares 1980 and 1981 fall enrollment and class size for various levels of courses in the mathematical sciences.

An article in this issue of the *Notices* summarizes the major findings of the new survey by the Conference Board of the Mathematical Sciences (CBMS). This is a comprehensive analysis of the mathematical sciences for 1975 to 1980 and compares the findings of the latest report with previous CBMS surveys. The CBMS survey agrees for the most part with the trends reported in the Annual AMS Survey reports, but has a much wider scope, uses more systematic statistical techniques and, of course, covers a span of five years.

This year's AMS Survey is noteworthy in at least one statistic. For the first time in many years, no 1980-1981 doctorate has been reported as still seeking employment. This confirms recent trends which indicate that the demand for new doctorates, mostly in the Group M and B departments, exceeds the supply. (See the box for descriptions of the groups.)

Estimates based on AMS Survey data suggest that over 700 full-time positions in U. S. colleges and universities were filled by nondoctorates last fall and that, for about half of these positions, the department would have preferred someone with a doctorate. About 85% of these positions were in Groups M and B schools. Of course this number does not represent an annual demand for new doctorates but indicates that at this time colleges cannot find enough mathematicians with doctorates to fill faculty positions. This demand is also seen in Table 2 which shows that the number

In this article departments in mathematical sciences in U.S. and Canadian universities and four-year colleges are classified as below. The first six groups consist of departments that have doctoral programs, of which Groups I-V are U.S. departments. (The numbers indicate how many departments were queried in the 1981 Survey.)

Group I is composed of the top 27 ACE ranked mathematics departments.

Group II is made up of the other 38 ACE rated mathematics departments.

Group III contains 87 mathematics departments not included in the ACE study.

Group IV includes 64 statistics, biostatistics and biometry departments.

Group V is made up of 137 other mathematical science departments (including 77 in computer science).

Group VI consists of 35 Canadian departments in the mathematical sciences.

Group M contains 369 departments with masters' programs (of which 24 are Canadian departments).

Group B is made up of 1,065 departments which offer at most bachelors' degrees (of which 34 are Canadian departments).

Notes: Group B includes about 100 departments with no degree programs. Both M and B include some departments in universities which have doctoral programs in other areas, in some cases in other areas of the mathematical sciences.

Response rates varied from one group to another, with the largest response rate from Groups I, II, and III. Of an estimated total of about 19,262 full-time U.S. mathematical sciences faculty members, over 9,500 are members of departments which responded to the survey.

For an account of the ACE ratings referred to above see *A Rating of Graduate Programs* by Kenneth D. Roose and Charles J. Andersen, American Council on Education, Washington, D.C., 1970, 115 pp. The information on mathematics was reprinted by the Society and may be found on pages 338-340 of the February 1971 issue of the *Notices*.

of nondoctorate-holding faculty members hired (739) is substantial compared to the number of doctorate-holding faculty members hired (1,366). While the estimated total increase for this year in the size of the full-time faculty (612) was one of the largest in recent years, the increase for Groups I, II and III was only 117 (Table 3). Further the net increase in the nondoctorate faculty (208) is positive for the second consecutive year, after nine consecutive years of decline.

As they have for the last several years, enrollments and class size continue to increase in most categories (Tables 7 and 8), far exceeding the increase in the number of faculty members. Part-time members of the faculty continue to play a significant role in undergraduate instruction. For example, departments in Groups M and B have four part-time members of the faculty (excluding graduate assistants) for every ten full-time members.

The number of graduate students showed the first significant increase in years (6%) with departments in Groups I, II and III showing the same increase. First-year graduate students increased by the same percentage over the previous year. The percentage of new doctorates taking nonacademic employment dropped slightly to 27% from the 1980 figure of 29%

(Table 4). Economic conditions may account for this as well as for the decline from 168 in 1980 to 116 in 1981 in the net outflow of doctorate-holding faculty members to nonacademic employment (Table 6).

Fall 1981 Employment Status of 1980-1981 New Doctorates

Table 1 contains the fall 1981 employment status by type of employer and field of degree for 904 new mathematical sciences doctorates who received the degree between July 1, 1980, and June 30, 1981. The names of these 904 people, and the titles of their doctoral theses, were published in the November 1981 *Notices*, pages 619-634. Table 1 updates the corresponding table on page 613 of the November 1981 *Notices*, using more recent information provided by departments and the recipients of the degrees. The total does not include a few more recipients of doctorates who were reported too late to gather employment information for these reports. (A supplementary list of recipients will appear in the April 1981 *Notices*.)

The first five rows in Table 1 refer to those 1980-1981 new doctorates employed by doctorate-granting departments in the U.S. The next two rows refer to those employed by U.S. mathematical sciences departments which grant masters and bachelors degrees

TABLE 1—1981-1982 EMPLOYMENT STATUS OF NEW DOCTORATES IN THE MATHEMATICAL SCIENCES

Type of Employer	PURE MATHEMATICS						Statistics	Computer Science	Operations Research	Applied Mathematics	Mathematics Education	Other	Total
	Algebra and Number Theory	Analysis and Functional Analysis	Geometry and Topology	Logic	Probability								
Group I	14	16	16	6	1		1			4		2	60
Group II	8	11	17	4	1		4			3		2	50
Group III	8	7	8	2	1		6	5		4	1	7	49
Group IV							28					1	31
Group V				1			4	24	8	7		1	45
Masters	13	21	11	3	2		14	3	3	9	1	5	85
Bachelors	24	18	11	1			8	2		5	1	2	72
Two-year College or High School		2								1	1	3	7
Other Academic Depts.	2	2	1		2		34	9	14	11	1	8	84
Research Institutes	1	3	4				6	1	2	8		1	26
Government	1	3	1		1		12		2	5		3	28
Business and Industry	7	15	7	2	7		48	28	17	30	1	7	169
Canada, Academic	2	3	1				6	6	1	5	1	3	28
Canada, Nonacademic	1	2	2				4	2	1	1			13
Foreign, Academic	17	8	9		4		18	5	2	8	1	2	74
Foreign, Nonacademic	6	10	6				10	2	11	10		2	57
Not seeking employ.					1				2		2		5
Not yet employed													
Unknown	2	2	2	1			5	5	1	3			21
Total	106	123	96	20	22		208	92	64	114	10	49	904

only. There seem to be good job prospects for new doctorates in departments in Groups M and B. It should be noted that the survey of enrollments shows that 50% of all computer science enrollment and 60% of all statistics enrollment reported are in M and B departments; mathematicians prepared to teach these courses will find no lack of opportunity to do so at those schools.

Faculty Mobility

This part of the Annual AMS Survey is concerned with the number of faculty members newly hired from various sources, as well as with the number of those individuals leaving faculty positions and with information on their subsequent employment status. The Survey also monitors trends in the percentage of faculty members with tenure, and the percentage of faculty members with doctoral degrees. The number of departments in each of the Groups, I, II, ..., B responding to the 1981 Survey of faculty mobility are similar to those of previous years. The responding departments represent about half of all mathematical sciences faculty members. More than two-thirds of the faculty members in doctorate-granting mathematics departments (Groups I-III) are included among responding departments.

Table 2 shows estimated faculty flow between 1980-1981 and 1981-1982 for U.S. departments. Further analyses for Groups I-III are given in Table 3. The left side of Table 2 shows the estimated numbers of new full-time faculty members hired from various sources between fall 1980 and fall 1981. The right side of Table 2 shows the fall 1981 employment status of those full-time faculty members (as of fall 1980) who permanently left their departments by fall 1981. The row "graduate school" on the left side includes new faculty members coming from departments outside the mathematical sciences, or from mathematics education.

Similarly, the second row in Table 2 includes some moving to or from departments in other fields or other positions in academia (e.g., in a university computer or statistical laboratory). The number (+74) in parentheses represents a flow from nondoctorate to doctorate status of individuals who remained as full-time faculty members in the same department.

The numbers in Tables 2 and 3 were obtained by extrapolating from AMS Survey data, and are not actual counts. The various totals of the responses from each group were adjusted according to the fraction of the total faculty reported within each group, as given in a previous article in this series (February 1979 *Notices*, page 108). Nevertheless, Tables 2 and 3 are believed to give a fairly reliable overall picture of current faculty mobility.

Table 2 shows an estimated increase, between fall 1980 and fall 1981, of 404 in the size of the doctorate-holding faculty and an increase of 208 in the nondoctorate faculty, for an overall increase of 612, the largest in a decade. However, the increase did not keep pace with rising enrollments. While faculty size increased by 3%, the number of teaching assistants reported for fall 1981 increased by 8% over the previous fall. But course enrollments again rose by 8% and inevitably class sizes also increased (Tables 7 and 8).

The pattern of faculty mobility obtained by comparing the two sides of Table 2 continues the trend of last year. More full-time faculty members are being hired before receiving the doctorate. The figure of 739 shown in Table 2 corresponds to the estimate of 435 four years ago (February 1978 *Notices*, page 101). Most (84%) of the new nondoctorate faculty members were hired by departments in Groups M and B.

Attrition due to deaths and retirements continues at the yearly rate of about 1% of the total faculty. In addition, some leave tenured faculty positions to

TABLE 2 - FACULTY FLOW 1980-1981 TO 1981-1982
Full-Time Mathematical Sciences Faculty in Four-Year Colleges and Universities in the U.S.

FROM	Sources of New Faculty		Fall 1981 Employment Status, Faculty Leaving		
	Doctorate-Holding	Nondoctorate	TO	Doctorate-Holding	Nondoctorate
Graduate school	468	317	Two-year college or high school	15	62
Another college or university position	638	132	Another college or university position	471	72
Nonacademic employment	96	106	Nonacademic employment	212	122
Outside U.S.	80	11	Deaths and retirements	116	72
			Position outside U.S.	37	0
			Graduate or professional school	32	50
Other sources ⁽¹⁾	84	173	Seeking employment	24	19
Total	1366	739	Other ⁽³⁾	55	60
			Total	962	457
Received doctorate and not moving ⁽²⁾	(+74) 1440		Received doctorate and not moving		(+74) 531

Estimated size of full-time U.S. mathematical sciences faculty, Fall 1981

Doctorate-holding 15,123 (+404 from Fall 1980)
Nondoctorate 4,144 (+208 from Fall 1980)

(1) Part-time to full-time in same department, from postdoctoral or two-year college position, etc.

(2) Mostly in Group M and B departments.

(3) No longer full-time in department, unknown employment status, etc.

take nonacademic positions or for other reasons. The number of faculty members who received tenure in their institutions is about 392, down from last year's total of 443.

Doctorate-granting departments of mathematics (Groups I, II, III). Table 3 gives a somewhat different perspective of faculty mobility in and out of the 152 U.S. mathematics departments with doctoral programs. In Table 3 the sources of new tenured and nontenured doctorate-holding faculty members are shown, as well as the employment status of those leaving between academic years 1980-1981 and 1981-1982.

This table confirms the pattern of previous years and emphasizes the cap on faculty size at these universities which has prevailed for almost a decade. Although enrollments in the mathematics courses soar, faculty size remains virtually constant. The 1974 AMS Survey (November 1974 *Notices*, page 339) estimates the size of faculty at 5,500, while the 1981 figures show an increase to 5,609.

Groups M and B. The number of nondoctorate faculty members hired by Groups M and B departments has been steadily increasing, from about 350 newly hired for fall 1977 to 624 for fall 1981.

The M and B departments are very diverse, ranging from medium-to-large departments in public institutions to quite small departments in private colleges of varying degrees of selectivity. Besides mathematics instruction, mathematics departments in Groups M and B often have responsibilities in applied areas which in larger universities are taken by separate departments of statistics, operations research, or computer science. As mentioned earlier, there are opportunities for young mathematicians with a strong

commitment to teaching, who can fit the needs of Groups M or B departments.

Nonacademic Employment of Doctorates in the Mathematical Sciences

Table 4 is a summary of AMS Survey data on the employment of new doctorates during the last six years 1975-1976 to 1980-1981.

TABLE 4

NEW MATHEMATICAL SCIENCES DOCTORATES TAKING NONACADEMIC POSITIONS IN U.S.

	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980	1980-1981
In Government	74	62	44	34	37	28
In Business/Industry	112	136	166	168	165	169
Total	186	198	210	202	202	197
Total new doctorates employed in U.S.	787	776	734	690	691	732
% in Govt./Bus./Ind.	24%	26%	29%	29%	29%	27%

Table 4 shows a levelling off in hiring of new doctorates by business and industry. Many of these jobs are in companies in high technology, computer-information processing, or communications areas. A significant number are with organizations which do consulting work in operations research, statistics or applied physics, or which provide computer software or data management services; other jobs are energy or automotive related, or health-care related. The November 1980 issue of *Employment Information in the Mathematical Sciences* contains lists of the names and addresses of nonacademic employers of the individuals included in Table 1 on page 608 of the November 1980 *Notices*, with an indication of the thesis field of the employee.

Table 5 shows that relatively few individuals included in Table 4 received a Ph.D. in pure mathematics. (The somewhat arbitrary classification "Pure" mathematics is the same as in Table 1. "Other" mathematical

TABLE 3 - FACULTY FLOW 1980-1981 TO 1981-1982

Full-time Doctorate-holding Faculty in 152 Doctorate-Granting Mathematics Departments in the U.S.

(Groups I, II, III)

FROM	Sources of New Faculty		Fall 1981 Employment Status, Faculty Leaving		
	Nontenured	Tenured	TO	Nontenured	Tenured
Graduate school	160		Doctorate-granting departments	91	37
Another college or university position	149	38	Other college or university position	43	9
Nonacademic employment	1	} 9 }	Nonacademic employment	55	12
Outside U.S.	42		Deaths and retirements	2	34
Other sources	19		Position outside U.S.	22	} 6 }
Total	371	47	Seeking employment	7	
Received doctorate and not moving	(+4)		Other	24	98
Received tenure and not moving		(+100)	Total	244	
	380	147	Received tenure and not moving	(+100)	336

Estimated size of full-time faculty, Fall 1981, Groups I-III

Doctorate, Nontenured	1,288 (+44 from Fall 1980)
Doctorate, Tenured	3,905 (+48 from Fall 1980)
Nondoctorate faculty	416 (+24 from Fall 1980)
Total full-time faculty	5,609 (+117 from Fall 1980)

Doctorates in Mathematics and Related Areas NRC Reports: July 1967–June 1980

	1967- 1968	1968- 1969	1969- 1970	1970- 1971	1971- 1972	1972- 1973	1973- 1974	1974- 1975	1975- 1976	1976- 1977	1977- 1978	1978- 1979	1979- 1980
Mathematics	970	1,063	1,218	1,236	1,281	1,222	1,196	1,149	1,003	959	838	768	745
A. Algebra	145	181	190	200	167	141	124	126	115	88	87	87	78
B. Analysis	246	266	244	262	241	244	213	180	141	152	118	111	91
C. Geometry	31	25	39	35	35	32	38	26	23	26	22	25	35
D. Logic	30	28	37	31	39	33	21	38	34	17	24	21	24
E. Number Theory	20	24	27	33	36	31	23	27	26	32	18	17	28
F. Probability, Mathematical Statistics	132	49	83	91	151	156	150	174	165	159	168	165	152
G. Topology	105	108	143	120	130	111	112	94	72	70	56	60	57
H. Computing Theory and Practice	51	79	118	139	163	221	194	167	147	101	55	25	13
I. Operations Research						3	24	55	36	42	43	43	41
J. Applied Mathematics	131	127	147	122	119	119	138	101	104	113	108	111	102
K. Mathematics, General	51	86	94	108	112	90	111	115	97	89	92	81	83
L. Mathematics, Other	28	90	96	95	88	41	48	46	43	70	47	22	41
Total Pure (A, B, C, D, E, G, K)	628	718	774	789	760	682	642	606	508	474	417	402	396
Total Other (F, H, I, J, L)	342	345	444	447	521	540	554	543	495	485	421	366	349
Computer Science											121	209	218
Engineering													
Computer Engineering							101	119	122	76	79	62	
Electrical Engineering	602	688	706	748	690	673	601	536	512	461	410	451	405
Engineering Mechanics	227	238	235	215	209	176	161	162	113	102	95	85	91
Operations Research					62	104	125	90	82	76	84	66	63
Systems Design & Systems Science								79	68	71	62	75	62
Life Sciences													
Biometrics and Biostatistics	23	18	37	42	30	34	35	37	46	52	45	44	42
Social Sciences													
Econometrics	30	20	27	27	32	31	20	27	30	29	23	22	22
Statistics	19	96	121	133	85	62	36	43	35	36	46	23	33
Education													
Mathematics Education	95	111	128	131	152	134	110	108	96	98	57	85	74

sciences refers to the right-hand columns: Statistics, . . . , Other in Table 1.) There is some inherent ambiguity in the count of "Other mathematical sciences" doctorates, since the boundary between the applied mathematical sciences and engineering is not sharp. In addition, responses to the AMS Survey of new doctorates from departments in Group V (especially from those in computer science) are less complete than from Groups I–IV. Nevertheless, the AMS data have generally fitted rather well with NRC data obtained from the doctorate recipients themselves (cf. February 1978 *Notices*, page 108).

TABLE 5
THESES SUBJECTS OF THE NEW DOCTORATES
IN TABLE 4

	1975- 1976	1976- 1977	1977- 1978	1978- 1979	1979- 1980	1980- 1981
Pure	46	38	41	53	59	44
Other	<u>140</u>	<u>160</u>	<u>169</u>	<u>149</u>	<u>143</u>	<u>153</u>
	186	198	210	202	202	197

The table entitled *Doctorates in Mathematics and Related Areas*, July 1967–1980, above, extends the table published in 1978 to cover the years 1967–1968 through 1979–1980. It depicts the rise and fall in the number of doctoral degrees in "mathematics" awarded each year in this interval. The reports of corresponding

numbers for statistics, computing and operations research are subject to variations in classification, as an examination of some of the lower lines in the printed table will reveal. The figures given are extracted from a series of NRC reports entitled *Doctorate Recipients from United States Universities*. (These reports are published annually and may be obtained from the Commission on Human Resources, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.)

TABLE 6
ESTIMATED NET OUTFLOW OF
DOCTORATE-HOLDING FACULTY MEMBERS
TO NONACADEMIC EMPLOYMENT

	1976	1977	1978	1979	1980	1981
Net Outflow	155	190	190	165	168	116

In addition to new Ph.D.'s shown in Table 5 whose job after receiving the doctorate was nonacademic, a significant number of others moved to positions in government, business or industry after a few years in faculty positions. Table 6 shows the estimated annual net outflow of doctorate-holding faculty members to nonacademic positions since 1977. For instance, the number 116 for 1981 is the difference of 212 doctorates shown in Table 2 leaving academia and 96 hired in academia from nonacademic positions: the number

TABLE 7 - PERCENT CHANGE IN COURSE ENROLLMENTS

By Type of Course, Fall 1980 to Fall 1981

Type of Course	Groups								All Groups
	I	II	III	IV	V	VI	M	B	
Below calculus	-6%	4%	1%	*	*	*	4%	5%	3%
First year calculus	3%	7%	9%	*	*	10%	10%	9%	8%
Statistics	*	*	*	7%	*	22%	9%	4%	8%
Computer Science	*	*	*	*	12%	29%	26%	35%	27%
Other undergraduate mathematics courses	7%	14%	7%	*	*	14%	8%	4%	9%
Graduate courses	6%	-1%	6%	15%	12%	10%	10%	7%	9%
All courses	2%	7%	5%	9%	18%	16%	9%	10%	8%

*Enrollments in this type of course amount to less than 5% of total undergraduate enrollments for this group of departments.

hired from nonacademic positions (96) exceeds last year's total of 88. However, almost none of these individuals were hired in Group I-III departments as seen from Table 3.

As mentioned above, the November 1980 issue of *Employment Information in the Mathematical Sciences* shows nonacademic employment of new doctorates for the period 1975 to 1980, by employer and field of degree. As might be expected 46% took positions in the Virginia to Massachusetts arc and 18% in California. In addition to the 1980 annual salary survey of new doctorates (November 1980 *Notices*, page 607), the AMS surveyed individual Ph.D. mathematicians in nonacademic jobs during 1980. This survey gave information about salaries. The results were summarized in the November 1980 *Notices*, pages 610 to 614.

In summary, the 1981 AMS Survey showed an increase of about 400 in the number of doctorate-holding faculty members in U.S. colleges and universities and a corresponding increase of over 200 in nondoctorate faculty members. Most new doctorates (65%) found employment in academic positions, while 22% took positions in government or industry. There were virtually no unemployed Ph.D.'s in mathematics at any level and there seems to be a shortage of new doctorate faculty members at schools in Groups M and B.

Changes in Enrollments and Class Size

As has been the case in recent years, enrollments continued to climb in nearly every category. Computer science and statistics courses showed the biggest increase. A most pleasing statistic was the dramatic increase of 15% in junior-senior mathematics majors. This increase was not confined to Groups M and B. The increase for Groups I, II and III was still a hefty 13%. Table 7 gives the percentage increases for various courses.

Finally Table 8 compares class sizes for mathematical sciences departments for fall 1980 and fall 1981. Class sizes continue to increase in most courses in mathematical sciences departments. (An analysis of the class sizes and related parameters for fall semesters 1976 and 1977 was presented by Lida K. Barrett in the February 1978 *Notices*, pages 104, 105).

Graduate student enrollments. Doctorate-granting mathematics departments in the U.S. (Groups I, II, III) happily reported a 6% increase in the number of full-time graduate students from fall 1980 to fall 1981. Further, the number of entering full-time first-time graduate students in Groups I, II, III increased by 7%.

Departments in other Groups reported similar increases.

TABLE 8 - AVERAGE CLASS SIZE IN FALL 1980 AND FALL 1981 (1980 figures appear in parentheses)

Type of Course	Groups							
	I	II	III	IV	V	VI	M	B
Below calculus	(31)	(44)	(45)	—	—	—	(41)	(32)
	32	45	46	—	—	—	42	32
First year calculus	(35)	(42)	(41)	—	—	(70)	(36)	(27)
	37	43	44	—	—	80	37	28
Statistics	—	—	—	(38)	(34)	(41)	(35)	(28)
	—	—	—	42	40	45	37	28
Computer Science	—	—	—	—	(40)	(82)	(30)	(26)
	—	—	—	—	43	93	32	27
Other undergraduate mathematics courses	(29)	(33)	(32)	—	—	(40)	(24)	(16)
	30	36	34	—	—	44	25	17
Graduate courses	(9)	(9)	(9)	(16)	(15)	(8)	(10)	(16)
	10	4	10	19	18	7	10	17
All courses	(29)	(37)	(37)	(28)	(30)	(47)	(33)	(27)
	31	38	38	32	35	51	34	27

A dash indicates that these courses represent less than 5% of total undergraduate enrollment for departments in this category.