

Second Report

A first report of the 1984 Survey appeared in the November 1984 *Notices*, pages 744–756. It included a report of the survey of faculty salaries, a first report of the survey of new 1983–1984 doctorates, and a list of the names and thesis titles of the 1983–1984 doctorates included in the Survey. This second report includes an update of the fall 1984 employment status of new doctorates, an analysis of faculty mobility, and a report on fall 1984 enrollments and class sizes.

The 28th Annual AMS Survey was made under the direction of the Society's Committee on Employment and Educational Policy (CEEP), whose members in 1984 were Lida K. Barrett, Stefan A. Burr, Lisl Novak Gaal, Gerald J. Janusz, Irwin Kra and Donald C. Rung (chairman). A Data Subcommittee of CEEP, consisting of Lida K. Barrett, Susan J. Devlin, 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, 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 1984

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 1984 employment status of new 1983–1984 doctorates, followed by an analysis of trends in the academic job market based upon the 1984 AMS Survey of Faculty Mobility. It also contains estimates on the total enrollment in courses for fall 1983 and fall 1984 as well as average class size for both fall 1983 and fall 1984. Also included are estimates for the number of majors at the junior and senior level and graduate student enrollment.

Estimates based on AMS Survey data suggest that 910 full-time positions in U.S. colleges and universities were filled by nondoctorates last fall and for 522 of these positions, the department would have preferred someone with a doctorate. Of these positions, 471 were in Groups M and B departments. (See the box for descriptions of the groups.) The estimated total increase for this year in the size of the full-time faculty (682) is the largest in recent years, as is the 134 increase in doctorate faculty for Groups I, II and III (Table 3). This is the largest increase in over eight years. The net increase in the nondoctorate faculty (259) is positive for the fifth consecutive year, after nine consecutive years of decline.

The enrollment data (Table 6) yields several interesting comparisons. Total enrollment showed no increase for the first time in memory, certainly for the first time in these surveys. Given the downturn in total collegiate enrollment caused by demographics, it seems likely that mathematics enrollment will show modest declines over the next decade. Not surprisingly, average class size (Table 7) also declined in most categories. However,

Groups I and II include the leading departments of mathematics in the U.S. according to the 1982 assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty.¹

Group I is composed of 39 departments with scores in the 3.0–5.0 range.

Group II is composed of 43 departments with scores in the 2.0–2.9 range.

Group III contains the remaining U.S. departments reporting a doctoral program.

Group IV contains U.S. departments (or programs) of statistics, biostatistics and biometrics reporting a doctoral program.

Group V contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a doctoral program.

Group VI contains doctorate-granting departments (or programs) in the mathematical sciences in Canadian universities.

Group M contains U.S. departments granting a master's degree as the highest graduate degree.

Group B contains U.S. departments granting a baccalaureate degree only.

Response rates varied from one group to another, with the largest response rate from Groups I, II, and III. Of an estimated total in 1983 of 18,527 full-time U.S. mathematical sciences faculty members, 9,425 are members of departments which responded to the survey.

¹These findings were published in *An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences*, edited by Lyle V. Jones, Gardner Lindzey and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics and computer science was presented in digest form in the April 1983 issue of the *Notices*, pages 257–267, and an analysis of the above classifications was given in the June 1983 *Notices*, pages 392–393.

junior-senior mathematics majors and graduate students continued to show impressive increases (Table 8).

Special note should be taken of the decline in computer science enrollments in Groups M and B. This decline is also reflected in a joint study of the Cooperative Institutional Research Program at UCLA and the American Council on Education, reported in the *Chronicle of Higher Education*, January 16, 1985, which showed a two-year decline in Freshmen interested in careers as computer programmers or analysts. A small fraction of the decline is a result of a reporting change: recently some colleges and universities have established separate departments of computer science. Some of these new computer science departments are not included in this year's survey report. However, an analysis shows that this fact did not account for very much of the reported decline.

Part-time members of the faculty continue to play a significant role in undergraduate instruction in departments in Groups M and B where there are an estimated 5,497 part-time faculty members as compared with 12,700 full-time faculty members. In contrast there are 904 part-time faculty members in Groups I, II, III where there are 5,757 full-time faculty members.

The number of graduate students increased by 9% in Groups I, II and III, as compared to last year's increase of 8% (Table 8). The percentage of new doctorates taking nonacademic employment continued at the same 22% figure as in 1983 (Table 4). There was a large increase in the net outflow of doctorate-holding faculty members (125) to nonacademic employment (Table 5).

Fall 1984 Employment Status of 1983-1984 New Doctorates

Table 1 contains the fall 1984 employment status by type of employer and field of degree for 789 new mathematical sciences doctorates who received the degree between July 1, 1983, and June 30, 1984. The names of these 789 people and the titles of their doctoral theses were published in the November 1984 *Notices*, pages 757-770. Table 1 updates the corresponding table on page 755 of the November 1984 *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 appears in this issue of the *Notices*.)

TABLE 1: 1984-1985 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 | 22 | 23 | 15 | 3 | 1 | 2 | | 1 | 6 | | 2 | 75 |
| Group II | 7 | 10 | 7 | 2 | | 3 | 1 | | 9 | | 1 | 40 |
| Group III | 4 | 5 | 6 | | 4 | 8 | | 2 | 5 | 1 | 4 | 39 |
| Group IV | | 1 | | | | 19 | | | | | 1 | 21 |
| Group V | | | 1 | 1 | | 2 | | 6 | 7 | | | 17 |
| Masters | 18 | 15 | 10 | 3 | 3 | 19 | 4 | 6 | 14 | | 9 | 101 |
| Bachelors | 21 | 11 | 14 | 2 | 1 | 8 | | 1 | 8 | | 8 | 74 |
| Two-year College or High School | | 2 | 1 | | 1 | 2 | | | | 1 | | 7 |
| Other Academic Departments | 1 | 4 | 1 | 1 | 1 | 19 | 2 | 23 | 5 | 1 | 16 | 74 |
| Research Institutes | | 2 | 4 | 1 | | 2 | 1 | 1 | 8 | | 3 | 22 |
| Government | 1 | | | | 1 | 12 | 1 | 4 | 3 | | 1 | 23 |
| Business and Industry | 9 | 6 | 5 | 1 | 3 | 35 | 8 | 11 | 14 | | 19 | 111 |
| Canada, Academic | 4 | 1 | 4 | 2 | | 8 | 1 | 4 | 2 | | | 26 |
| Canada, Nonacademic | | | | | | | | | 1 | | | 1 |
| Foreign, Academic | 14 | 16 | 8 | | 2 | 20 | | 5 | 13 | | 10 | 88 |
| Foreign, Nonacademic | 6 | 3 | 1 | 2 | 2 | 10 | 1 | 2 | 7 | | 4 | 38 |
| Not seeking employ. | | 1 | | | | | | | 3 | | 1 | 5 |
| Not yet employed | 3 | | 2 | 1 | | 4 | 1 | | 3 | | 2 | 16 |
| Unknown | 1 | 2 | 1 | 2 | | | | | 2 | | 3 | 11 |
| Total | 111 | 102 | 80 | 21 | 19 | 173 | 20 | 66 | 110 | 3 | 84 | 789 |

The first five rows in Table 1 refer to those 1983-1984 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 only. Again 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 in Groups M and B computer science and statistics enrollments are plentiful. Mathematicians prepared to teach these courses will find no lack of opportunity to do so at those schools.

The numbers in Tables 2, 3, 5, 6 and 8 were obtained by extrapolation from the AMS Survey and are not actual counts. The various totals from each Group were multiplied by the ratio of the size of the faculty in various groups (obtained by adjusting the figures in the 1980 CBMS report or using actual counts in Group VI) to the number of faculty members represented in the responding departments.

Continuing the policy enunciated in the first report of the 1983 Survey, the survey no longer contains data from departments of computer science. The limited response from these departments made reliable estimates difficult. For the second year, returns from Group V departments were too small to be included. This

survey, then, is an analysis of what might be called the traditional mathematics and statistics community. Because the response rate in the remaining groups continues at a high level, this year's survey gives a fairly accurate picture of faculty mobility, enrollments etc. within this community. It should be noted that while departments of computer science are not included in the survey many departments of mathematics in Groups M and B teach the computer science courses whose enrollment (281,000) is at least 60% of all computer science enrollments in the U.S.

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 Groups I, II, III, IV, M and B responding to the 1984 Survey of Faculty Mobility is similar to that of previous years. The responding departments represent about half (51%) of all mathematical sciences faculty members. About 70% of the faculty members in doctorate-granting mathematics departments (Groups I-III) are included among responding departments.

TABLE 2: Faculty Flow 1983-1984 To 1984-1985

Full-Time Mathematical Sciences Faculty in Four-Year Colleges and Universities in the U.S.

| FROM | Sources of New Faculty | | TO | Fall 1984 Employment Status, Faculty Leaving | |
|--|------------------------|--------------|--|--|--------------|
| | Doctorate-Holding | Nondoctorate | | Doctorate-Holding | Nondoctorate |
| Graduate School | 452 | 347 | Two-year college or high school | 3 | 66 |
| Another college or university position | 637 | 208 | Another college or university position | 514 | 155 |
| Nonacademic employment | 66 | 83 | Nonacademic employment | 170 | 104 |
| Outside U.S. | 115 | 23 | Deaths and retirements | 133 | 89 |
| | | | Position outside U.S. | 48 | 7 |
| | | | Graduate or professional school | 27 | 93 |
| | | | Seeking employment | 14 | 35 |
| Other sources (1) | 66 | 249 | Other (3) | 43 | 63 |
| Total | 1336 | 910 | Total | 952 | 612 |
| Received doctorate and not moving (2) | (+39) | | Received doctorate and not moving | | (+39) |
| | 1375 | | | | 651 |

Estimated size of full-time U.S. mathematical sciences faculty, Fall 1984

| | |
|-------------------|-------------------------------------|
| Doctorate-holding | 14,535 (+423 from Fall 1983) |
| Nondoctorate | 4,674 (+259 from Fall 1983) |
| | <u>19,209 (+682 from Fall 1983)</u> |

(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.

Table 2 shows estimated faculty flow between 1983-1984 and 1984-1985 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 1983 and fall 1984. The right side of Table 2 shows the fall 1984 employment status of those full-time faculty members (as of fall 1983) who permanently left their departments by fall 1984. 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 (+39) in parentheses represents a change from nondoctorate to doctorate status of individuals who remained as full-time faculty members in the same department.

Table 2 shows an estimated increase, between fall 1983 and fall 1984, of 422 in the size of the doctorate-holding faculty and an increase of 259 in the nondoctorate faculty, for an overall increase of 681, as compared to last year's increase of 672.

The pattern of faculty mobility obtained by comparing the two sides of Table 2 continues somewhat the trend of last year. Many full-time nondoctorate faculty members are being hired.

The figure of 910 shown in Table 2 corresponds to the estimate of 435 seven years ago (February 1978 *Notices*, page 101). Most (92%) of the new nondoctorate faculty members were hired by departments in Groups M and B.

Attrition due to deaths and retirements is about (1.2%) of the total faculty. This figure seems to hover about the 1% level. The number of faculty members who received tenure in their institutions is 453, up from last year's total of 418.

Doctorate-granting Departments of Mathematics (Groups I, II, III). Table 3 gives a somewhat different perspective of faculty mobility in and out of the 155 U.S. 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 1983-1984 and 1984-1985. The increase of 134 doctorate faculty is one of the largest in recent years.

Group VI. The number of faculty in Canadian doctorate-granting universities (Group VI) increased from 896 in fall 1983 to 953 in fall 1984; with ten receiving tenure.

Groups M and B. The number of nondoctorate faculty members hired by Groups M and B departments had been steadily increasing, from about 350 newly hired for fall 1977 to 734 for fall 1982; there was a slight decrease to 674 for fall 1983, and a large increase to 834 for fall 1984.

TABLE 3: Faculty Flow 1983-1984 To 1984-1985

Full-Time Doctorate-Holding Faculty in 155 Doctorate-Granting Mathematics Departments in the U.S.
(Groups I, II, III)

| FROM | Sources of New Faculty | | Fall 1984 Employment Status, Faculty Leaving | | |
|--|------------------------|------------|--|------------|------------|
| | Nontenured | Tenured | TO | Nontenured | Tenured |
| Graduate School | 179 | 0 | Doctorate-granting departments | 97 | 33 |
| Another college or university position | 146 | 33 | Other college or university position | 41 | 10 |
| Nonacademic employment | 9 | 1 | Nonacademic employment | 21 | 19 |
| Outside U.S. | 48 | 7 | Deaths and retirements | 1 | 44 |
| Other sources | 14 | — | Position outside U.S. | 21 | 6 |
| | | | Seeking employment | 3 | 6 |
| | | | Other | 14 | — |
| Total | 396 | 41 | Total | 198 | 112 |
| Received doctorate and not moving | (+7) | | Received tenure and not moving | (+125) | 112 |
| Received tenure and not moving | | (+125) | | 323 | |
| | <u>403</u> | <u>166</u> | | | |

Estimated size of full-time faculty, Fall 1984 Groups I-III

| | |
|-----------------------|----------------------------|
| Doctorate, Nontenured | 1,378 (+80 from Fall 1983) |
| Doctorate, Tenured | 3,986 (+54 from Fall 1983) |
| Nondoctorate faculty | 393 (+3 from Fall 1983) |

Total full-time faculty 5,757 (+137 from Fall 1983)

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 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 1978-1979 to 1983-1984.

TABLE 4: New Mathematical Sciences Doctorates Taking Nonacademic Positions in U.S.

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---------------------------------------|------|------|------|------|------|------|
| | -79 | -80 | -81 | -82 | -83 | -84 |
| In government | 34 | 37 | 28 | 22 | 24 | 23 |
| In business/industry | 168 | 165 | 169 | 141 | 105 | 110 |
| Total | 202 | 202 | 197 | 163 | 129 | 133 |
| Total new doctorates employed in U.S. | 690 | 691 | 732 | 659 | 583 | 597 |
| % in govt./bus./ind. | 29% | 29% | 27% | 25% | 22% | 22% |

Table 4 shows a levelling in the 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. 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. Also see a related article by David H. Bailey in the November 1983 *Notices*, pages 756-758. (*Errata*—In the Bailey article, there are two errors. An employer's name is misspelled. The last entry under Massachusetts should be: Verbex (5) 2 Oak Park, Bedford, MA 01730. Also, there is an incorrect address. The second entry under Virginia should be: Center for Naval Analyses (35) 2000 North Beauregard, Alexandria, VA 22311.)

TABLE 5: Estimated Net Outflow of Doctorate-Holding Faculty Members To Nonacademic Employment

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|-------------|------|------|------|------|------|------|
| Net outflow | 165 | 168 | 116 | 94 | 46 | 125 |

Table 5 shows the estimated annual net outflow of doctorate-holding faculty members to nonacademic positions since 1979. The number 125 for 1984 is the difference between 170 doctorates shown in Table 2 leaving academia and 66 hired in academia from nonacademic positions: the 1984 number is again comparable to earlier figures after a low last year of 46.

In summary, the 1984 AMS Survey showed an increase of 423 in the number of doctorate-holding faculty members in U.S. colleges and universities and a corresponding increase of 259 in nondoctorate faculty members. Most new doctorates (70%) found employment in academic positions, while 22% took positions in government or industry in the U.S. These are the identical figures as given in last year's survey. There are very few unemployed Ph.D.'s in mathematics at

TABLE 6: Total Course Enrollments (in Thousands)
(Percent increase from fall 1983 in parentheses)

By Type of Course, Fall 1984

| Type of Course | Groups | | | | All Groups |
|---|------------|------------|-------------|-----------|-----------------|
| | I, II, III | IV | VI | M, B | |
| Below calculus | 286 (0%) | 3.4 (4%) | * | 612 (1%) | |
| First year calculus | 228 (-2%) | * | 30.3 (-11%) | 262 (-2%) | |
| Statistics | * | 43.6 (6%) | 12.9 (-6%) | 118 (8%) | |
| Computer Science | * | * | * | 281 (-4%) | |
| Other undergraduate mathematics courses | 175 (1%) | * | 47.0 (-7%) | 207 (3%) | |
| Graduate courses | 24.5 (4%) | 13.4 (+6%) | 1.01 (-16%) | 24.5 (7%) | |
| All courses | 763 (0%) | 62.1 (5%) | 94.1 (-9%) | 1505 (0%) | 2424 (0%) Total |

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

TABLE 7: Average Class Size in Fall 1984
(Average class size as reported in Fall 1983 survey in parentheses)

| Type of Course | Groups | | | | | | |
|---|---------|---------|---------|---------|---------|---------|---------|
| | I | II | III | IV | VI | M | B |
| Below calculus | 34 (38) | 41 (46) | 44 (48) | 34 (—) | — (—) | 38 (40) | 30 (32) |
| First year calculus | 38 (35) | 39 (43) | 44 (43) | — (—) | 84 (96) | 35 (36) | 28 (29) |
| Statistics | — (—) | — (—) | 38 (—) | 46 (44) | 57 (54) | 37 (35) | 30 (30) |
| Computer Science | — (—) | — (—) | 29 (—) | — (—) | — (—) | 29 (33) | 26 (29) |
| Other undergraduate mathematics courses | 31 (33) | 33 (35) | 35 (34) | — (—) | 52 (52) | 27 (26) | 18 (18) |
| Graduate courses | 11 (11) | 11 (10) | 9 (9) | 17 (13) | 6 (6) | 11 (11) | 12 (13) |
| All courses | 32 (34) | 36 (39) | 37 (39) | 33 (32) | 55 (57) | 32 (33) | 26 (28) |

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

TABLE 8: Junior-Senior Majors and Graduate Enrollment
(Percent increase over fall 1983 enrollment in parentheses)

| | Fall 1984 | | | |
|---|-------------|-------------|------------|--------------|
| | Groups | | | |
| | I, II, III | IV | VI | M, B |
| Total junior-senior majors in department | 18,600 (6%) | 712 (23%) | 4245 (11%) | 68,430 (10%) |
| Total full-time graduate students (including teaching assistants) | 7,797 (9%) | 1,935 (-5%) | 804 (6%) | 4,693 (10%) |
| Total full-time first year graduate students (including teaching assistants) | 2,595 (10%) | 553 (-11%) | 277 (-14%) | 2,218 (10%) |

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

For the second year total enrollments have been estimated. Table 6 gives these figures.

Table 7 gives class sizes for mathematical sciences departments for Fall 1983 and Fall 1984.

Junior-Senior Major and Graduate Student Enrollments. Another set of data is given in Table 8, where total enrollment of junior-senior majors and graduate students is presented. Doctorate-granting mathematics departments in the U.S. (Groups I, II, III) reported a 9% increase in the

number of full-time graduate students from fall 1983 to fall 1984. Further, the number of entering full-time first-year graduate students in Groups I, II, III increased by 10%.

This was the fourth year of such increases. Junior-senior majors also showed a good increase in all categories.

By way of a postscript the author welcomes any comments or suggestions on the format, data presented, etc. of these annual reports, as well as the various ad hoc reports of CEEP. Please send your remarks to Donald Rung, Department of Mathematics, 203 McAllister Building, Pennsylvania State University, University Park, Pennsylvania 16802.