

# Mathematicians

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## Significant Points

- A Ph.D. degree in mathematics usually is the minimum education needed, except in the Federal Government.
- Employment is expected to contract, reflecting the decline in the number of jobs with the title mathematician; competition will be keen for the limited number of jobs.
- Master's and Ph.D. degree holders with a strong background in mathematics and a related discipline, such as computer science or engineering, should have better employment opportunities in related occupations.

## Nature of the Work

Mathematics is one of the oldest and most fundamental sciences. Mathematicians use mathematical theory, computational techniques, algorithms, and the latest computer technology to solve economic, scientific, engineering, physics, and business problems. The work of mathematicians falls into two broad classes—theoretical (pure) mathematics and applied mathematics. These classes, however, are not sharply defined, and often overlap.

*Theoretical mathematicians* advance mathematical knowledge by developing new principles and recognizing previously unknown relationships between existing principles of mathematics. Although these workers seek to increase basic knowledge without necessarily considering its practical use, such pure and abstract knowledge has been instrumental in producing or furthering many scientific and engineering achievements. Many theoretical mathematicians are employed as university faculty, and divide their time between teaching and conducting research. (See the statement on teachers—postsecondary, elsewhere in the *Handbook*.)

*Applied mathematicians*, on the other hand, use theories and techniques, such as mathematical modeling and computational methods, to formulate and solve practical problems in business, government, and engineering, and in the physical, life, and social sciences. For example, they may analyze the most efficient way to schedule airline routes between cities, the effect and safety of new drugs, the aerodynamic characteristics of an experimental automobile, or the cost-effectiveness of alternative manufacturing processes. Applied mathematicians working in industrial research and development may develop or enhance mathematical methods when solving a difficult problem. Some mathematicians, called cryptanalysts, analyze and decipher encryption systems designed to transmit military, political, financial, or law enforcement-related information in code.

Applied mathematicians start with a practical problem, envision the separate elements of the process under consideration, and then reduce the elements to mathematical variables. They often use computers to analyze relationships among the variables and solve complex problems by developing models with alternative solutions.

Much of the work in applied mathematics is done by individuals with titles other than mathematician. In fact, because mathematics is the foundation upon which so many other aca-

demical disciplines are built, the number of workers using mathematical techniques is much greater than the number formally designated as mathematicians. For example, engineers, computer scientists, physicists, and economists are among those who use mathematics extensively. Some professionals, including statisticians, actuaries, and operations research analysts, actually are specialists in a particular branch of mathematics. Frequently, applied mathematicians are required to collaborate with other workers in their organizations to achieve common solutions to problems. (For more information, see the statements on actuaries, operations research analysts, and statisticians elsewhere in the *Handbook*.)

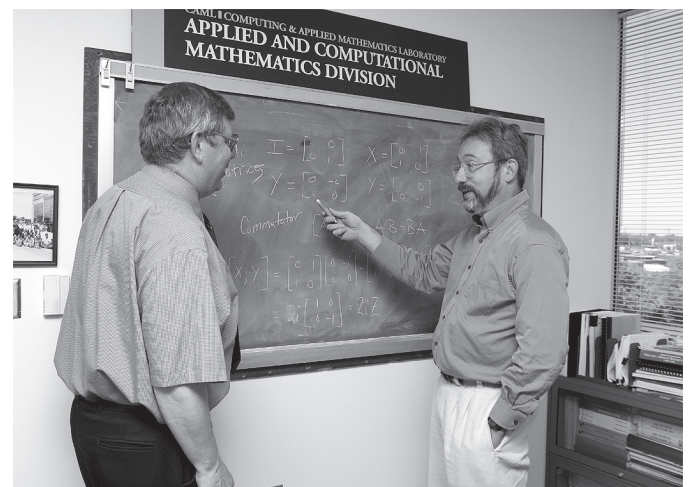
## Working Conditions

Mathematicians usually work in comfortable offices. They often are part of an interdisciplinary team that may include economists, engineers, computer scientists, physicists, technicians, and others. Deadlines, overtime work, special requests for information or analysis, and prolonged travel to attend seminars or conferences may be part of their jobs. Mathematicians who work in academia usually have a mix of teaching and research responsibilities. These mathematicians often conduct research alone, or are aided by graduate students interested in the topic being researched.

## Employment

Mathematicians held about 2,900 jobs in 2002. In addition, about 20,000 persons held full-time mathematics faculty positions in colleges and universities in 2002, according to the American Mathematical Society.

Many nonfaculty mathematicians work for Federal or State governments. The U.S. Department of Defense is the primary Federal employer, accounting for about three-fourths of the mathematicians employed by the Federal Government. Most other mathematicians employed by the Federal Government work for the National Aeronautics and Space Administration (NASA). In the private sector, major employers include insurance carriers, scientific research and development services, and management, scientific, and technical consulting services. Within manufacturing, the aerospace and pharmaceutical industries are the key employers. Some mathematicians also work for investment banks, insurance companies, and securities and commodity exchanges.



Mathematicians often use theory to explain mathematical relationships in the real world.

### **Training, Other Qualifications, and Advancement**

A Ph.D. degree in mathematics usually is the minimum education needed for prospective mathematicians, except in the Federal Government. In the Federal Government, entry-level job candidates usually must have a 4-year degree with a major in mathematics or a 4-year degree with the equivalent of a mathematics major—24 semester hours of mathematics courses.

In private industry, candidates for mathematician jobs typically need a master's or Ph.D. degree. Most of the positions designated for mathematicians are in research and development laboratories, as part of technical teams. Research scientists in such positions engage either in basic research on pure mathematical principles or in applied research on developing or improving specific products or processes. The majority of those with a bachelor's or master's degree in mathematics who work in private industry do so not as mathematicians, but in related fields such as computer science, where they have titles such as computer programmer, systems analyst, or systems engineer.

A bachelor's degree in mathematics is offered by most colleges and universities. Mathematics courses usually required for this degree include calculus, differential equations, and linear and abstract algebra. Additional courses might include probability theory and statistics, mathematical analysis, numerical analysis, topology, discrete mathematics, and mathematical logic. Many colleges and universities urge or require students majoring in mathematics to take courses in a field that is closely related to mathematics, such as computer science, engineering, life science, physical science, or economics. A double major in mathematics and another related discipline is particularly desirable to many employers. High school students who are prospective college mathematics majors should take as many mathematics courses as possible while in high school.

In 2003, about 225 colleges and universities offered a master's degree as the highest degree in either pure or applied mathematics; about 200 offered a Ph.D. degree in pure or applied mathematics. In graduate school, students conduct research and take advanced courses, usually specializing in a subfield of mathematics.

For jobs in applied mathematics, training in the field in which the mathematics will be used is very important. Mathematics is used extensively in physics, actuarial science, statistics, engineering, and operations research. Computer science, business and industrial management, economics, finance, chemistry, geology, life sciences, and behavioral sciences are likewise dependent on applied mathematics. Mathematicians also should have substantial knowledge of computer programming, because most complex mathematical computation and much mathematical modeling are done on a computer.

Mathematicians need good reasoning ability and persistence in order to identify, analyze, and apply basic principles to technical problems. Communication skills are important, as mathematicians must be able to interact and discuss proposed solutions with people who may not have an extensive knowledge of mathematics.

### **Job Outlook**

Competition is keen for the limited number of jobs as mathematicians. Employment of mathematicians is expected to decline through 2012, reflecting the decline in the number of jobs with the title mathematician. However, master's and Ph.D. degree holders with a strong background in mathematics and a related

discipline, such as engineering or computer science, should have better opportunities. Many of these workers have job titles that reflect their occupation, such as systems analyst, rather than the title mathematician, reflecting their primary educational background.

Advancements in technology usually lead to expanding applications of mathematics, and more workers with knowledge of mathematics will be required in the future. However, jobs in industry and government often require advanced knowledge of related scientific disciplines in addition to mathematics. The most common fields in which mathematicians study and find work are computer science and software development, physics, engineering, and operations research. More mathematicians also are becoming involved in financial analysis. Mathematicians must compete for jobs, however, with people who have degrees in these other disciplines. The most successful jobseekers will be able to apply mathematical theory to real-world problems, and possess good communication, teamwork, and computer skills.

Private industry jobs require at least a master's degree in mathematics or in one of the related fields. Bachelor's degree holders in mathematics usually are not qualified for most jobs, and many seek advanced degrees in mathematics or a related discipline. However, bachelor's degree holders who meet State certification requirements may become primary or secondary school mathematics teachers. (For additional information, see the statement on teachers—preschool, kindergarten, elementary, middle, and secondary, elsewhere in the *Handbook*.)

Holders of a master's degree in mathematics will face very strong competition for jobs in theoretical research. Because the number of Ph.D. degrees awarded in mathematics continues to exceed the number of university positions available, many of these graduates will need to find employment in industry and government.

### **Earnings**

Median annual earnings of mathematicians were \$76,470 in 2002. The middle 50 percent earned between \$56,160 and \$91,520. The lowest 10 percent had earnings of less than \$38,930, while the highest 10 percent earned over \$112,780.

According to a 2003 survey by the National Association of Colleges and Employers, starting salary offers averaged \$40,512 a year for mathematics graduates with a bachelor's degree, and \$42,348 for those with a master's degree. Doctoral degree candidates averaged \$55,485.

In early 2003, the average annual salary for mathematicians employed by the Federal Government in supervisory, nonsupervisory, and managerial positions was \$80,877; that for mathematical statisticians was \$83,472; and for cryptanalysts, the average was \$78,662.

### **Related Occupations**

Other occupations that require extensive knowledge of mathematics or, in some cases, a degree in mathematics include actuaries; statisticians; computer programmers; computer systems analysts, database administrators, and computer scientists; computer software engineers; and operations research analysts. A strong background in mathematics also facilitates employment as teachers—postsecondary; teachers—preschool, kindergarten, middle, elementary, and secondary; engineers; economists; market and survey researchers; financial analysts and personal financial advisors; and physicists and astronomers.

### **Sources of Additional Information**

For more information about careers and training in mathematics, especially for doctoral-level employment, contact:

► American Mathematical Society, 201 Charles St., Providence, RI 02940. Internet: <http://www.ams.org>

For specific information on careers in applied mathematics, contact:

► Society for Industrial and Applied Mathematics, 3600 University City Science Center, Philadelphia, PA 19104-2688. Internet: <http://www.siam.org>

Information on obtaining a mathematician position with the Federal Government is available from the Office of Personnel Management (OPM) through a telephone-based system. Consult your telephone directory under U.S. Government for a local number or call (703) 724-1850; Federal Relay Service: (800) 877-8339. The first number is not tollfree, and charges may result. Information also is available from the OPM Internet site: <http://www.usajobs.opm.gov>.