Actuarial Mathematics (Actuarial Science)

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Background

In the early twentieth century a few US colleges and universities began to offer courses in actuarial mathematics. The number of such schools and enrollments in actuarial courses grew slowly until the 1970s. Federal pension legislation in 1974 dramatically increased the demand for actuaries; the 1988 publication of *Jobs Rated Almanac* listing the job of an actuary as #1 further stimulated student interest, which has remained high as that ranking has remained no lower than fourth. The last quarter of the century consequently witnessed a steady increase in both the number of schools with such courses and the number of schools providing extensive actuarial education programs. By early in the twenty-first century nearly 150 colleges or universities—still a small fraction of the nearly 2500 total—offered some level of actuarial courses or program; over half of these featured extensive programs with multiple courses.

Programs

In the terminology introduced in the section **Program types** below and used throughout this report, current undergraduate programs in actuarial mathematics range from Preparatory to Advanced. Some actuarial programs are structured as majors or minors, some as concentrations or application/interest areas; see the section **Program types** for examples. Most of the roughly thirty terminal Masters programs in actuarial mathematics admit graduates of either the Preparatory or the Introductory Programs.

Actuarial mathematics courses typically stress both intuitive understanding and problem solving. Students develop skills in modeling, especially modeling risk and its financial consequences. While actuarial education emphasizes the specific techniques for traditional actuarial work in the insurance and benefits industry, the curriculum has expanded to include financial risk management more broadly. Thus, actuarial education contains intellectually significant and interesting mathematics applicable to a variety of careers.

A successful actuarial program at any level, from Preparatory to Advanced, requires a faculty member as its Program Coordinator (see the section **Faculty** below)—to advise interested students, promote the program, maintain current knowledge of at least the early stages of the professional actuarial exam systems (see the section **Actuarial exams and designations** below), etc.

Program types

The knowledge base and course expectations recommended by the professional actuarial organizations evolve over time. In recommending actuarial mathematics courses for various types of programs, we use "specialized actuarial course" to mean a mathematics course treating a significant part of the content of one subject whose mastery is required for an actuarial designation (see the section **Actuarial exams and designations** below) by either the Casualty Actuarial Society (CAS) or the Society of Actuaries (SOA). [By "course" we mean a three semester-credit-hour course that is frequently taught as an organized course rather than as individual instruction, with the equivalent of approximately 43 50-minute classes.] As of exam-system changes that took effect in fall 2015, these specialized actuarial courses should be chosen from among the following that relate to the then-current system of exams and VEE requirements described in in the section **Actuarial exams and designations** below:

a) a course treating the content of CAS Exam 3F and SOA Exam MFE (hereafter denoted CAS/SOA Exam 3F/MFE);
b) two courses treating the content of either CAS Exam S (beyond basic statistics) or SOA Exam MLC;
c) two courses treating the content of CAS/SOA Exam 4/C; and
d) one or two courses covering the VEE requirement called Applied Statistical Methods (for which VEE credit can be obtained in various ways as described in the section **Actuarial exams and designations** below).

Detailed learning objectives and recommended textbooks for each of the exams and VEE subjects mentioned in here can be found through the links in the section **Actuarial exams and designations** below and can be used as the basis for the syllabi for courses covering that material.

While there is a broad range of program types in existence, most undergraduate programs fall into one of the four categories described below; there are also graduate programs, both professional masters programs designed to quickly take graduates of the more basic programs through additional exam material, and Ph.D. programs designed to prepare students for research or academic careers. In the description below of each type of undergraduate program, note that each subsequent level includes all the requirements of the previous level program as well as certain additional course offerings.

Preparatory Program

A Preparatory Program consists only of courses regularly offered at most undergraduate institutions; no specialized actuarial courses need be offered. It provides its students the preparatory background to apply for graduate actuarial programs. For those interested in immediately embarking on an actuarial career, it provides the knowledge needed to make initial headway with the professional exam and designation systems described in the section **Actuarial exams and designations** below. As of early 2014, a Preparatory Program would cover the content of CAS/SOA Exam 1/P, at least the basic one-course probability-based statistics part of CAS Exam S, and the VEE requirement called Economics (for which VEE credit can be obtained in various ways as described in the section **Actuarial exams and designations** below).

The required content of a Preparatory Program is as follows:

1. a course sequence covering single- and multi-variable calculus;
2. a course on linear algebra;
3. a two-course sequence covering calculus-based probability and probability-based statistics; and
4. one course each on introductory microeconomics and macroeconomics.

Some examples of Preparatory Programs follow. The programs listed were chosen (in late 2012) to represent a variety of kinds of schools—not necessarily in some sense the "best" Preparatory Programs. Links to many more actuarial programs can be found on the SOA's list of programs (http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-college-listings-details.aspx), which uses a classification of program types that differs from what is used here.

a) Grand Valley State University: http://www.gvsu.edu/math/
b) Harvey Mudd College: http://www.math.hmc.edu/
c) Lewis and Clark University: http://college.lclark.edu/departments/mathematical_sciences/
d) University of Idaho: http://www.uidaho.edu/sci/math/Academics/undergraduate/actuarial
e) University of Vermont: http://www.uvm.edu/~cems/mathstat/

Introductory Program

An Introductory Program contains—in addition to the content of a Preparatory Program—a course providing a mathematical treatment and analysis of compound interest and its applications to financial transactions, with a semester of calculus as a prerequisite; such a course is here called "mathematical interest theory". It provides background for further actuarial study as well as most of the knowledge needed to make additional headway with the professional exam and designation systems described in the section **Actuarial exams and designations** below. A course on mathematical interest theory would cover about 75% of the content of CAS/SOA Exam 2/FM. The remaining 25% could be left for students to study on their own, or be included in an expanded version (four or five semester-credit-hours) of the interest-theory course; discussions of moving most of this additional material to CAS/SOA Exam 3F/MFE were under way in 2015. A course on corporate finance, if available, would cover the content of the VEE requirement called Corporate Finance (for which VEE credit can be obtained in various ways as described in the section **Actuarial exams and designations** below); it may well have an accounting or initial finance course as a prerequisite.

In summary, the required content of an Introductory Program consists of that listed above for a Preparatory Program in addition to:

5. a course on mathematical interest theory; and
6. if available, a course on corporate finance.

Some examples of Introductory Programs follow. The programs listed were chosen (in late 2012) to represent a variety of kinds of schools—not necessarily in some sense the "best" Introductory Programs. Links to many more actuarial programs can be found on the SOA's list of programs (http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-college-listings-details.aspx), which uses a classification of program types that differs from what is used here.

a) Arizona State University: http://math.asu.edu/actuary/

b) Case Western Reserve University: http://stat.case.edu/program_actuarial.shtml
c) DePauw University: http://www.depauw.edu/academics/departments-programs/mathematics/studentresources/actuarial/
d) Howard University: http://www.coas.howard.edu/mathematics/programs_undergraduate_actuarial.html
e) Slippery Rock University: http://www.sru.edu/academics/colleges/ches/math/Pages/special_interest_areas.aspx
f) Texas Christian University: http://www.math.tcu.edu/actuarial.html

Intermediate Program

An Intermediate Program contains—in addition to the content of an Introductory Program—the remaining 25% of the content of CAS/SOA Exam 2/FM plus two specialized actuarial courses as described in the first paragraph of this section **Program types**. These courses apply probability and statistics to actuarial problems and provide the knowledge needed to make additional headway with the professional exam and designation systems described in the section **Actuarial exams and designations** below. Depending on exactly which two specialized actuarial courses were chosen, as of the exam-system changes in fall 2015 the two courses could cover content as follows:

- all the material for CAS/SOA Exam 4/C; or
- all the material beyond basic statistics for CAS Exam S; or
- all the material for SOA Exam MLC; or
- all the material for CAS/SOA Exam 3F/MFE plus some portion of another exam; or
- all the material for VEE Applied Statistics plus possibly some portion of another exam.

In summary, the required content of an Intermediate Program consists of that listed above for an Introductory Program in addition to:

7. two specialized actuarial courses.

Some examples of Intermediate Programs follow. The programs listed were chosen (in late 2012) to represent a variety of kinds of schools—not necessarily in some sense the "best" Intermediate Programs. Links to many more actuarial programs can be found on the SOA's list of programs (http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-college-listings-details.aspx), which uses a classification of program types that differs from what is used here.

a) Aurora University: http://www.aurora.edu/academics/programs-majors/undergraduate/actuarial-science/index.html#axzz2ASJTnml5
b) Binghamton University: http://www.math.binghamton.edu/actuary/
c) Elizabethtown College: http://www.etown.edu/depts/math/areas.aspx
d) Indiana University–Purdue University Indianapolis: http://www.math.iupui.edu/
e) Oregon State University: http://www.math.oregonstate.edu/Actuarial_Science_Program
f) University of Central Oklahoma:: http://www.math.uco.edu/undergrad/index.html

Advanced Program

An Advanced Program contains—in addition to the content of an Intermediate Program—two additional specialized actuarial courses as described in the first paragraph of this section **Program types**. These courses apply probability and statistics to actuarial problems and provide the knowledge needed to make still further headway with the professional exam and designation systems described in the section **Actuarial exams and designations** below. Depending on exactly what specialized actuarial courses are chosen, as of the exam-system changes in fall 2015 the resulting total of four specialized actuarial courses could cover topics as follows:

- all the material in both CAS/SOA Exam 4/C and either CAS Exam S or SOA Exam MLC; or
- all the material in one of those exams together with half of the other plus the material in CAS/SOA Exam 3F/MFE.

In summary, the required content of an Advanced Program consists of that listed above for an Intermediate Program in addition to:

8. two additional specialized actuarial courses.

Some examples of Advanced Programs follow. The programs listed were chosen (in late 2012) to represent a variety of kinds of schools—not necessarily in some sense the "best" Advanced Programs. Links to many more actuarial programs can be found on the SOA's list of programs (http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-college-listings-details.aspx), which uses a classification of program types that differs from what is used here.

a) Central Washington University: http://www.cwu.edu/math/
b) Florida State University: http://www.math.fsu.edu/~paris/actmath.math
c) Lebanon Valley College: http://www.lvc.edu/mathematics/program-mathematics.aspx
d) Robert Morris University: http://www.rmu.edu/Undergraduate/AcademicPrograms/ActuarialScience
e) University of Michigan: http://www.math.lsa.umich.edu/undergrad/actuarial.html
f) University of St. Thomas: http://www.stthomas.edu/mathematics/actuarialscience/default.html

Actuarial exams and designations

CAS/SOA exams

Two major actuarial organizations in the United States have examination systems for actuaries: the Society of Actuaries (SOA) and the Casualty Actuarial Society (CAS). Historically the Society of Actuaries has been focused on life insurance, health insurance, and employee benefits; in the summer of 2013 the SOA began offering an examination track for those working in property and casualty insurance. The Casualty Actuarial Society is focused solely on property and casualty insurance.

Each organization has its own series of examinations and other procedures leading first to the designation of Associate of that society and then to the designation of Fellow of that society. Each also offers a credential as Chartered Enterprise Risk Analyst. For details, for the SOA see http://www.soa.org/Education/Exam-Req/default.aspx and see http://www.casact.org/admissions/process/ for the CAS. Fortunately for students, most of the initial examinations currently satisfy requirements for both organizations. College students therefore need not choose which organization's designation to seek until they are employed. However, most employers will expect a student to have passed one or two of the actuarial exams prior to graduation.

The defining feature of an actuarial career is the exam system (http://www.beanactuary.org/exams/). Passing actuarial exams is a key part of the path to raises, promotion, and success as an actuary. A minimum passing score on an exam usually equates to solving around 60% of the problems correctly. Each exam is very challenging, and the more mathematical exams—the preliminary exams—typically have pass rates of only about 35% – 40%. One cause of this low pass rate on exams is students' initial overconfidence. In order to pass, actuarial students should plan to spend at least 100 hours of study for each hour of the exam—beyond the time spent on relevant course work. While students who have earned A's or strong B's in problem-solving mathematics courses like calculus may have the *ability* to pass exams, they will succeed only if they commit to the necessary study hours. It is not sufficient to merely be familiar with the material and/or memorize the important topics. Passing the exam requires deep understanding of the concepts and demands working a very large number of problems in preparation in order to master the material and to develop an efficient exam-taking strategy. The later exams especially require the self-discipline to study independently. Exams can be taken repeatedly until passed.

Many sources provide practice problems and study aids to help students prepare for exams. Various organizations publish study manuals, and students can utilize online and in-person review seminars and workshops (http://www.soa.org/education/exam-req/resources/edu-sem-workshops.aspx) (http://www.casact.org/admissions/studytools/) as well as "email study groups" (http://www.casact.org/admissions/index.cfm?fa=email). Many past exam questions and solutions are also available online from the SOA and the CAS. A detailed exam syllabus and a list of references can be found on the SOA and CAS websites http://www.soa.org and http://www.casact.org . Once students thoroughly understand the material, they should focus on taking practice exams. As the examination day approaches, students should take the practice exams under conditions that closely mimic the actual exam situation (time limits, use of approved calculators, etc.).

Any specific discussion of the actuarial exam structure must start with the caveat that both actuarial organizations can (and do) make significant changes in the structure and exam requirements with relatively short notice. The business model does not fully take into account the timetables and multiple approval stages for new or significantly revised courses at academic institutions, although for major changes the CAS and SOA strive to provide advance notice of at least one year.

For many years, the SOA and CAS jointly administered various preliminary exams, providing credit within each organization's exam system. However, joint administration ended 31 December 2013, and each organization held separate preliminary exams starting in 2014. This report's description of the exams also reflects changes in fall 2015. For the latest information on preliminary exams, see the CAS website (http://www.casact.org/admissions/exams/), the SOA website (http://www.soa.org/Education/Exam-Req/edu-asa-req.aspx), or the BeAnActuary.org website (http://www.beanactuary.org/exams/preliminary/?fa=preliminary-exams).

CAS Exam 1/SOA Exam P (http://www.beanactuary.org/exams/preliminary/?fa=probability-exam) covers calculus-based probability, primarily the probability contained in a standard two-semester probability and statistics (or mathematical statistics) sequence. The SOA administers this computer-based exam as SOA Exam P; the CAS does not administer a separate CAS Exam 1 but instead gives credit for its Exam 1 to anyone passing SOA Exam P.

CAS Exam 2/SOA Exam FM (http://www.beanactuary.org/exams/preliminary/?fa=financial-math-exam) covers calculus-based interest theory and an introduction to derivative securities. The SOA administers this computer-based exam as SOA Exam FM; the CAS does not administer a separate CAS Exam 2 but instead gives credit for its Exam 2 to anyone passing SOA Exam FM. The interest-theory content might be found in a mathematics course on interest theory and the material on derivative securities might be found in a finance course (although there are sufficient references for students to learn this on their own) or in an expanded version of an interest-theory course; these topics may be studied in either order. Discussions of moving most of derivative securities material to CAS/SOA Exam 3F/MFE were under way in 2015.

It is worth noting that a thorough knowledge of the material from both of these Exams 1/P and 2/FM is assumed for most of the other more advanced exams. Employers expect applicants and new hires to have credit for at least one of these two exams.

CAS Exam 3F/SOA Exam MFE (http://www.beanactuary.org/exams/preliminary/?fa=financial-economics-exam) covers models for financial economics, including material on the mathematics of financial derivatives. The SOA administers this computer-based exam as SOA Exam MFE; the CAS does not administer a separate CAS Exam 3F but instead gives credit for its Exam 3F to anyone passing SOA Exam MFE.

SOA Exam MLC (http://www.soa.org/education/exam-req/edu-exam-m-detail.aspx) covers probability models in life insurance. There is no corresponding CAS exam.

CAS Exam S

(http://www.casact.org), new in fall 2015, covers probability models (stochastic processes, Markov Chains, introductory survival models with applications to life insurance), basic statistics (as covered in the typical undergraduate two-course sequence in probability and statistics), extended linear models (regression, generalized linear models), and times series. There is no corresponding SOA exam.

CAS Exam 4/SOA Exam C covers statistical techniques for constructing and evaluating actuarial models, particularly in property and casualty insurance (http://www.beanactuary.org/exams/preliminary/?fa=construction-and-evaluation-of-actuarial-models-exams). The SOA administers this computer-based exam as SOA Exam C; the CAS does not administer a separate CAS Exam 4 but instead gives credit for its Exam 4 to anyone passing SOA Exam C.

Enrolled Actuary exams

An Enrolled Actuary is a person who has been certified by the Joint Board for the Enrollment of Actuaries (http://www.irs.gov/Tax-Professionals/Enrolled-Actuaries) to perform tasks required for pension plans under the Employee Retirement Income Security Act (ERISA). The signature of an Enrolled Actuary is required on many pension plan documents. The members of the Joint Board are appointed by the U.S. Secretary of the Treasury and the Secretary of Labor. The Enrolled Actuary designation is distinct from SOA and CAS designations.

The Joint Board administers two examinations for the Enrolled Actuary designation (http://www.soa.org/Education/Exam-Req/edu-exam-ea-detail.aspx):
Exam EA-1 covers the mathematics of compound interest, the mathematics of life contingencies, and practical demographic analysis.
Exam EA-2 is given in two parts and covers the selection of actuarial assumptions and calculation of minimum required and maximum tax-deductible contributions under current pension law, the relevant pension laws as they affect pension actuarial practice, along with the related actuarial mathematics.

The Joint Board waives the Exam EA-1 requirement for candidates passing SOA Exams FM and MLC; information on exam waivers for appropriate education can be found at a link on http://www.irs.gov/Tax-Professionals/Enrolled-Actuaries/Joint-Board-Examination-Program .

Validation by Educational Experience (VEE)

Both the CAS and the SOA require knowledge of certain subjects on which they do not offer exams; instead, they are subject to Validation by Educational Experience (VEE) (http://www.soa.org/education/exam-req/edu-vee.aspx or http://www.casact.org/admissions/syllabus/index.cfm?fa=vee#asm). The SOA requires students to obtain VEE credit for Economics, Corporate Finance, and Applied Statistics; the CAS only requires Economics and Corporate Finance, since the Applied Statistics material is tested in CAS Exam S.

Students primarily earn VEE credit by passing (with a minimum grade of B-) approved university or college courses, but approved distance-learning courses and exams by other organizations can provide VEE credit as well. Students may apply for VEE credit for approved experiences only after passing two of the SOA/CAS exams, although the experiences may be completed prior to having passed exams. See the CAS or SOA website for information on how to get a course approved for VEE credit (http://www.soa.org/education/exam-req/course-info/edu-vee-evaluation-process.aspx) or http://www.casact.org/admissions/syllabus/index.cfm?fa=vee#asm) and for the list of all currently approved methods of obtaining VEE credit (http://www.soa.org/education/exam-req/resources/edu-vee-approved-courses.aspx or http:// www.casact.org/admissions/syllabus/index.cfm?fa=vee#asm).

Faculty

Program Coordinator

A successful actuarial program relies heavily on the leadership and guidance of a faculty member serving as Program Coordinator. Advising students, teaching actuarial coursework, and preparing students for the job market are the primary focus of the Program Coordinator.

In building a program, the Coordinator also needs to develop a strong relationship with colleagues in the Economics Department, Finance Department, and School of Business generally, both to ensure that actuarial students have access to appropriate courses in economics, accounting, and finance and to offer opportunities for students in these related disciplines to double major or minor in actuarial mathematics. The Program Coordinator should also be aware of and recommend to students courses outside of mathematics that are related to or useful in the actuarial field, such as economics, accounting, business law, finance, risk management, technical writing, public speaking, computer programming, and spreadsheet and database use.

A Program Coordinator additionally plays an important role as the official contact person to the Society of Actuaries (SOA) and Casualty Actuarial Society (CAS). Updates on exam changes (see the section **Actuarial exams and designations** above), requisite paperwork for approval of VEE courses (see the section **Actuarial exams and designations** above), and information on national scholarship programs are communicated to the Program Coordinator by these organizations. Furthermore, because prospective students frequently use the SOA listing of actuarial programs to locate programs to contact, it is critical to have a school representative serve as liaison to the societies and be listed on that website (http://www.soa.org/Education/Resources/actuarial-colleges/actuarial-college-listings-details.aspx) .

An active and strong program connects students to working actuaries through actuarial club activities, on-campus presentations from actuarial firms, and promoting summer internships. The Program Coordinator needs to work directly with campus career services personnel and college relation officers at actuarial companies to create these networking opportunities for students. Furthermore the Program Coordinator needs to ensure that actuarial firms are informed about the campus employment system and career fair events. Program Coordinators should consider organizing an advisory board of actuarial professionals.

Faculty training and resources

The standardized syllabi for the preliminary exams (see the section **Actuarial exams and designations** above) are the natural starting place for actuarial curriculum development. Instructors planning to teach these courses should be familiar with the detailed course requirements and utilize one of the texts recommended for the course by the SOA and CAS. Faculty should acquaint themselves with the style and content of exam questions. Various problem-solving techniques must be presented to students in addition to the pure financial, economic, or mathematical content.

In order to understand the exam system, Program Coordinators should consider taking some of the exams themselves. Advanced Programs (see the section **Program types** above) would be well served with a leader who has attained Associate or Fellow status in one of the actuarial societies. In many cases, the SOA will reimburse faculty members for the registration fees for the SOA exams they pass beyond P and FM; see http://www.soa.org/education/resources/reimbursement/edu-academic-fee-prgm.aspx .

Various resources exist to support actuarial educators. The CAS University Liaison Program pairs a practicing actuary with a college actuarial faculty member. The Actuarial Educators Network operated by the International Association of Actuaries has a website with resources on actuarial education. The Mathematical Association of America usually offers a session on actuarial education at the January Joint Mathematics Meetings. The summer Actuarial Research Conference provides an opportunity for actuarial educators to share ideas on actuarial education as well as on research. The Education and Research Section of the SOA promotes connections between academics and working actuaries. The SOA Educational Grant program awards funds to college programs when actuarial faculty members attain Associate or Fellow designations. Academics can also register as members of the CAS Academic Central Program; membership is free and provides academics with access to educational resources, complimentary attendance at CAS national meetings and seminars, as well as other additional benefits including funds to college programs when Academic Central members attain Associate or Fellow designations. The CAS also offers a free student membership program, CAS Student Central, with a dedicated website that academics can share with their students. Here are some relevant websites:

CAS University Liaison Program

http://www.casact.org/community/academic/index.cfm?fa=ulprog

Actuarial Educators Network
http://www.actuarialeducators.org

Mathematical Association of America
http://www.maa.org/meetings/joint-mathematics-meetings

Actuarial Research Conference
Search for this topic on http://www.soa.org or http://www.casact.org

Education and Research Section of the SOA
http://www.soa.org/professional-interests/education-and-research/eandr-detail.aspx

SOA Educational Grants
http://www.soa.org/education/resources/edu-institution-grant/default.aspx

CAS Academic Central Program
http://www.casact.org/membership/join/index.cfm?fa=acadcorr

CAS Student Central
http://www.CASstudentcentral.org

Informing students about careers and job seeking

Career paths

A Program Coordinator (see the section **Faculty** above) has a key responsibility to provide interested students with information on actuarial and other careers for graduates of the actuarial program and to advise actuarial students about job hunting. Simply put, actuaries assess and manage risk. In managing risk, actuaries design policies and products to both reduce the chance of unfavorable events and diminish the impact of undesirable outcomes. Through analyzing data and developing mathematical models actuaries weigh and compare risks and benefits.

Slightly less than half of all actuaries work at insurance companies—health, life, property and casualty, or reinsurance. A similar fraction of SOA actuaries work for consulting companies, consulting on employee benefits, insurance, and general risk management; among CAS actuaries, about one-sixth work in the consulting field. Most of the remaining actuaries work in regulatory or other government agencies, investment banks, the financial services industry, and academia. Students from actuarial programs who do not actually pursue actuarial careers often work in financial services where their analytical abilities are highly valued.

Each of these fields encounters various challenges of risk management. Insurance firms need actuaries to accurately determine how much money must be set aside or reserved for future claims. Actuaries design systems to price insurance products so as to keep them competitive and profitable. In the federal government, actuaries play important roles in evaluating the financial viability of key social insurance and similar programs; in state government, actuaries play key roles in regulating insurance companies. Pension actuaries manage retirement plans in order to ensure that these plans are financially sound. Actuaries employed in finance or banking may handle hedge funds or develop financial products. Risk consultants work with a wide variety of data, based on the project at hand and their clients' needs. Weather data, energy supplies, varying market prices, demographic data, or health and longevity data offer a few examples of ever changing information that impacts risks of various kinds. Actuaries need to keep abreast of legislative changes, new regulations, and the current economic climate as well. Analytic reasoning ability and the proficiency to engineer mathematical models are the key skills in each of these actuarial careers.

Career-information resources

To explore the actuarial field and career options, begin with—and direct students to—the website http://www.BeAnActuary.org . This site also includes links to both the CAS and SOA Career Centers. These career centers maintain lists of job postings and information about internships. The CAS offers a free student membership program for students interested in the actuarial career with a dedicated website at http://www.CASstudentcentral.org and information and other resources including a student online community, the CAS Curriculum Guide, and case studies. The Mathematical Association of America's jobsite, http://mathclassifieds.org , also features job openings of interest.

To learn more about the profession, consult *Actuaries' Survival Guide: How to succeed in one of the most desirable professions* by F. Szabo. It provides an introductory chapter on career information. The *Vault Guide to Actuarial Careers: Get the inside scoop on actuarial careers* includes profiles of the larger actuarial consulting firms.

Helping students seek jobs

The Program Coordinator needs to help students be effective job seekers. Students need to learn about and use campus career-services offices to improve their interview skills, polish their résumés, and seek employment.

In addition to attaining designations through the actuarial exam and VEE system (see the section **Actuarial exams and designations** above), future actuaries need to possess solid technology and communication skills. Employers expect expertise with Excel, including the ability to develop Excel Macros. They also value database management, programming, and other computer skills; the ability to use statistical software is especially important both in property and casualty insurance and in health insurance.

Actuaries must work together and communicate effectively both with clients and with other actuaries; therefore, they must be able to prepare both non-technical and technical reports. To sell ideas and explain solutions to clients and colleagues, actuaries must be able to make presentations and explain complex problems in language comprehensible to a layperson.

Students should also participate in actuarial club activities and attend campus talks offered by actuarial firms. After passing an exam, students should seek a summer internship position; the experience, training, and connections provided by an internship are invaluable in finding a full-time position. Successful programs help students identify internship opportunities.