This is an updated Course 5 Sample Examination. Please note: This version updates the sample exam that was posted on the SOA web site September 22, 2000. Some of the questions have changed on this updated sample exam and an answer key is included for the multiple-choice questions. It also includes some sample answers for select written-answer and short-answer questions.

Course 5 Sample Exam

Application of Basic Actuarial Principles

This sample exam has a total of 100 points. It consists of a sample morning session (worth 60 points) and a sample afternoon session (worth 40 points).

The sample morning session consists of:

a) The 8 written-answer questions, numbered 1 through 8, are worth a total of 43 points.

b) The 6 short written-answer questions, numbered 9 through 14, are worth a total of 6 points.

c) The 23 multiple-choice questions are worth a total of 11 points.

d) True-False questions are each worth \(\frac{1}{4}\) point; all other questions are each worth \(\frac{1}{2}\) point.

The sample afternoon session consists of 8 written-answer questions numbered 15 through 22.
Course 5

Morning Session

Section A – Written Answer
Written Answer

1. (6 points) The Acme Corporation has employees in several different locations around the world. The Company would like to provide a benefit package that will be attractive to employees, but needs to hold down company costs as much as possible.

(a) Describe the types of medical plans Acme might consider for the employees who do not live in a country with national health care. Briefly describe the advantages and disadvantages of each plan for Acme and for employees.

(b) For the employees who live in a country with national health care, describe the types of health benefits Acme could provide.

(c) Describe the factors that must be considered in underwriting Acme’s medical plan (i) as new business; (ii) as renewal business.

2. (5 points) A small island off the coast of Africa recently declared its independence. Currently, 85% of the new inhabitants of the island are immigrants who go there to retire and the other 15% are native born. This new country wants to begin an old age social insurance program.

(a) Describe the three types of formal plans.

(b) Describe the problems that this country will encounter in developing these plans.

3. (8 points) You are the chief actuary for a stock life insurance company. Market Research has indicated there is a need to develop two new products, a Flexible Premium Universal Life and a 10-Year Level Premium Renewable Term.

For each of the products describe the following:

(a) describe typical steps market research took in defining the need for these two products.

(b) pricing strategies the company should consider in designing these products; and

(c) describe the similarities and differences in pricing assumptions for those products.

4. (4 points) You are the consulting actuary for a small company that wants to establish a flat-dollar defined benefit pension plan effective January 1, 2001. Benefits will be granted for service prior to
The average age of the participants is 53. You are informed that the company is concerned with short term fiscal needs and cyclical cash flow problems.

(a) (3 points) Discuss and compare the cost components and patterns under the traditional accrued benefit method and the aggregate (without supplemental liability) cost method.

(b) (1 point) Recommend the more appropriate method for the company and discuss how the method addresses the company’s concerns.

5. (6 points) ABC Company has two employee groups. One group of employees work in coal mines at five different mine sites throughout the country. The other group of employees work at ABC’s head office overseeing the company’s operations. The total number of employees is divided equally between the two groups.

ABC sponsors the following three coverages:
(1) a defined benefit pension plan,
(2) a group term life insurance plan, and
(3) a group long term disability plan.

Competitive pressures may force salary/wage reviews to decrease company expenses. Employee participation in each coverage will change from mandatory to voluntary. Financial forecasts anticipate poor investment returns over the next two to four years. You have been asked to price each of the three coverages for ABC.

For each of the two employee groups, compare and contrast the risk characteristics for each of the three coverages.

6. (3 points) Describe the similarities and differences in risk classification factors used for Individual life insurance and Group life insurance.
7. (7 points) You are the actuary for a non-contributory defined benefit pension plan covering 600 employees established January 1, 1992. You are performing the initial valuation using the following data:

Normal retirement age: 60

Benefit formula:
- $25 per month for each year of service – first 15 years
- $35 per month for each year of service – years 15-30

At valuation rate $I$

$(1 + i)$ to the $10^{th}$ power = 2
Life annuity factor for age 60 (payable monthly) = 12

<table>
<thead>
<tr>
<th>$n$</th>
<th>Annuity due for $n$ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7.143</td>
</tr>
<tr>
<td>15</td>
<td>9.234</td>
</tr>
<tr>
<td>20</td>
<td>10.714</td>
</tr>
<tr>
<td>25</td>
<td>11.760</td>
</tr>
<tr>
<td>30</td>
<td>12.500</td>
</tr>
<tr>
<td>35</td>
<td>13.023</td>
</tr>
<tr>
<td>40</td>
<td>13.393</td>
</tr>
</tbody>
</table>

Decrements before retirement: none

<table>
<thead>
<tr>
<th>Number of Participants</th>
<th>Age at Hire</th>
<th>Current Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>200</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
<td>45</td>
</tr>
</tbody>
</table>

Calculate the normal cost and accrued liability for:
(i) the entry-age normal cost method and
(ii) the individual level premium cost method.

Show all work.

8. (4 points)
With respect to mortality rates and selection of mortality tables for pricing…

(a) Describe factors that can affect the mortality rates experienced by your company
(b) Define the types of mortality tables and describe the considerations in choosing the type of table to use
Course 5

Morning Session

Section B – Short Written Answer *

* These questions are worth 1 point each

Short Answer – Questions are worth 1 point each. Students should attempt to keep answers to one paragraph.


11. Define anti-selection as it applies to life insurance.

12. Define subrogation

13. List the objectives of a statutory valuation.

14. Describe disintermediation risk as it applies to life insurance
Course 5

Morning Session

Section C – Multiple Choice
Multiple Choice

In the list at the left are two items, lettered X and Y. In the list at the right are three items, numbered I, II, and III. ONE of the lettered items is related in some way to EXACTLY TWO of the numbered items. Indicate the related items using the following answer code:

<table>
<thead>
<tr>
<th>Lettered Item</th>
<th>Is Related to Numbered Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) X</td>
<td>I and II only</td>
</tr>
<tr>
<td>(B) X</td>
<td>II and III only</td>
</tr>
<tr>
<td>(C) Y</td>
<td>I and II only</td>
</tr>
<tr>
<td>(D) Y</td>
<td>I and III only</td>
</tr>
<tr>
<td>(E)</td>
<td>The correct answer is not given by (A), (B), (C) or (D)</td>
</tr>
</tbody>
</table>

1. X. Pay-as-you-go funding of social security
   Y. Advance funding of social security
   I. Defined Contribution Plan
   II. Privately managed Defined Benefit Plans
   III. Public Plans

2. X. Cooperative Pricing
   Y. Adaptive Pricing
   I. Used when few companies dominate a market segment
   II. Tend to set prices higher than the price leaders
   III. Used by some companies that are not strong competitors
3. X. Participating Products
   I. Tend to have higher premiums
   Y. Non-participating Products
   II. Historically associated with mutual companies
       III. Do not pay dividends

4. X. Segmentation Method
   I. Ability to back different lines of business with separate blocks of assets
   Y. Portfolio Method
   II. Single interest rate calculated for entire company
       III. Most commonly used by mutual companies for participating policies

5. X. Supplemental Liability
   I. Never arises under individual level premium cost method
   Y. Actuarial Liability
   II. Does not directly emerge under the aggregate method
       III. May arise out of a change in actuarial assumptions

6. X. Full Cost Pricing
   I. Company allocates only those expenses that would be affected by changes in sales levels
Y. Relevant Cost Pricing

II. Inability to field competitive products is a common problem

III. Company allocates all expenses to the various expense rates used in pricing

7. X. Experience loss with respect to retirement benefit

I. Salary increases greater than expected

II. Fewer deaths than expected

Y. Experience gain with respect to retirement benefit

III. More withdrawals than expected

8. X. Projected Accrued Benefit Cost Method

I. Cost Allocation Cost Method

II. Benefit Allocation Cost Method

Y. Aggregate Cost Method

III. Spread Gain Cost Method

9. X. Traditional Accrued Benefit Cost Method

I. Has the smaller normal cost of the two methods

II. Actuarial liability is the present value of all benefits credited to date

Y. Projected Accrued Benefit Cost Method

III. Does not have a supplemental liability
In the list at the left are two items, lettered X and Y. In the list at the right are four items, numbered I, II, III and IV. EACH of the lettered items is related in some way to EXACTLY TWO of the numbered items. Match the lettered items (X and Y) with their numbered items (I, II, III and IV) shown below.

Indicate the related item using the following answer code:

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>I and II</td>
</tr>
<tr>
<td>(B)</td>
<td>I and III</td>
</tr>
<tr>
<td>(C)</td>
<td>I and IV</td>
</tr>
<tr>
<td>(D)</td>
<td>II and III</td>
</tr>
<tr>
<td>(E)</td>
<td>II and IV</td>
</tr>
</tbody>
</table>

10. X. Group long term disability income policy - common basic benefits
    I. Partial disability benefits
    II. Inflation protection
    III. Residual disability benefit
    IV. Survivor sum benefit

Each of the following questions consists of an assertion in the left-hand column and a reason in the right-hand column.

(A) If both the assertion and the reason are true statements, and the reason is a correct explanation of the assertion.
(B) If both the assertion and the reason are true statements, but the reason is **NOT a correct explanation** of the assertion.

(C) If the assertion is a true statement, but the reason is a false statement.

(D) If the assertion is a false statement, but the reason is a true statement.

(E) If both the assertion and the reason are false statements.

<table>
<thead>
<tr>
<th>ASSERTION</th>
<th>REASON</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Benefits under a survivor income benefit plan are typically a percentage of the employee’s monthly earnings.</td>
<td><strong>BECAUSE</strong> The benefit is intended to more closely meet the needs of employee’s surviving dependents</td>
</tr>
<tr>
<td>12. Solvency reserves are often lower than earnings reserves.</td>
<td><strong>BECAUSE</strong> Solvency reserve regulations are usually biased toward overstating future benefits and expenses, and underestimating future interest rates</td>
</tr>
<tr>
<td>13. Self-insured sick leave programs are rarely used in place of a formal STD insurance program.</td>
<td><strong>BECAUSE</strong> STD has a much higher frequency of claims than LTD, but has much smaller variation in claim duration</td>
</tr>
<tr>
<td>14. The normal cost determined under the Frozen Initial Liability (Attained Age Normal) Method is lower than the normal cost determined under the Frozen Initial Liability (Entry Age Normal) Method.</td>
<td><strong>BECAUSE</strong> The unfunded actuarial liability determined under the Frozen Initial Liability (Attained Age Normal) Method is larger than the unfunded actuarial liability determined under the Frozen Initial Liability (Entry Age Normal) Method.</td>
</tr>
<tr>
<td>15. Under the aggregate cost method, actuarial gains and losses are automatically</td>
<td><strong>BECAUSE</strong> Under the aggregate cost method, actuarial gains and losses are reflected in the unfunded liability</td>
</tr>
</tbody>
</table>
spread over the remaining service lifetimes of the active participants

16. The ultimate normal cost under the entry age cost method using the level dollar approach is higher than the entry age normal cost method using the level dollar approach.

BECAUSE

The entry age cost method using the level dollar approach generates a larger actuarial liability than the entry age normal cost method using the level percentage approach.

17. In a defined benefit plan, the employee bears the investment risk.

BECAUSE

In defined benefit plan, the employer will need to contribute less if there are bigger investment returns.

18. You are given the following information on asset classes available for constructing a new asset portfolio:

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Gross Yield</th>
<th>Annual Default Cost</th>
<th>Investment Expenses</th>
<th>Maturity (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Bonds</td>
<td>5.8%</td>
<td>0.00%</td>
<td>0.05%</td>
<td>3</td>
</tr>
<tr>
<td>Corporate Bonds</td>
<td>8.0</td>
<td>0.02</td>
<td>0.10</td>
<td>10</td>
</tr>
<tr>
<td>Junk Bonds</td>
<td>12.5</td>
<td>3.50</td>
<td>0.25</td>
<td>5</td>
</tr>
</tbody>
</table>

The company has decided to limit the investment in junk bonds to no more than 15%. The company’s objective is to have an average maturity of assets equal to six years.

Calculate the maximum net yield of the company’s portfolio given these restraints.

a) 6.7%

b) 7.0

c) 7.7

d) 8.0

e) 8.8
19. Rank in descending order (largest to smallest) the following life insurance products on Mary and John according to total annual premiums required.

I. Joint last survivor policy with death benefits of $200,000 on Mary and John
II. Joint with first-to-die policy with death benefits of $200,000 on Mary and John
III. Single life policy of $200,000 on Mary plus single life policy of $200,000 on John

(A) I > II > III
(B) I > III > II
(C) II > III > I
(D) III > I > II
(E) III > II > I

20. You are given the following information about a group health claim:

Incurral Date: June 1, 1997
Service Date: June 5, 1997
Reporting Date: June 25, 1997
Payment Date: June 27, 1997

Rank in ascending order (smallest to largest) the following:

I. Service Lag
II. Reporting Lag
III. Payment Lag
IV. Accrual Lag

(A) I < II < III < IV
(B) I < II < IV < III
(C) I < IV < II < III
(D) III < I < II < IV
(E) III < IV < I < II

21. You are given the following information on a dental insurance plan for which the paid claims are $50,000 every month.

<table>
<thead>
<tr>
<th>Month Incurred in June</th>
<th>% Claim Paid</th>
</tr>
</thead>
</table>
February or earlier 0%
March 7
April 14
May 31
June 48

Assume the same payment pattern occurs every month. Calculate an estimate of the total claims outstanding at June 30 using a claim lag table. Round to the nearest $1,000

(A) $26,000
(B) $37,000
(C) $40,000
(D) $50,000
(E) $75,000

The following questions relate to level term insurance

22. Operational efficiency is a core competency
   (A) True
   (B) False

23. Sophisticated distribution is a core competency
   (A) True
   (B) False
15. (4 points) Describe the similarities and differences in design components of Private Employer sponsored retirement plans and Government sponsored retirement plans.

16. (5 points) For the purpose of ratemaking, describe the relative merits of the pure premium and loss ratio methods for each of the following:

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Exposure Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Liability</td>
<td>Car Year</td>
</tr>
<tr>
<td>Homeowners</td>
<td>Dwelling Year</td>
</tr>
<tr>
<td>Products Liability</td>
<td>Annual Sales</td>
</tr>
</tbody>
</table>

17. (8 points) You are the actuary for a non-contributory pension plan that provides a pension equal to 1.5% of final 3-year average salary for each year of service, up to a maximum of 35 years.
You are given the following:

<table>
<thead>
<tr>
<th>Actuarial cost method:</th>
<th>Projected Unit Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumptions:</td>
<td></td>
</tr>
<tr>
<td>Interest rate</td>
<td>7%</td>
</tr>
<tr>
<td>Compensation increase</td>
<td>5%</td>
</tr>
<tr>
<td>Decrements before retirement</td>
<td>none</td>
</tr>
<tr>
<td>Retirement age</td>
<td>65</td>
</tr>
</tbody>
</table>
Life annuity factor for age 65 (payable monthly) = 10.0

<table>
<thead>
<tr>
<th>Data as of January 1, 1995</th>
<th>Adam</th>
<th>Eve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of birth</td>
<td>1/1/35</td>
<td>1/1/55</td>
</tr>
<tr>
<td>Date of hire</td>
<td>1/1/60</td>
<td>1/1/90</td>
</tr>
<tr>
<td>Salary</td>
<td>$40,000</td>
<td>$50,000</td>
</tr>
</tbody>
</table>

You are asked to consider two different approaches for the funding of the plan:

Approach 1: Benefits prorated on accrued service
Approach 2: Benefits prorated on projected total service until retirement

(a) Calculate the Normal Cost and the Actuarial Liability for both participants as of January 1, 1995 under:

(i) Approach 1
(ii) Approach 2

Describe the similarities and the differences between these two approaches.

18. (4 points) You are pricing a participating one-year nonconvertible, non-renewable term product. The following assumptions are used for pricing and valuation of the age 35, female, non-smoker class:

- Assumed investment returns are 2% for the year
- There will be 5 deaths per 1,000 (end of year)
- Commission is 5% of premium
- Premium taxes are 2% of premium
- Investment expenses are $4 per 1,000 of face amount
- No lapses are expected for the year
- The contribution to surplus required is 3% of premium
- All surplus is distributable at the end of the year
- Sales volume was $100 million at the beginning of the year

At the end of the year, your actual experience shows that:

- The investment returns were 12% for the year
- There was one death claim of $100,000 at the end of the year
- All other experience factors emerged as expected.

(a) Calculate the gross and net annual premium rates for this class.

Show all work.
19. (4 points) Describe life insurance company expenses and how they are reflected in pricing.

20. (5 points) Your company is considering the purchase of a large block of group disability income policies with both short duration and long duration coverage.

   Describe the considerations involved in estimating appropriate reserves for these policies.

21. (5 points) Compare and contrast the expected loss-ratio method and the loss-development triangle method for calculating Property and Casualty loss reserves.

22. (5 points)
   (a) Describe some of the manifestations of old age security problems in different parts of the world.
   (b) Outline some of the reasons why government cannot rely on voluntary actions by individuals to provide for their old age security.
   (c) Describe different ways government can get involved in old age security.

COURSE 5 SAMPLE EXAM MULTIPLE CHOICE QUESTIONS

ANSWER KEY

1. C 13. D
2. E (Y to II and III) 14. E
3. A 15. A
4. E (Y to II and III) 16. A
5. E 17. D
8. D 20. C
10. B 22. A
Course 5

Sample answers for select Written-answer and Short-answer questions

- Question #8 (written-answer)
- Question #9 (short-answer)
- Question #10 (short-answer)
- Question #12 (short-answer)
The Committee is unable to provide full solutions to the sample questions in time to provide useful assistance to candidates studying for the November 2000 Course 5 exam. Accordingly, answers are provided for a very limited set of written-answer and short-answer questions as an indication of the types of answers expected. Candidates are encouraged to share their solutions through the online study groups and submission to the SOA office.

Sample for written-answer questions:

Question #8 (4 points)

With respect to mortality rates and selection of mortality tables for pricing . . .

(a) Describe factors that can affect the mortality rates experienced by your company

Answer:

• Mortality experience can vary from company to company.

• Factors that can affect mortality would include:
  1. Personal risk factors including:
     • gender
     • age
     • medical history
  2. Environmental Risk Factors, such as air and water pollution
  3. Geographic location risk factors
     • exposure to tropical diseases
  4. Medical care – access, quality, cost
5. Cultural differences
   • incidence of fraud or violence

6. Underwriting processes
   • Experience of underwriters
   • Underwriting methods and tools
   • Level of aggressiveness
   • Consistency
   • Agents’ roles
   • Information collected for underwriting

7. Possibility of Catastrophic events
   • wars
   • epidemics
     • natural disasters – earthquakes, floods, etc.

(b) Define the types of mortality tables and describe the considerations in choosing the type of table to use.

Answer:

- There are three basic types of mortality tables:

Sample for written-answer questions (cont.):

Question #8 (4 points)

1. Aggregate tables

   Definition:
   • Rates vary only by the attained age of the insured.
   • Is not affected by the issue age or policy year.

   Considerations:
   • Use of an aggregate table is not likely to accurately reflect the selection effect of underwriting.

2. Select tables

   Definition:
   • Rates vary by both issue age and policy year.
   • Lower mortality rates result from the selection effect of underwriting.

   Considerations:
   • Most select tables are constructed from industry data
3. Select and ultimate tables

Definition:
• Combination of select and aggregate tables.
• The select table is used for the first portion of the policy lifetime (typically 15 to 20 years)
• The effect of selection wears off over time.
• The aggregate table (also called “ultimate” after the effect of selection has worn off)

Considerations:
• Many years of data are needed to develop a reliable select and ultimate table.
• Discontinuities may occur when shifting from select to ultimate rates.
• Discontinuities may indicate that a longer select period should be used.

Sample for short-answer questions

Question #9 (1 point)

Describe modified coinsurance reinsurance.

Answer:
• With a standard coinsurance arrangement, the ceding company pays a share of premiums to the reinsurer, and the reinsurer shares in the loss exposure with the ceding company by the same percentage. The reinsurer also generally pays the ceding company an expense allowance.
• “Modco” is a variation of coinsurance where the company retains all invested assets.
• As a result, the ceding company retains the reinsurer’s share of reserves and related assets, and the reinsurer periodically pays the company its share of the reserve increases.
• Ceding company pays the reinsurer for its share of reserve decreases, and provides reimbursement for interest on the reserves that the ceding company holds on behalf of the reinsurer.
Sample for short-answer questions

Question #10 (1 point)

List the Social Purposes of income taxation:

Answer:

List at least five of the following for full credit –

- Redistribution of income
- Encouraging charitable donations
- Encouraging specific types of construction
- Promoting high health standards and financial security of employees
- Encouraging women to enter the work force
- Reducing the economic effect of catastrophic events
- Promoting savings for socially, culturally or economically desirable purposes
- Encouraging the operation of small businesses
Sample for short-answer questions

Question #12 (1 point)

Define subrogation.

Answer:

- The insurer assumes the legal rights of the policyholder.
- This happens once the insurer has indemnified the policyholder for the loss.
- The insurer can then sue the party at fault to recover its costs.
- The true costs are more appropriately allocated to the party at fault, rather than to an innocent victim.