# Assessment Report

**For**  
Department of Mathematics & Statistics  
(Academic Unit Name)

<table>
<thead>
<tr>
<th>2013-14 Academic Year</th>
<th>December 19, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Assessment Period Covered)</td>
<td>(Date Submitted)</td>
</tr>
</tbody>
</table>

Include Assessment Reports for the Instructional Programs listed below:

<table>
<thead>
<tr>
<th>Title of Degree Program</th>
<th>Degree Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science in Applied Mathematics (Option Actuarial Science)</td>
<td>Bachelor</td>
</tr>
</tbody>
</table>

Submitted By: Narendra Kumar Govil, Associate Chair  
(Department or Unit Representative)
Assessment Report
For

Bachelor of Science in Applied Mathematics
(Option Actuarial Science)
(Instructional Degree Program)

Academic Year 2013-14
(Assessment Period Covered)

Bachelor
(Degree Level)

December 19, 2013
(Date Submitted)

NOTE: There should be one form B for each degree program offered by your department.

Expected Outcomes of this Degree Program:
When they complete this degree program, students will be able to . . .

1. Actuarial Mathematics

When the students complete this degree program, they will be able to demonstrate to have acquired the understanding of the concepts in Actuarial Mathematics, in topics including, Survival Functions, Insurance Benefit, Premiums, and Annuities.

2. Probability and Statistics

When students complete this degree program, they will be able to demonstrate to have acquired the understanding of the concepts in Probability and Statistics, in topics including, Basic Concepts, Discrete Distributions, Continuous Distributions, and Functions of Normal Random Variables.

3. <Brief description>

<Full description>

4. <Brief description>

<Full description>

5. <Brief description>

<Full description>

6. <Brief description>

<Full description>

If you wish to record additional expected outcomes, simply cut and paste one of the boxes above.
NOTE: There should be at least one form C for each expected outcome listed on form B. If you used more than one assessment method to gather information about an expected outcome, there should be one form C for each assessment method. Thus, if you studied three outcomes during the year and used two means of assessment to gather information about each outcome, you would provide a total of six different copies of form C.

Expected Outcome Brief Description:

Students will demonstrate an understanding of concepts in Actuarial Mathematics, in topics including, Survival Functions, Insurance Benefit, Premiums, and Annuities.

Assessment Method, Brief Description:

Common Examination on Items

Assessment Method, Full Description:

The Chair of the department Dr. T.Y. Tam set up an Assessment Committee of the department for the purpose of assessing the programs, comprising of the faculty N.K. Govil (Chair), Ziqin Feng (Co-chair), Dmitry Glotov (Member), Erkan Nane (Member) and Jessica McDonald (Member). This committee then identified some concepts in Actuarial Mathematics that the committee thought every undergraduate student majoring in Applied Mathematics (Option Actuarial Science) must know before graduation. Also, this committee helped in making a test having minimum of two questions on each of these concepts, which was then used to find learning outcomes to test the understanding of different concepts in Actuarial Mathematics, that have been identified by the committee.

The students were given this test towards the end of Fall Semester 2013 in the course on “Actuarial Mathematics” and the data concerning the performance in these tests was collected and analyzed. The total number of students who took this test for learning outcome “Understanding of Concepts in Actuarial Mathematics” was 20, and every undergraduate student majoring in Applied Mathematics (Option Actuarial Science) is required to take this test at some stage because the course where these concepts are covered is a required course for graduation. A copy of the Test is attached with this form.

The data, along with its analysis, concerning the performance in this test is given in the next section, which is on “Assessment Method, Findings”.

Assessment Method, Findings:

In the table given below, the data (and its analysis) is obtained on the basis of test given to students. Test items, 1 and 2, are on the concept, Survival Functions; test items, 3, 4, 5 and 6, are on the concept,
Insurance Benefit, and so on. The average proportion of students answering test items 1 and 5 correctly is 60%, and similarly the average proportion of students answering test items 2, 4, 9, and 10 is 81%. See the Appendix 2 for more detailed findings of the assessment.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Test Items Addressing This Learning Goal</th>
<th>Average Proportion of Students Answering These Questions Correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival Functions</td>
<td>1 and 2</td>
<td>60%</td>
</tr>
<tr>
<td>Insurance Benefit</td>
<td>3, 4, 5 and 6</td>
<td>81%</td>
</tr>
<tr>
<td>Premiums</td>
<td>7 and 8</td>
<td>53%</td>
</tr>
<tr>
<td>Annuities</td>
<td>9 and 10</td>
<td>80%</td>
</tr>
</tbody>
</table>

Based on the table given above we find that the students appear to be strong in “Insurance Benefit” and “Annuities”, not so strong in “Survival Functions”, while weak in “Premiums”.

**Assessment Method, Use of Findings for Improvement:**

The findings obtained and mentioned in the above section on “Assessment Method, Findings” were discussed with the members of the committee and agreed upon that the instructors teaching these concepts in future will be told of these finding and advised to take measures for correcting this by

(i) Spending more time on the topics, “Survival Functions” and “Premiums” where students appear to be not so strong or are weak.

(ii) Provide longer office hours, and encourage students to seek help during the office hours.

Also, the committee will place a request to the department chair to provide some Graduate Teaching Assistants, or some other means so that the students could be provided some extra help in “Survival Functions” and “Premiums”, where they are not so strong or are weak.

**Any Additional Comments?**
Appendix 1. Test used for the Assessment:

A copy of the test prepared with the help of the Department Assessment Committee, and used for the purpose of assessment is attached below.

MATH5800 PROBLEMS FOR UNDERGRADUATE PROGRAM ASSESSMENT

1. You are given:
   (i) An excerpt from a select and ultimate life table with a select period of 2 years:

<table>
<thead>
<tr>
<th>$x$</th>
<th>$l_x$</th>
<th>$l_x+1$</th>
<th>$l_{x+2}$</th>
<th>$x+2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>99,000</td>
<td>96,000</td>
<td>93,000</td>
<td>52</td>
</tr>
<tr>
<td>51</td>
<td>97,000</td>
<td>93,000</td>
<td>89,000</td>
<td>53</td>
</tr>
<tr>
<td>52</td>
<td>93,000</td>
<td>88,000</td>
<td>83,000</td>
<td>54</td>
</tr>
<tr>
<td>53</td>
<td>90,000</td>
<td>84,000</td>
<td>78,000</td>
<td>55</td>
</tr>
</tbody>
</table>

   (ii) Deaths are uniformly distributed over each of year of age.

   Calculate $10,000 \, q_{[51]+0.5}$
   (A) 705
   (B) 709
   (C) 713
   (D) 1070
   (E) 1074

2. You are given:
   (i) $S_0(t) = \left(1 - \frac{t^{1/4}}{\omega}\right)$, for $0 \leq t \leq \omega$
   (ii) $\mu_{65} = \frac{1}{189}$

   Calculate $e_{106}$, the curtate expectation of life at age 106.
   (A) 2.2
   (B) 2.5
   (C) 2.7
   (D) 3.0
   (E) 3.2

3. For a fully discrete 3-year term insurance of 1000 on $(x)$, you are given:
   (i) $p_x = 0.975$
   (ii) $i = 0.06$
   (iii) The actuarial present value of the death benefit is 152.85
   (iv) The annual benefit premium is 56.05

   Calculate $p_{x+2}$.
   (A) 0.91
4. For a special increasing whole life insurance on (40), payable at the moment of death, you are given:
   (i) The death benefit at time $t$ is $b_t = 1 + 0.2t$, $t \geq 0$
   (ii) The interest discount factor at time $t$ is $v(t) = (1+0.2t)^{-2}$, $t \geq 0$
   (iii) $\nu_{40|40+t} = \begin{cases} 0.025, & 0 \leq t < 40 \\ 0, & \text{otherwise} \end{cases}$
   (iv) $Z$ is the present value random variable for this insurance.
   Calculate $\text{Var}(Z)$.
   (A) 0.032
   (B) 0.036
   (C) 0.040
   (D) 0.044
   (E) 0.048

5. $Z$ is the present-value random variable for a whole life insurance of $b$ payable at the moment of death of $(x)$. You are given:
   (i) $\delta = 0.04$
   (ii) $\mu_{x+t} = 0.02$, $t \geq 0$
   (iii) The single benefit premium for this insurance is equal to $\text{Var}(Z)$
   Calculate $b$.
   (A) 2.75
   (B) 3.00
   (C) 3.25
   (D) 3.50
   (E) 3.75

6. For a special whole life insurance on $(x)$, you are given:
   (i) $Z$ is the present value random variable for this insurance.
   (ii) Death benefits are paid at the moment of death.
   (iii) $\mu_{x+t} = 0.02$, $t \geq 0$.
   (iv) $\delta = 0.08$.
   (v) The death benefit at time $t$ is $b_t = e^{0.03t}$, $t \geq 0$.
   Calculate $\text{Var}(Z)$.
   (A) 0.075
   (B) 0.080
   (C) 0.085
   (D) 0.090
(E) 0.095

7. For a fully discrete whole life insurance of 1000 on \( (x) \), you are given:
   (i) The following expenses are incurred at the beginning of each year:

<table>
<thead>
<tr>
<th>Percent of premium</th>
<th>Year 1</th>
<th>Year 2+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75%</td>
<td>10%</td>
</tr>
<tr>
<td>Maintenance expenses</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

   (ii) An additional expense of 20 is paid when the death benefit is paid.
   (iii) The gross premium is determined using the equivalence principle.
   (iv) \( i = 0.06 \).
   (v) \( \bar{a}_x = 12.0 \).
   (vi) \( 2A_x = 0.14 \).

   Calculate the variance of the loss at issue random variable.
   (A) 51,700
   (B) 70,300
   (C) 88,900
   (D) 90,500
   (E) 95,800

8. For a fully discrete whole life insurance of 1000 on \( (50) \), you are given:
   (i) The annual per policy expense is 1.
   (ii) There is an additional first year expense of 15.
   (iii) The claim settlement expense of 50 is payable when the claim is paid.
   (iv) All expenses, except the claim settlement expense, are paid at the beginning of the year.
   (v) \( l_x = 20(100 - x), \ 0 \leq x \leq 100 \).
   (vi) \( i = 0.05 \).

   Calculate the level gross premium using the equivalence principle.
   (A) 29
   (B) 31
   (C) 33
   (D) 35
   (E) 37

9. For a special whole life insurance policy issued on \( (40) \), you are given:
   (i) Death benefits are payable at the end of the year of death.
   (ii) The amount of benefit is 2 if death occurs within the first 20 years and is 1 thereafter.
(iii) $Z$ is the present value random variable for the payments under this insurance.

(iv) $i = 0.03$.

(v) \[
\begin{array}{c|c|c}
 x & A_x & 20E_x \\
\hline
40 & 0.36987 & 0.51276 \\
60 & 0.62567 & 0.17878 \\
\end{array}
\]

(vi) $E[Z^2] = 0.24954$

Calculate the standard deviation of $Z$.

(A) 0.17
(B) 0.22
(C) 0.27
(D) 0.32
(E) 0.37

10. For a continuously increasing whole life insurance on $(x)$, you are given:

(i) The force of mortality is a constant

(ii) $\delta = 0.06$

(iii) $A_x = 0.25$

Calculate $(TA)_x$

(A) 2.50
(B) 3.00
(C) 3.50
(D) 4.00
(E) 4.50
Appendix 2. Table with Detailed Data:

Given below is the table consisting of the data (and its analysis) collected on the basis of scores obtained by the students in the test. In this table, s1, s2, s3, …, refer to Student #1, Student #2, Student #3, and so on. For example Student #1 obtained a score of 1 on Question #1, score of 1 on Question #2, a score of 1 on Question #3, and so on, and thus obtaining average of 90% in all the questions. Similarly looking at the first (two rows covered in purple) of the table we find that all the students obtained an average of 60% on the concept of “Survival Functions” (covered by Questions 1 and 2), an average of 81% on the concepts of “Insurance Benefit” (covered by Questions 3, 4, 5 and 6), an average of 53% on the concepts of “Premiums” (covered by Questions 7 and 8), and 80% on the concepts of “Annuities” (covered by Questions 9 and 10). This data has been summarized in the Table given above in the Section on “Assessment Method, Findings”.

| Questions | s1 | s2 | s3 | s4 | s5 | s6 | s7 | s8 | s9 | s10 | s11 | s12 | s13 | s14 | s15 | s16 | s17 | s18 | s19 | s20 |
|-----------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1         | 1  | 1  | 0  | 1  | 0  | 1  | 0  | 0  | 0  | 1   | 0   | 0   | 1   | 0   | 0   | 0   | 0   |     |     |     |
| 2         | 2  | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 0  | 1   | 1   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 0   | 0   |
| 3         | 3  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1   | 0   | 1   | 1   | 0   | 1   | 0   | 1   | 1   | 0   | 1   |
| 4         | 4  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 0   | 1   | 1   |
| 5         | 5  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1   | 0   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 1   | 1   |
| 6         | 6  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1   | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 1   | 1   |
| 7         | 7  | 1  | 1  | 0  | 1  | 1  | 1  | 0  | 1  | 1   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   |
| 8         | 8  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 0   | 1   | 0   | 1   |
| 9         | 9  | 1  | 0  | 1  | 1  | 1  | 1  | 0  | 1  | 1   | 1   | 1   | 1   | 1   | 0   | 1   | 1   | 1   | 1   | 1   | 0   |
| 10        | 10 | 1  | 1  | 1  | 0  | 1  | 1  | 0  | 1  | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 1   | 0   | 0   | 1   |

Survival Functions 65%
Insurance Benefit 81%
Premiums 53%
Annuities 80%
Assessment Report

For

Bachelor of Science in Applied Mathematics
(Option Actuarial Science)
(Instructional Degree Program)

Bachelor
(Degree Level)

Academic Year 2013-14
(Assessment Period Covered)

December 19, 2013
(Date Submitted)

NOTE: There should be at least one form C for each expected outcome listed on form B. If you used more than one assessment method to gather information about an expected outcome, there should be one form C for each assessment method. Thus, if you studied three outcomes during the year and used two means of assessment to gather information about each outcome, you would provide a total of six different copies of form C.

Expected Outcome Brief Description:

Students will demonstrate an understanding of concepts in Probability and Statistics, in topics including, Basic Concepts, Discrete Distributions, Continuous Distributions, and Functions of Normal Random Variables.

Assessment Method, Brief Description:

Common Examination on Items

Assessment Method, Full Description:

The Chair of the department Dr. T.Y. Tam set up an Assessment Committee of the department for the purpose of assessing the programs, comprising of the faculty N.K. Govil (Chair), Ziqin Feng (Co-chair), Dmitry Glotov (Member), Erkan Nane (Member) and Jessica McDonald (Member). This committee then identified some concepts in Probability and Statistics that the committee thought every undergraduate student majoring in Applied Mathematics (Option Actuarial Science) must know before graduation. Also, this committee helped in making a test having minimum of two questions on each of these concepts, which was then used to find learning outcomes to test the understanding of different concepts in Probability and Statistics, that have been identified by the committee.

The students were given this test towards the end of Fall Semester 2013 in the course on “Probability and Statistics” and the data concerning the performance in these tests was collected and analyzed. The total number of students who took this test for learning outcome “Understanding of Concepts in Probability and Statistics” was 3, and every undergraduate student majoring in Applied Mathematics (Option Actuarial Science) is required to take this test at some stage because the course where these concepts are covered is a required course for graduation. A copy of the Test is appended at the end of this form, as Appendix 1.

The data, along with its analysis, concerning the performance in this test is given in the next section, which is on “Assessment Method, Findings”.

Assessment Method, Findings:
In the table given below, the data (and its analysis) is obtained on the basis of test given to students. Test items, 1 and 2, are on the concept, Basic Concepts; test items, 3 and 4, are on the concept, Discrete Distributions, and so on. The average proportion of students answering test items 1 and 2 correctly is 50%, on items 3 and 4 it is 67%, on items 5, 6, 7 and 8 it is 100%, and on items 9 and 10, it is 17%. See the Appendix 2 for more detailed findings of the assessment.

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<thead>
<tr>
<th>Topics</th>
<th>Test Items Addressing This Learning Goal</th>
<th>Average Proportion of Students Answering These Questions Correctly</th>
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<tr>
<td>Basic Concepts</td>
<td>1 and 2</td>
<td>50%</td>
</tr>
<tr>
<td>Discrete Distributions</td>
<td>3 and 4</td>
<td>67%</td>
</tr>
<tr>
<td>Continuous Distributions</td>
<td>5, 6, 7, and 8</td>
<td>100%</td>
</tr>
<tr>
<td>Functions of Normal Random Variables</td>
<td>9 and 10</td>
<td>17%</td>
</tr>
</tbody>
</table>

Based on the table given above we find that the students appear to be strong in “Continuous Distributions” and “Discrete Distributions”, not so strong in “Basic Concepts”, while weak in “Functions of Normal Random Variables”.

**Assessment Method, Use of Findings for Improvement:**

The findings obtained and mentioned in the above section on “Assessment Method, Findings” were discussed with the members of the committee and agreed upon that the instructors teaching these concepts in future will be told of these finding and advised to take measures for correcting this by

(i) Spending more time on the topics, “Basic Concepts” and “Functions of Normal Random Variables” where students appear to be not so strong or are weak.

(ii) Provide longer office hours, and encourage students to make use of the Instructor’s office hours.

Also, the committee will place a request to the department chair to provide some Graduate Teaching Assistants or some other means so that the students could be provided some extra help in the topics “Basic Concepts” and “Functions of Normal Random Variables”, where the students are not so strong or are weak.

**Any Additional Comments?**

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**Appendix 1. Test used for the Assessment:**

Appended below is the copy of the test prepared with the help of the Department Assessment Committee, and used for the purpose of assessment.
I. Basic Concepts

1. Two events $A$ and $B$ in a sample space are mutually exclusive means that $P(A \cup B) = P(A) + P(B)$. True False

2. Any probability function $P: S \rightarrow [0,1]$ satisfy $P(A \cup B) = P(A) + P(B)$ for any two events $A$ and $B$. True False

II. Discrete Distributions

3. Sample mean value can be used as measure of variability of values in the sample. True False

4. $63/512$ is the probability that the fifth head is observed on the 10th independent flip of a fair coin. True False

III. Continuous Distributions

5. Histogram of the observations from a continuous population can be seen as an approximation to the probability density function of the random variable. True False

6. Median of a Uniform $(0, 1)$ random variable is 0.5. True False

7. Chi-squared distribution with $r$-degrees of freedom is a special Gamma distribution. True False

8. If the joint density of the random vector $(X, Y)$ is given as a product of the marginal probability density functions then $X$ and $Y$ are independent. True False

IV. Functions of Normal Random Variables

9. Sum of two normal random variables is normal. True False

10. Sampling distribution of the sample mean has normal distribution. True False

Appendix 2. Table with Detailed Data:

Given below is the table consisting of the data (and its analysis) collected on the basis of scores obtained by the students in the test. In this table, $s1$, $s2$, $s3$, refer to Student # 1, Student # 2, Student # 3. For example Student #1 obtained a score of 0 on Question # 1, score of 1 on Question # 2, a score of 1 on Question # 3, and so on, and thus obtaining average of 70% in all the questions. Similarly looking at the first two rows (covered in purple) of the table we find that all the students obtained an average of 50% on the concept of “Basic Concepts” (covered by Questions 1 and 2), an average of 67% on the concepts of “Discrete Distributions” (covered by Questions 3 and 4), an average of 100% on the concepts of ...
“Continuous Distributions” (covered by Questions 5, 6, 7 and 8), and 17% on the concepts of “Functions of Normal Random Variables” (covered by Questions 9 and 10). This data has been summarized in the Table given above in the Section on “Assessment Method, Findings”.

<table>
<thead>
<tr>
<th>Questions</th>
<th>s1</th>
<th>s2</th>
<th>s3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td>1</td>
<td>1</td>
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<td>10</td>
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<thead>
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<th>Basic Concepts</th>
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