

*Curriculum for MTH 4452: Short Term Actuarial Mathematics II*

1. Frequentist Estimation
  - Method of moments and percentile matchings
  - Maximum Likelihood estimation
  - Variance and Interval estimation
  - Non-normal confidence intervals
  - Maximum likelihood estimation of decrement probabilities
2. Frequentist Estimation for Discrete Distributions
  - Poisson
  - Negative binomial
  - Binomial
  - The (a,b,1) class
  - Effects of exposure on maximum likelihood estimation
3. Bayesian estimation
  - Inference and Prediction
  - Conjugate prior distributions and the linear exponential family
4. Model Selection
  - Representations of the data and model
  - Graphical comparison of the density and distribution functions
  - Hypothesis tests
    - Kolmogorov-Smirnov test
    - Chi-square goodness-of-fit test
    - Likelihood ratio test
  - Selecting a modeling
    - Judgment-based approaches
    - Score-based approaches
5. Limited Fluctuation Credibility
  - Limited fluctuation credibility theory
  - Full credibility
  - Partial credibility
6. Greatest accuracy credibility
  - The Bayesian methodology
  - The credibility premium
  - The Buhlmann model and the Buhlmann-Straub model
  - Exact credibility
7. Empirical Bayes Parameter Estimation
  - Non-parametric estimation
  - Semi-parametric estimation
8. Simulation
  - Simulation for specific distributions
  - Examples of simulation in actuarial modeling

**Course Materials:**

Klugman, et. al., *Loss Models: From Data to Decisions*, 4<sup>th</sup> edition, Wiley, 2012

*Foundations of Casualty Actuarial Science*, Fourth Edition, Short-Term Actuarial Mathematics Study Note, CAS, 2001

*Topics in Credibility Theory*, Short-Term Actuarial Mathematics Study Note, SOA 2005

Instructor's notes published on Blackboard

## Sample Course Schedule:

- Section numbers correspond to “*Loss Models: From Data to Decisions*” by Klugman, et.al.
- Sections or suggested problems beginning with an “S” are from *Topics in Credibility Theory*, Short-Term Actuarial Mathematics Study Note, SOA 2005
- Some topics may be supplemented with information from *Foundations of Casualty Actuarial Science*, Fourth Edition, Short-Term Actuarial Mathematics Study Note, CAS, 2001 or other notes published by the SOA or CAS.

| Lect. #   | Topics  | Suggested Problems   |
|-----------|---|--|
| 1         | 13.1: Method of Moments   | 13.1, 13.3, 13.4, 13.5, 13.6, 13.7, 13.9, 13.11, 13.15, 13.17, 13.21 |
| 2         | 13.2: Maximum likelihood estimation (mle)   | 13.26, 13.27, 13.30, 13.33, 13.34, 13.36, 13.42, 13.47, 13.48, 13.56 |
| 3         | 13.3: Variance and interval estimation<br>13.4: Non-normal confidence intervals<br>13.5: MLE of decrement probabilities   | 13.62, 13.65, 13.66, 13.68, 13.71, 13.72<br>13.76<br>13.77           |
| 4         | 14.1 – 14.4: Frequentist Estimation for Discrete Distributions - Poisson, negative binomial, binomial, and the (a,b,1) class<br>14.6: Effect of exposure on mle | 14.1, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8                             |
| 5         | 15.2: Inference and Prediction  | 15.3, 15.4, 15.6, 15.11, 15.12, 15.14, 15.15, 15.17, 15.18           |
| 6         | 15.3: Conjugate prior distribution<br>16.2: Representations of the data and model   | 15.21, 15.22, 15.23, 15.25, 15.27                                    |
| 7         | 16.3: Graphical comparison<br>16.4.1: Kolmogorov-Smirnov test   | 16.1, 16.2, 16.3<br>16.4, 16.5, 16.6                                 |
| 8         | 16.4.3: Chi-square goodness-of-fit test   | 16.9, 16.10, 16.12, 16.17, 16.18, 16.19                              |
| 9         | 16.4.4: Likelihood ratio test   | 16.13, 16.21   |
| 10        | 16.5: Selecting a model   | 16.22, 16.24, 16.26, 16.28,  |
| 11        | Review for Test 1   |  |
| <b>12</b> | <b>Test 1 - in class - Chapters 13 - 16</b>   |  |
| 13        | 17.2: Limited fluctuation credibility theory<br>17.3: Full credibility  | 17.1, 17.2, 17.5, 17.8, 17.9, 17.10, 17.14, 17.16                    |
| 14        | 17.4: Partial credibility   | 17.3, 17.6, 17.7, 17.11, 17.13                                       |
| 15        | 18.3: The Bayesian methodology  | 18.8(a-j), 18.9(a-j), 18.15(a), 18.23(a), 18.34                      |
| 16        | 18.4: The credibility premium   | 18.10, 18.13   |
| 17        | 18.5: The Bühlmann model  | 18.8(k,l), 18.9(k-m), 18.11  |
| 18        | 18.5: The Bühlmann model (cont.)<br>S1.1: The Bühlmann model  | 18.15(b), 18.19, 18.23(b)<br>S3                                      |

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|-----------|---|-----------------------------------|
| 19        | <i>18.6: The Bühlmann-Straub model</i><br><i>S1.2: The Bühlmann-Straub model</i>                      | 18.45<br>S4 - S11                 |
| 20        | <i>18.7: Exact credibility</i>  | 18.14                             |
| 21        | Review for Test 2   |                                   |
| <b>22</b> | <b>Test 2 - in class - Chapters 17-18</b>   |                                   |
| 23        | <i>19.2: Nonparametric estimation</i><br><i>S2.1: Nonparametric estimation</i>                        | 19.6, 19.10, 19.11<br>S12 - S19   |
| 24        | <i>19.3: Semiparametric estimation</i><br><i>S2.2: Semiparametric estimation</i>                      | 19.12, 19.13<br>S20, S21, S22     |
| 25        | <i>20.2.1: Simulation for discrete mixtures</i>   | 20.3, 20.5                        |
| 26        | <i>20.2.3: Simulating from the (a,b,0) class</i><br><i>20.2.4: Normal and lognormal distributions</i> | 20.4<br>20.6                      |
| 27        | <i>20.4: Simulation in actuarial science</i>  | 20.11, 20.13, 20.18, 20.20, 20.24 |
| 28        | Review for final exam   |                                   |
|           | <b>Final Exam - cumulative</b>  |                                   |