KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF MATHEMATICS & STATISTICS
DHAHRAN, SAUDI ARABIA

AS475: Survival Models for Actuaries - **Term 132** **(3-0-3)**

Course Objectives:

The statistical process of analyzing survival data, particularly for insurance applications. Techniques for estimating mortality rates; construction of mortality tables from the records of insured lives, employee benefit plans, and population statistics. Life tables, graph and related procedures. Graduation. Special attention to censoring and truncation. Single samples: complete or Type II censored data and Type I censored data for Exponential, Weibull, Gamma and other Distributions. Parametric regression for Exponential, Weibull and Gamma Distributions. Distribution-free methods for proportional hazard and related regression models.

Prerequisites: STAT302 and STAT310

We shall often refer to the description of SOA Exam C at:
http://www.beanactuary.org/exams/preliminary/exams/syllabi/2013-02-exam-c.pdf

Textbook and Package:

1. Kleinbaum, D. G. & Klein, M. (2012). *Survival Analysis: A Self-Learning Text 3rd edition*. New York, USA: Springer.
2. Chap 11 through 16 of Klugman, S.A., Panjer, H.H. and Willmot, G.E. (2012). *Loss Models: From Data to Decisions* 4th Edition. Wiley and the Society of Actuaries: Hoboken, NJ.
3. Texas BAII Plus Calculator or Texas BAII Professional

Reference:

1. Hosmer, D. W. & Lemeshow, S. (2003). Applied Survival Analysis: Regression Modeling of Time to Event Data, 2nd ed., John Wiley and Son, New York.

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Office Hours: UTR: 11.05-11.50am and 1.00pm -1.45pm or by appointment.

Assessment

Assessment for this course will be based on attendance, homework, term report, 3 major exams and a comprehensive final exam, as in the following:

Activity	Weight
Attendance, homework and Term Paper Report	(2%+5%+10%)
Exam 1 (Chapters 1, 2, & 3) **Monday (Mar 3 – week 6) , 6.00 pm (venue TBA)**	20%
Exam 2 (Chapters 4 & 5) **Wednesday (Apr 2- week 9), 7:00 pm (venue TBA)**	20%
Exam 2 (Chapters 6 & 7) **Monday (May 3 - week 14), 7:00 pm (venue TBA)**	18%
Final Exam (Comprehensive) **Sunday May 18 7pm (as posted on registrar website)**	25%

IMPORTANT NOTE on GRADES: There is no quota on the number of students who can get an A+ grade.

- ✓ ***Attendance*** on time is ***very*** important. Mostly, attendance will be checked within the ***first five minutes*** of the class. Entering the class after that, is considered as late (**2 lates= 1 Absence**) and
- ✓ **More than 10 minutes late = Absence** (regardless of any excuse).

Letter grade	A+	A	B+	B	C+	C	D+	D	F	DN
Cut-off	90%	85%	80%	75%	67%	60%	55%	50%	<50%	≥ 9 absences

General Notes:

- Students are required to carry **pens**, **note-taking equipment** and a **calculator** to **EVERY lecture and exams**. It is strongly recommended to keep a **binder** for class-notes.
- Students are also expected to bring the book, take notes and organize their solved questions in a **binder** for easy retrieval to help them in study and review for class, exams, etc
  - It is to the student's advantage to keep a binder for storing class notes, homework, and other graded assignments. Students who are **organized** will find it **easier** to find important materials when **studying for exams**.

- To successfully prepare for the SOA exams, students MUST **solve problems** regularly and with discipline. The selected assigned problems are specifically designed to prepare you for major and final exams. So, it is expected that you complete these problems **step-by-step** and with comprehension.
  - If you happen to stumble upon a solution manual somewhere, remember 2 important points. (1) Due to publishing costs and deadlines, these solutions are brief and may have mistakes and (2) in your career as an actuary and your exams and quizzes in this class, you are expected to know every step to a problem and to know if a solution is incorrect. Thus, the best way to solve problem is without these brief solutions.
- ***Never round*** your intermediate results to problems when doing your calculations. This will cause you to lose calculation accuracy. Your answers may then be different from the SOA exam key even when you use the right procedure.
- For every exam, so you need to bring with you ***pens***, ***pencils***, ***a sharpener***, ***an eraser***, and a ***SOA approved calculator***.
- Students should wait until completion of the next course AS482 before they attempt to take the professional exam MLC.

Academic Integrity: All KFUPM policies regarding **ethics** and **academic honesty** apply to this course.

Syllabus (Tentative)

Week	*Sections*	Topics	*Notes*
1 (Jan 26 –30)	Ch 1 KK	**Introduction to Survival Analysis (2-1/2 class).**	
2 (Feb 2 – 6)	Supplementary	**Life Table functions (from reference book KPW)**	
3 (Feb 9 – 13)	Ch 11 and 12 KPW	**Estimation of Actuarial Survival Data** Nelson-Aalen Estimate.	
4 (Feb 16 – 20)	Ch 2 KK	**Kaplan-Meier Survival Curves and the Log-Rank Test**	
5 (Feb 23 – 27)	Ch 3 KK	**The Cox Proportional Hazards Model and its Characteristics**,	**(2 wks):** Midterm grade reports starts
Monday, Mar 3 – 1st Major Exam (chapters 1,2, 3, supplementary reading, ch 11 KPW & Ch12 KPW)			
6 (Mar 2 – 6)	Ch 4 KK Ch5 KK	**Evaluating the PH Model assumptions** **The Stratified Cox Procedure**	**Declare your Term paper topic: Sunday Mar 2**
7 (Mar 9 – 13)	Ch5 KK Ch 6 KM	**The Stratified Cox Procedure (cont.)** **Extension of the Cox PH Model for Time-Dependent Variables**	
8 (Mar 16 – 20)	Ch 6 KM Ch 7 KM & Ch13-14 KPW	**Extension of the Cox PH Model for Time-Dependent Variables (cont.)** **Parametric Survival Models**	
Midterm Vacation March 23-27, 2014			
9 (Mar 30 – Apr 3)	Ch 14 KPW	**Parametric Survival Models (continued)**	
Wednesday, Apr 2 – 2nd Major Exam (chapters 4, 5, 6, 7 & Ch 13-14 KPW)			
10 (Apr 6 – 10)	Ch 15 KPW Ch 16 KPW	**Bayesian Estimation** **Model Selection**	
11 (Apr 13 – 17)	Ch 16 KPW	**Model Selection (continued)** Background. Deferred Annuity Products. Immediate Annuity Products.	
12 (Apr 20 – 24)	Ch 8 KM	**Recurrent Event Survival Analysis**	**Sun Apr 20**: Term Paper Report due to instructor.
13 (Apr 27 – May 1)	Ch 9 KM	**Competing Risks Survival Analysis**	
Monday, May 3- 3rd Major Exam (chapters 8 & ch15-16 KPW)			
14 (May 4 – 8)	Ch 10 KM Supplementary	**Design Issues for Randomized Trials** **Topics: Graduation**	
15 (May 11 – 15)	Review	**Review**	
Final Exam (Comprehensive): Sun May 18 7pm			

Student Learning Outcomes: (From the Society of Actuaries Exam C) May change in 2014

a) Post-2014 Outcomes with SOA weights of 20-25%

SOA Learning Outcomes		Weights	Course
F.	**Construction of Empirical Models**		
1.	Estimate failure time and loss distributions using: a) Kaplan-Meier estimator, b) Nelson-Åalen estimator, c) Kernel density estimators		AS475
2.	Estimate the variance of estimators and confidence intervals for failure time and loss distributions.		AS475
3.	Apply the following concepts in estimating failure time and loss distribution: a) Unbiasedness, b) Consistency, c) Mean squared error	**20-25%**	AS475
G.	**Estimation of decrement probabilities from large samples**		
1.	Estimate decrement probabilities using both parametric and nonparametric approaches for both individual and interval data		AS475
2.	Approximate the variance of the estimators		AS475
H.	**Construction and Selection of Parametric Models**	**25-30%**	
1.	Estimate the parameters of failure time and loss distributions using: a) Maximum likelihood, b) Method of moments, c) Percentile matching, d) Bayesian procedures		AS475
2.	Estimate the parameters of failure time and loss distributions with censored and/or truncated data using maximum likelihood.		AS475
3.	Estimate the variance of estimators and the confidence intervals for the parameters and functions of parameters of failure time and loss distributions.		AS475
4.	Apply the following concepts in estimating failure time and loss distributions: a) Unbiasedness, b) Asymptotic unbiasedness, c) Consistency, d) Mean squared error, e) Uniform minimum variance estimator		AS475
5.	Determine the acceptability of a fitted model and/or compare models using: a) Graphical procedures, b) Kolmogorov-Smirnov test, c) Anderson-Darling test, d) Chi-square goodness-of-fit test, e) Likelihood ratio test, f) Schwarz Bayesian Criterion		AS475

Other SOA learning objectives are covered by your AS483 class.

Interesting links on the internet:
http://www.statsoft.com/Textbook/Survival-Failure-Time-Analysis/button/2