

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

AS475: Survival Models for Actuaries - Term 142 (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 (except 15) 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 BAI Plus Calculator or Texas BAI 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.

Instructor: Dr. Mohammad H. Omar

Office: Bldg – 5, room – 508. **Phone:** 2471

E-mail: omarmh@kfupm.edu.sa (Not by WebCT/Blackboard email)

Office Hours: UTR: 11.00-11.55am and UR 12.45pm -2.00pm 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 (due Sun Apr 26)	(2%+5%+10%)
Exam 1 (Chapters 1, 2, 3 & KPW ch11 &12) Thursday (Mar 5 – week 6) , 6.00 pm (venue TBA)	20%
Exam 2 (Chapters 4, 5, 6 & KPW ch 13& 14) Thursday (Apr 2- week 9), 7:00 pm (venue TBA)	20%
Exam 3 (Chapters 7 & 8 & KPW ch16) Tuesday (May 5 - week 14), 7:00 pm (venue TBA)	18%
Final Exam (Comprehensive) ??day May ?? 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 25 –29)	Ch 1 KK	Introduction to Survival Analysis (2-1/2 class).	
2 (Feb 1 – 5)	Ch 11 KPW	KPW11 Estimation of Modified Data	
3 (Feb 8 – 12)	Ch 12 KPW	Estimation of Actuarial Survival Data Nelson-Aalen Estimate.	
4 (Feb 15 – 19)	Ch 2 KK	Kaplan-Meier Survival Curves and the Log-Rank Test	Declare your Term paper topic: Sunday Feb 15
5 (Feb 21 – 26)	Ch 3 KK	The Cox Proportional Hazards Model and its Characteristics,	(2 wks): Midterm grade reports starts
Tuesday, Mar 5 – 1st Major Exam (chapters 1,2, 3, ch 11 KPW & Ch12 KPW)			
6 (Mar 1 – 5)	Ch 4 KK Ch5 KK	Evaluating the PH Model assumptions The Stratified Cox Procedure	
7 (Mar 8 – 12)	Ch5 KK Ch 6 KK	The Stratified Cox Procedure (cont.) Extension of the Cox PH Model for Time-Dependent Variables	
8 (Mar 15 – 19)	Ch 6 KK Ch13-14 KPW	Extension of the Cox PH Model for Time-Dependent Variables (cont.) Parametric Survival Models	
Midterm Vacation March 22-26, 2014			
9 (Mar 29 – Apr 2)	Ch 14 KPW	Parametric Survival Models (continued)	
Thursday, Apr 2 – 2nd Major Exam (chapters 4, 5, 6 & Ch 13-14 KPW)			
10 (Apr 5 – 9)	Ch 16 KPW Ch 7 KK	Model Selection	
11 (Apr 12 – 16)	Ch 7 KK	Model Selection (continued)	
12 (Apr 19 – 23)	Ch 8 KK	Recurrent Event Survival Analysis	Sun Apr 26: Term Paper Report due to instructor.
13 (Apr 26 – 30)	Ch 9 KK	Competing Risks Survival Analysis	
Tuesday, May 5- 3rd Major Exam (chapters 7, 8 & ch16 KPW)			
14 (May 3 – 7)	Ch 10 KK Supplementary	Design Issues for Randomized Trials Topics: Graduation	
15 (May 10 – 14)	Review	Review	
Final Exam (Comprehensive): ?? May ?? 7pm			

Student Learning Outcomes: (From the Society of Actuaries Exam C) May change in 2016

a) Post-2014 Outcomes with SOA weights of 45-55%

SOA Learning Outcomes		Weights	Course
F. Construction of Empirical Models		20-25%	
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		AS475 & STAT302
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 & AS483
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 & STAT302
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 C learning outcomes are discussed in AS483 Actuarial Risk Theory and Credibility.

As a summary, the number of SOA C learning outcomes per KFUPM course is as follows:

Course	# SOA C Learning Outcomes
STAT301	3
STAT302	4
AS475	23
AS483	34
AS475/AS483	1
Total	65

Interesting links on the internet:

<http://www.statsoft.com/Textbook/Survival-Failure-Time-Analysis/button/2>

Extra topics (if time permits & if not already covered in AS483)

KleinBaum's topics

Ch 1. Introduction to Survival Analysis

KPW11 Estimation of Complete Data

KPW12 Estimation of Modified Data

Ch 2. Kaplan-Meier Survival Curves and the Log-Rank Test

Ch 3. The Cox Proportional Hazards Model and its Characteristics

Major 1

Ch 4. Evaluating the PH Model assumptions

Ch 5. The Stratified Cox procedure

Ch 6. Extension of the Cox PH Model for Time-Dependent Variables

KPW11 Frequentist Estimation

KPW12 Frequentist Estimation for Discrete Distributions

Major 2

KPW16 Model Selection

Ch 7. Parametric Survival Models

Ch 8. Recurrent Event Survival Analysis

Major 3

Ch 9. Competing Risks Survival Analysis

Ch 10. Design Issues for Randomized Trials

- 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.

Week	Sections	Topics	Assignments
1 (Jan 25 –29)	Ch 1 KK	Introduction to Survival Analysis (2-1/2 class).	
2 (Feb 1 – 5)	Ch 11 KPW	Estimation of Actuarial Survival Data	Hwk 1: KPW Q11.1, Q11.2, Q11.6
3 (Feb 8 – 12)	Ch 12 KPW	Estimation of Actuarial Survival Data Nelson-Aalen Estimate.	Hwk 2: KPW Q12.2, Q12.3, Q12.33
4 (Feb 15 – 19)	Ch 2 KK	Kaplan-Meier Survival Curves and the Log-Rank Test	Declare your Term paper topic: Sunday Feb 15
5 (Feb 22 – 26)	Ch 3 KK	The Cox Proportional Hazards Model and its Characteristics,	
Tuesday, Mar 5 – 1st Major Exam (chapters 1,2, 3, ch 11 KPW & Ch12 KPW)			
6 (Mar 1 – 5)	Ch 4 KK Ch5 KK	Evaluating the PH Model assumptions The Stratified Cox Procedure	
7 (Mar 8 – 12)	Ch5 KK Ch 6 KK	The Stratified Cox Procedure (cont.) Extension of the Cox PH Model for Time-Dependent Variables	
8 (Mar 15 – 19)	Ch 6 KK Ch 7 KK & Ch13-14 KPW	Extension of the Cox PH Model for Time-Dependent Variables (cont.) Parametric Survival Models	Hwk 3: KPW Q13.4, Q13.32
Midterm Vacation March 22-26, 2014			
9 (Mar 29 – Apr 2)	Ch 14 KPW	Parametric Survival Models (continued)	Hwk 4: KPW Q14.3, Q14.5, Q14.7
Wednesday, Apr 2 – 2nd Major Exam (chapters 4, 5, 6, 7 & Ch 13-14 KPW)			
10 (Apr 5 – 9)	Ch 16 KPW	Model Selection	
11 (Apr 12 – 16)	Ch 16 KPW	Model Selection (continued)	Hwk 5: KPW Q16.1, Q16.4, Q16.9, Q16.13
12 (Apr 19 – 23)	Ch 8 KK	Recurrent Event Survival Analysis	Sun Apr 26: Term Paper Report due to instructor.
13 (Apr 26 – 30)	Ch 9 KK	Competing Risks Survival Analysis	
Monday, May 3- 3rd Major Exam (chapters 8 & ch15-16 KPW)			
14 (May 3 – 7)	Ch 10 KK Supplementary	Design Issues for Randomized Trials Topics: Graduation	
15 (May 10 – 14)	Review	Review	
Final Exam (Comprehensive): ?? May ?? 7pm			