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

AS476: Survival Models for Actuaries - **Term 251 (2-2-3)**

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 LTAM at:
https://www.soa.org/Files/Edu/2019/spring/spring-2019-ltam-syllabi.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 11,12 and 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: 10:00 AM - 10:50 AM or by appointment.

Assessment

Assessment for this course will be based on attendance, homework, lab work, 2 major exams and a comprehensive final exam, as in the following:

Activity	Weight
Attendance*, Quiz*, and homework*	**20** (5+9+6)%
Labwork and Lab Exam	**10** (5+5)%
Exam 1 (Chapters 1, 2, & KPW ch11 &12) **Week 5 (Tentative). Venue, Date, Time: TBA**	20%
Exam 2 (Chapters 3, 4, 5, & 6) **Week 12 (Tentative). Venue, Date, Time: TBA**	20%
Final Exam (Comprehensive) **As posted on registrar website**	30%

* for both coursework and labwork

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).
- ✓ Out of the 5 marks for attendance, the first three absences will result in 0 mark reduction each while the next 5 will result in 1 mark reduction each.
- ✓ Official warning will be sent on the 4th and 8th Absence.

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 course AS482 before they attempt to take the professional exam LTAM.

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

Syllabus (Tentative)

Week	*Dates*	*Sections*	*Topic*	*Notes*
1	Aug 24 - 28	Ch 1 KK	**Introduction to Survival Analysis (2-1/2 class).**	
2	Sep 1 - Sep4	Ch 11 KPW	**KPW11 Estimation of Modified Data**	
3	Sep 7 - 11	Ch 12 KPW	**Estimation of Actuarial Survival Data Nelson-Aalen Estimate.**	Quiz
4	Sep 14 - 18	Ch 2 KK	**Kaplan-Meier Survival Curves and the Log-Rank Test**	
5	Sep 21 - 25	Ch 3 KK	**The Cox Proportional Hazards Model and its Characteristics**,	
Sunday (Sep 21) – 1st Major Exam (KK: chapters 1-2; KPW: chapters 11-12)				
6	Sep 28 - Oct 2	Ch 4 KK Ch 5 KK	**Evaluating the PH Model assumptions** **The Stratified Cox Procedure**	
7	Oct 5 - 9	Ch 5 KK Ch 6 KK	**The Stratified Cox Procedure (cont.)** **Extension of the Cox PH Model for Time-Dependent Variables**	(2 wks): Midterm grade reports start
8	Oct 12 - 16	Ch 6 KK	**Extension of the Cox PH Model for Time-Dependent Variables (cont.)** **Parametric Survival Models**	
9	Oct 19 - 23	Ch 16 KPW	**Model Selection**	
Midterm Break: Oct.26 - 30, 2025				
10	Nov 2 6	Ch 7 KK	**Model Selection (continued)**	
11	Nov 9 - 13	Ch 8 KK	**Recurrent Event Survival Analysis**	
12	Nov 16 - 20	Ch 8 KK	**Recurrent Event Survival Analysis (cont.)**	
Thursday (Nov 16) – 2nd Major Exam (chaps 3, 4, 5 & 6)				
13	Nov 23 - 27	Ch 9 KK	**Competing Risks Survival Analysis**	Quiz
14	Nov 30 - Dec4	Ch 9 KK	**Competing Risks Survival Analysis (cont.)**	
15	Dec 7 - 11	Review	**Review**	
16	TBA TBA	"Comprehensive" Final Exam		

Student Learning Outcomes: (From the Society of Actuaries Exam LTAM)

a) **Topic: Survival models and their estimation-- SOA weights of 15-25%**

Learning Objectives: The Candidate will understand key concepts concerning parametric and non-parametric (tabular) and multi-state models including single life, or multiple life, and multiple decrements.

Learning Outcomes: The Candidate will be able to:

a) Explain and interpret survival models and transitioning between states.
b) Calculate nonparametric estimates of survival models using the Kaplan-Meier and Nelson-Aalen formulas for seriatim data and adaptations for grouped data.
c) Calculate, using both seriatim and grouped data, maximum likelihood estimates of transition probabilities assuming constant transition intensity during fixed age intervals.
d) Calculate the variances of and construct confidence intervals for the estimators in parts b) and c).
e) Describe and apply simple longevity models.

Note: Other outcomes are covered in AS380 and AS481.

Interesting links on the internet:

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

Lab syllabus and assignment details

Week	*Sections*	*Topic*	*Assignments*	*LabWork*
1	Ch 1 KK	**Introduction to *R* studio function for Survival Analysis**		
2	Ch 11 KPW	**KPW11 Estimation of Modified Data**	Hwk 1: KPW Q11.1, Q11.2, Q11.6	
3	Ch 12 KPW	**Estimation of Actuarial Survival Data Nelson-Aalen Estimate.**	Hwk 2: KPW Q12.2, Q12.3, Q12.33	
4	Ch 2 KK	**Kaplan-Meier Survival Curves and the Log-Rank Test**		Lab quiz
5	Ch 3 KK	**The Cox Proportional Hazards Model and its Characteristics,**		
Sunday (Sep 22) – 1st Major Exam (KK: chapters 1-2; KPW: chapters 11-12)				
6	Ch 4 KK Ch 5 KK	**Evaluating the PH Model assumptions The Stratified Cox Procedure**		
7	Ch 5 KK Ch 6 KK	**The Stratified Cox Procedure (cont.) Extension of the Cox PH Model for Time-Dependent Variables**		Lab quiz
8	Ch 6 KK	**Extension of the Cox PH Model for Time-Dependent Variables (cont.) Parametric Survival Models**		
9	Ch 16 KPW	**Model Selection**		
Midterm Break: Oct.26 - 30, 2025				
10	Ch 7 KK	**Model Selection (continued)**	Hwk 3: KPW Q16.1, Q16.4, Q16.9, Q16.13	
11	Ch 8 KK	**Recurrent Event Survival Analysis**		
12	Ch 8 KK	**Recurrent Event Survival Analysis (cont.)**		
Thursday (Nov 16) – 2nd Major Exam (chaps 3, 4, 5 & 6)				
13	Ch 9 KK	**Competing Risks Survival Analysis**		
14	Ch 9 KK	**Competing Risks Survival Analysis (cont.)**		Final Exam
15	Review	**Review**		