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

AS475: Survival Models for Actuaries - **Term 182** **(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 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.

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: 11.00-11.50am and UT 12.20pm -12.45pm or by appointment.
Biweekly Optional lab: R 10.00-10.50am

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 and homework	(2%+5%)
Exam 1 (Chapters 1, 2, & KPW ch11 &12) **Wednesday (Feb 6 – week 5) , 6.00 pm (venue TBA)**	25%
Exam 2 (Chapters 3, 4, 5, & 6) **Monday (Mar 4- week 10), 7:00 pm (venue TBA)**	23%
Term Paper Report **Sunday (Mar 31 – week 13) due – in class**	15%
Final Exam (Comprehensive) **Monday Apr 22 7pm (as posted on registrar website)**	30%

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	*Dates*	*Sections*	*Topic*	*Notes*
1	Jan 6 - 10	Ch 1 KK	**Introduction to Survival Analysis (2-1/2 class).**	
2	Jan 13 - 17	Ch 11 KPW	**KPW11 Estimation of Modified Data**	
3	Jan 20 - 24	Ch 12 KPW	**Estimation of Actuarial Survival Data Nelson-Aalen Estimate.**	
4	Jan 27 - 31	Ch 2 KK	**Kaplan-Meier Survival Curves and the Log-Rank Test**	Declare your Term paper topic: Sun
5	Feb 3 - 7	Ch 3 KK	**The Cox Proportional Hazards Model and its Characteristics,**	(2 wks): Midterm grade reports starts
		Wednesday, Feb 6 – 1st Major Exam (chapters 1, 2, KPW ch11, & KPW ch12)		
6	Feb 10 - 14	Ch 4 KK Ch 5 KK	**Evaluating the PH Model assumptions** **The Stratified Cox Procedure**	
7	Feb 17 - 21	Ch 5 KK Ch 6 KK	**The Stratified Cox Procedure (cont.)** **Extension of the Cox PH Model for Time-Dependent Variables**	
8	Feb 24 - 28	Ch 6 KK	**Extension of the Cox PH Model for Time-Dependent Variables (cont.)** **Parametric Survival Models**	
9	Mar 3 - 7	Ch 16 KPW	**Model Selection**	
		Monday, Mar 4 – 2nd Major Exam (chapters 3, 4, 5 & 6)		
10	Mar 10 - 14	Ch 7 KK	**Model Selection (continued)**	
11	Mar 17 - 21	Ch 8 KK	**Recurrent Event Survival Analysis**	
12	Mar 24 - 28	Ch 8 KK	**Recurrent Event Survival Analysis (cont.)**	
13	Mar 31 - Apr 4	Ch 9 KK	**Competing Risks Survival Analysis**	**Sun Mar 31**: Term Paper Report due to instructor
14	Apr 7 - 11	Ch 9 KK	**Competing Risks Survival Analysis (cont.)**	
15	Apr 14 - 18	Review	**Review**	
16	Apr 22 Mon 7pm	"Comprehensive" Final Exam		

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

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 and interpret standard functions including survival and mortality probabilities, force of mortality, and complete and curtate expectation of life.
c) Calculate nonparametric estimates of survival models using the Kaplan-Meier and Nelson-Aalen formulas for seriatim data and adaptations for grouped data.
d) Calculate, using both seriatim and grouped data, maximum likelihood estimates of transition probabilities assuming constant transition intensity during fixed age intervals.
e) Calculate the variances of and construct confidence intervals for the estimators in parts c) and d).
f) Calculate transition intensities exactly, or estimate transition intensities using large sample approximations.
g) Describe and apply simple longevity models.
h) For models dealing with multiple lives and/or multiple states, explain the random variables associated with the model and calculate and interpret marginal and conditional probabilities.
i) Construct and interpret select and ultimate survival models.
j) Describe the behavior of Markov chain models, identify possible transitions between states, and calculate and interpret the probability of being in a particular state and transitioning between states.
k) Apply to calculations involving these models appropriate approximation methods for fractional ages based on uniform distribution of deaths or constant force.

Note: some of the above outcomes are covered in AS381 and AS482.

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