Spring 2023, MATH 473: Reliability and Survival Models:
MWF 2:00-2:50 EGRA 222. Webpage: (http://parker.ad.siu.edu/Olive/M473.html).

Text: Olive, D.J. (2023), *Survival Analysis*, online course notes:
(http://parker.ad.siu.edu/Olive/survbk.pdf).

This course considers the analysis of "time to event" data. There are n individuals and the time until an event is recorded for each individual. Typical events are failure of a product or death of a person or reoccurrence of cancer after surgery, but other events such as first use of cigarettes or the time that baboons come down from trees (early in the morning) can also be modeled. The data is typically right skewed and censored data is often present. Censoring occurs because of time and cost constraints. A product such as light bulbs may be tested for 1000 hours. Perhaps 30% fail in that time but the remaining 70% are still working. These are censored: they give partial information on the lifetime of the bulbs because it is known that about 70% last longer than 1000 hours. Handling censoring and time dependent covariates is what makes the analysis of time to event data different from other fields of statistics.

Reliability analysis is used in *engineering* to study the lifetime (time until failure) of manufactured products while survival analysis is used in *actuarial sciences*, *statistics* and *biostatistics* to study the lifetime (time until death) of humans, often after contracting a deadly disease. In the *social sciences*, the study of the time until the occurrence of an event is called the analysis of event time data or event history analysis. In *economics*, the study is called duration analysis or transition analysis. Hence reliability data = failure time data = lifetime data = survival data = event time data.

This course covers the hazard and cumulative hazard functions, the survivor = reliability function, the Kaplan Meier product limit estimator, the Nelson Aelen estimator, life tables and censoring. The Weibull and lognormal distributions are important. The main topic is proportional hazards regression. Cox regression, Weibull regression, and exponential regression are special cases. The accelerated lifetime model is also a regression model. These regression models are handled much like the Math 484 regression models.

This type of course is taken by *students in biostatistics, industrial and mechanical engineering, math, statistics,* and the *social sciences*. Math 473 is useful for parts of the actuarial exams and courses Math 401-404.

The *prerequisites* for this class are Math 480 or Math 483 which is a better prereq than Math 480. (Math 221 is useful.) You should be familiar with the normal, gamma, binomial, Poisson and exponential distributions, confidence intervals and hypothesis testing. *Heavy use of the computer package R* will be made. *SAS* will likely also be used.

For more information contact David Olive, 261 Neckers.
Phone: 453-6566, Email: dolive@siu.edu

Other references.

Allison, P.D. (1995), *Survival Analysis Using SAS: A Practical Guide,* SAS Institute, Cary, NC. (used for much of the SAS homework)

Collett, D. (2003), *Modelling Survival Data in Medical Research*, 2nd ed, Chapman and Hall/CRC $65

Office: (J.W.) Neckers 261 (wing A) *Phone:* (618)-453-6566
email: dolive@siu.edu *Office hours: MWThF 9:30-10:30, 1:10-1:40*
I am also available by appointment and on a walkin basis, eg before class.

This course covers reliability and survival analysis including the hazard function, survival function, lognormal and Weibull distributions, censoring, the Kaplan Meier estimator, life tables and the proportional hazards regression model.

Cumulative Final: Tuesday May 9, 2:45-4:45.

The grading and syllabus below are tentative. (Drop day in Friday, March 31, with advisor, Sunday, April 2 online.)

Students receive a WF if they stop attending class and fail. An INC is given if for reasons beyond their control, students engaged in *passing* work are unable to complete all class assignments. One HW may be turned in one class period late with 25% penalty except for the last week of classes. One or more sheets of notes will be allowed on quizzes and exams. A calculator is permitted. I sometimes give $A-$, $B+$, $B-$, and $C+$.

HW	300	drop 1 HW	Quizzes	100	
exam1	100	exam 2	100	exam 3	100
final	300			total	1000
min. grade	points	min. grade	points	min. grade	points
A	900-1000	B	800-899	C	700-799
D	550-699				

Parentheses refer to Hosmer and Lemeshow (1999).

Week of	MON	WED	FRI
Jan 16	no class	1.1,1.2,(2.1,2.2)	1.2,(2.2)
Jan 23	1.2,1.3,(2.2,2.3)	1.3,(2.3)	1.3,(2.3),HW1, Q1
Jan 30	lab?	1.3,(2.4)	1.5,(2.4,2.5), HW2, Q2
Feb 6	1.5,(2.5)	2.1,(3.1), Q3	2.2,(3.2), HW3
Feb 13	2.3,(3.2, 3.3),	Exam 1	2.3,(3.4)
Feb 20	lab?	2.3,(3.4,3.5), Q4	2.3,(3.5,4.1), HW4
Feb 27	2.3,(4.2)	2.3,(4.3), Q5	2.3,(4.4,4.4), HW5
March 6	2.3,(4.5)	2.3,(4.5), Q6	2.3,(4.5,4.6), HW6
March 13	no class	no class	no class
March 20	2.3,2.4,(4.6,5.1)	Exam 2	2.4(5.2)
March 27	2.4,(5.2)	2.4,(5.2), Q7	2.4,(5.3,5.4), HW7
April 3	4.1,(5.4,6.1)	4.1,(6.2), Q8	2.4,(6.2,6.3), HW8
April 10	lab?	(6.4), Q9	(6.4,6.5), HW9
April 17	(6.5,7.1)	2.5,(7.2)	3.1,3.2,(8.1,8.2), HW10
April 24	3.2,(8.2)	Exam 3	3.2,(8.3)
May 1	3.3,(8.3), HW11	3.3,(7.3?,8.4?), Q10	review

Other references. Hosmer, D.W., Lemeshow, S., and May, S. (1999, 2008), *Applied Survival Analysis: Regression Modeling of Time to Event Data*, 1st or 2nd ed., Wiley, NY. The library has the 2nd edition online.