University of Manitoba
Department of Statistics

STAT 4170 / STAT 7240, CRN 24882
Lifetime Data Analysis (Survival Analysis)
Second Term, 2010 – 2011

Instructor	Dr. Xikui Wang Office: 321 Machray Hall (Phone: 474 – 6275 or 474 – 8172) E-mail: xikui_wang@umanitoba.ca
Office hours	To be decided, or by appointment
Course web	All course materials are posted on the University of Manitoba ANGEL
General description	An introduction to basic principles and techniques for survival analysis in biostatistics and reliability, with emphasis on both theory and applications. Topics to be covered include: censoring, survival, hazard and other functions, parametric, semi-parametric and nonparametric methods, proportional hazards regression, clinical trials.
Prerequisites	STAT 3480 and STAT 3800 (or STAT 3600). Some knowledge of calculus is also assumed.
Recommended references	*Statistical Methods for Survival Data Analysis* (Third Edition), by E. T. Lee and J. W. Wang, John Wiley and Sons, New York, 2003 *Statistical Models and Methods for Lifetime Data* (Second Edition), By J. F. Lawless, John Wiley and Sons, New York, 2003 *Modelling survival data in medical research* (Second Edition), by David Collett, Chapman & Hall / CRC, 2003, ISBN 1584883251
SAS reference	*Applied statistics and the SAS programming language* (4th ed.) by R. P. Cody and J. K. Smith, Prentice Hall *Survival analysis using the SAS system – a practical guide*, by P. D. Allison, SAS institute, 1995, ISBN 1 – 55544 – 279 – X
Grading	Three Assignments 15% Midterm Test (1.5 hours, **time/date and place TBA**) 35% Final Examination (2 hours, place TBA) 50% **Note: Students in STAT 7240 are required to do some extra work for the assignments and exams.**
Examinations	Both the mid-term test and final examination are closed book. A calculator is necessary. Required statistical tables and a formula sheet (see the next page) are provided. The test / examination questions will range from computations to concepts and proofs.

Course contents Module I – Basic concepts, models, functions and distributions

Censoring: Types I, Type II, interval, random, etc.
Continuous and discrete models: survival function, (cumulative) hazard function, mean residual lifetime function, mean and median survival times
Distribution: exponential, Weibull, Gamma, normal, etc.

Module II – Nonparametric methods – one-sample and multiple-sample

Product-limit (Kaplan-Meier) and actuarial (life-table) estimators
Greenwood's formula, confidence band
(Mantel-Haenszel) log-rank test, Wilcoxon test, etc.

Module III – Semi-parametric regression: Cox's proportional hazards

Partial likelihood, global and local tests, estimation, etc.
Model building, variable selections, and diagnostics for PH assumptions

Module IV – Parametric methods: MLE for Type I / II censoring

Exponential and Weibull distributions
Other distributions: normal, log-normal, Gamma, etc. (time permitting)

Module V – Optional topics (time permitting)

Parametric regression, accelerated failure time models, competing risks models, time-dependent covariates, stratified models, recurrent events, sample size determination, etc.

Formula Sheet (all other formulas need to be memorized)

$$R = \sum_{i=1}^{n}\left(1 - e^{-\frac{L_i}{\theta}}\right) \qquad U = \frac{1+0.5/r_2}{1+0.5/r_1}\frac{\theta_2}{\theta_1}\frac{\hat{\theta}_1}{\hat{\theta}_2}$$

Exponential Distribution, Multiple samples, Type I: $\Lambda = \left(2\sum_{i=1}^{m} r_i\right)\ln\tilde{\theta} - 2\sum_{i=1}^{m} r_i \ln\hat{\theta}_i$

$$\Lambda_1 = 2r_1 \ln\frac{\tilde{\theta}_1}{\hat{\theta}_1} + 2r_2 \ln\frac{\tilde{\theta}_2}{\hat{\theta}_2}, \qquad \tilde{\theta}_1 = a\tilde{\theta}_2 = \frac{T_1 + aT_2}{r_1 + r_2}, \qquad Ha: \theta_1 \neq a\theta_2$$

Exponential Distribution, Multiple samples, Type II: $\Lambda = \left(2\sum_{i=1}^{m} r_i\right)\ln\tilde{\theta} - 2\sum_{i=1}^{m} r_i \ln\hat{\theta}_i$

Weibull Distribution, One Sample, Type I: $\dfrac{\sum_{i=1}^{n} t_i^{\hat{\beta}} \ln t_i}{\sum_{i=1}^{n} t_i^{\hat{\beta}}} - \dfrac{1}{\hat{\beta}} - \dfrac{1}{r}\sum_{i\in D}\ln t_i = 0,\ \hat{\alpha} = \left(\dfrac{1}{r}\sum_{i=1}^{n} t_i^{\hat{\beta}}\right)^{1/\hat{\beta}}$