

### Discipline Specific Elective (DSE) Course 4g: Survival Analysis

Structure 1: PG Curricular Structure with only Course Work  
 Structure 2: PG Curricular Structure with Course Work + Research  
 Structure 3: PG Curricular Structure with Research only

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the course (if any)
		Lecture (45 Hours)	Tutorial (00 Hours)	Practical (30 Hours)		
<b>DSE 4g: Survival Analysis</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>NIL</b>	<b>NIL</b>

#### Course Objectives:

- To introduce the theoretical and inferential framework for data in survival analysis.
- To develop understanding of special features of survival data structures including censoring, frailty, competing risks, and multistate model.

**Course Learning Outcomes:** After successful completion of this course, students will be able to:

- Understand the concepts of survival data, including survival and hazard functions, censoring, and estimation of lifetime distributions.
- Perform regression modeling in survival data using Cox proportional hazards and frailty models.
- Apply survival models that handle complex structure of survival data such as censoring and masked data.
- Apply and interpret some parametric and semi-parametric survival models.
- Analyze competing risks and masked cause-of-failure data to address real-life problems.
- Model multistate process in survival analysis.
- Perform model assessment and diagnostics for survival models.

#### Unit I (11 Hours)

Overview of survival function, hazard functions, various forms of censoring, and parametric estimation of lifetime distributions, Probability plotting, non-parametric hypothesis testing: Gehan and Mantel Hanzel statistics, stratified log-rank test.

#### Unit II (12 Hours)

Cox Proportional hazard: Time-dependent covariates and stratified Cox model, Frailty models: Likelihood formulation for Gamma frailty under Exponential and Weibull baselines. Parameter estimation, and comparison of frailty models with Cox models.

**Unit III (11 Hours)**

Competing risks model for masked data, Likelihood formulation for exponential, and Weibull distributed risks, Issue of identifiability, Parameter estimation, Model selection, Multiple decrement life table under competing risks.

**Unit IV (11 Hours)**

Introduction to multistate models: concept of states and transitions, parametric modeling of transition intensities (Exponential, Weibull).

**Essential Readings:**

1. Barlow, R. E., and Proschan, F. (1985). *Statistical Theory of Reliability and Life Testing*, Holt, Rinehart and Winston.
2. Beyersmann, J., Allignol, A., and Schumacher, M. (2011). *Competing Risks and Multistate Models with R*, Springer.
3. Deshpande, J. V., and Purohit, S. G. (2015). *Lifetime Data: Statistical Models and Methods*, World Scientific Publishing Company.
4. Lawless, J. F. (1982). *Statistical Models and Methods of Lifetime Data*, John Wiley & Sons.

**Suggested Readings:**

1. Bain, L. J., and Engelhardt, M. (1991). *Statistical Analysis of Reliability and Life Testing Models*, Marcel Dekker.
2. Hanagal, D. D. (2019). *Modeling Survival Data Using Frailty Models*, Chapman & Hall/CRC.
3. Kalbfleisch, J. D., and Prentice, R. L. (2002). *The Statistical Analysis of Failure Time Data*, John Wiley & Sons.
4. Lee, E. T., and Wang, J. W. (2003). *Statistical Methods for Survival Data Analysis*, John Wiley & Sons.
5. Nelson, W. (1982). *Applied Life Data Analysis*, John Wiley & Sons.

**List of Practicals:**

1. Estimation of survival and hazard functions under different lifetime distributions and censoring schemes.
2. Probability plotting for exponential, Weibull, and log-normal distribution for complete and censored data.
3. Non-Parametric hypothesis testing using Gehan's test and Mantel-Haenszel.
4. Analyze survival data with stratified groups and perform stratified log-rank test and interpret results.

5. Fit a Cox proportional hazards model with time-varying covariates and compare results with a simple Cox model.
6. Fit frailty models under exponential and Weibull baselines and compare it with Cox models.
7. Perform analysis of competing risks with missing cause of failure.
8. Construct a multiple decrement life table using competing risks data.
9. Simulate simple 3-state data and summarize transition patterns.
10. Fit a parametric multistate model, estimate the parameters, and interpret the estimated transition probabilities.