

DEPARTMENT OF STATISTICS				CLASS: I M.Sc. Statistics				
Sem	Course Type	Course Code	Course Title	Credits	Contact Hours/week	CIA	Ext	Total
II	C-Elective-I	21P2SME2 (A)	Reliability Theory and Survival Analysis	4	5	25	75	100

Nature of Course			
Knowledge and skill	✓		Employability oriented
Skill oriented			Entrepreneurship oriented

Course Objectives:

1. Students are able to understand the concepts of Reliability, Survival analysis and its applications.
2. Students able to apply the Survival analysis using various distributions.

Unit	Description	Hours	K-level	CLO(s)
I	Reliability concepts and measures; components and systems; coherent systems; reliability fcoherent systems; cuts and paths; modular decomposition; boundson system reliability; structural and reliability importance of components.	15	K2	1
II	Life distributions; reliability function; hazardrate; common life distributions exponential, Weibull, Gamma, etc. Estimation of parameters and tests in these models.	13	K3	2
III	Reliability growth models; probability plotting techniques; Hollander-Proschan and Deshpande tests for exponentiality – Basic idea so accelerated life testing. Concepts of time, Order and random Censoring, likelihood in these cases.	16	K3	3
IV	Life tables, failure rate, mean residual life and their elementary properties. Ageing classes and their properties, Bathtub Failure rate. Estimation of survival function Actuarial Estimator, Kaplan-Meier Estimator. Estimation under the assumption of IFR/DFR. Tests of exponentiality against non- parametric classes.Total time on test, Deshpandetest.	16	K4	4
V	Two sample problem-Gehan test, Logranktest. Mantel-Haenzeltest, Tarone Ware tests. Semi-parametric regression Cox proportional hazards model with one and several convariates. Rank test for the regression coefficients. Competing risks model, parametric and non-parametric inference for this model. Multiple decrement life table.	15	K4	5

Books for Reference:

1. Barlow R.E. and Proschan F. (1985) Statistical Theory of Reliability and Life Testing, To Begin with, Silver Spring.
2. Lawless J.F. (1982) Statistical Models and Method sof Life Time Data, Wiley, New York.
3. BainL.J. and Engelhardt, M. (1991) Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker, New York.
4. Nelson,W. (1982) Applied Life Data Analysis, Wiley, New York.
5. Zacks,S. (1995) Reliability Analysis, Springer, New York.
6. Miller,R.G.(1981) Survivalanalysis, Wiley, New York.Cox,D.R.andOakes,D.(1984) AnalysisofSurvivalData,Chapman&Hall,New York.
7. Gross,A.J.andClark,V.A.(1975)Survival distribution: Reliability applications in the Biomedical Sciences,Wiley, New Delhi.
8. Kalbfleisch,J.D.andPrentice,R.L.(1980)The Statistical Analysis of FailureTimeData,Wiley, New York .
9. Lawless,J.F.(1982)Statistical Models and Methods of LifeTimeData,Wiley, New York.

Web references:

1. Reliability: <https://nptel.ac.in/courses/105/108/105108128/>
2. Hazard Rate: <https://www.youtube.com/watch?v=RvWxh4Bk0lc>
3. Residuals in Reliability: <https://www.youtube.com/watch?v=yMgFHbjbAW8>
4. <https://www.youtube.com/watch?v=xnAuIbiLS8Y>
5. https://www.youtube.com/watch?v=vX3l36ptrTU&list=PLqzoL9-eJTNDdnKvep_YHIwk2AMqHhuJ0

Rationale for Nature of the course

- The course provides the knowledge on evaluation of the life time of a product and its related distributions.

Activities having direct bearing on Skill development / Employability / Entrepreneurship

- Problem solving on Reliability i.e. Life time of a product with suitable distributions

Pedagogy

Chalk and Talk, PPT, Seminar, Interaction, Problem solving.

Lecture Schedule

Unit	Topics	Hours	Mode
I	Reliability concepts and measures	3	PPT, Chalk and Talk and Assignments
	components and systems	2	
	coherent systems; reliability fcoherent systems	2	
	cuts and paths	2	
	modular decomposition; boundson system reliability	3	
	structural and reliability importance of components	2	
	Real time applications	1	
II	Life distributions;;;	2	PPT, Chalk and Talk and Assignments
	reliability function	3	
	Hazardrate	1	
	common life distributions exponential, Weibull, Gamma, etc.	4	
	Estimation of parameters and tests in these models.	3	
III	Reliability growth models	3	PPT, Chalk and Talk, Assignments
	probability plotting techniques	3	
	Hollander-Proschan and Deshpande tests for exponentiality	4	
	Basic idea so accelerated life testing	3	
	Concepts of time, Order and random Censoring, likelihood in these cases.	3	
IV	Life tables	2	PPT, Chalk and Talk, Assignments and seminar
	failure rate, mean residual life and their elementary properties	3	
	Ageing classes and their properties	3	
	Bathtub Failure rate	1	
	Estimation of survival function Actuarial Estimator, Kaplan- Meier Estimator.	2	
	Estimation under the assumption of IFR/DFR.	2	
	Tests of exponentiality against non- parametric classes.	2	
	Total time on test, Deshpandetest.	1	
V	Two sample problem-Gehan test, ,,	2	PPT, Chalk and Talk, Assignments and seminar
	Logranktest. Mantel-Haenszel test	3	
	Tarone Ware tests. Semi-parametric regression	2	
	Cox proportional hazards model with one and several convariates	3	
	Rank test for the regression coefficients.	1	
	Competing risks model	2	
	parametric and non-parametric inference for this model.	1	
	Multiple decrement lifetable.	1	

Course Learning Outcomes

On the successful completion of the course, students attain

CLO's	Course Learning Outcomes	Knowledge Level
CLO-1	To gain the knowledge on Reliability and its conceptual measures	Up to K2
CLO-2	To study the life distribution and estimation of parameters	Up to K3
CLO-3	To built the growth models with its properties	Up to K3
CLO-4	To analyze the Life tables through various estimators	Up to K4
CLO-5	To study the risk models and its applications	Up to K4

MAPPING CLOs WITH PSOs

#	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CLO-1	2	1	1		1	1	2
CLO-2	1	2	3		1	2	1
CLO-3	1	3	1		1	2	1
CLO-4	1	1	2		2	2	1
CLO-5	1	2	1		1	2	2

Advance application – 3; Intermediate level – 2; Basic level – 1

CIA-I BLUE PRINT

CLO's	K-Level	Section – A Short Answer		Section B Either / Or type		Section C Open Choice	
		No. of Questions	K Level	No. of Questions	K Level	No. of Questions	K level
CLO 1	Up to K2	2	K1, K2	2	K1, K2	1	K2
CLO 2	Up to K3	3	K1, K2, K3	2	K2, K3	2	K3, K3
No. of questions to be		5		4		3	
No. of question to be		5		2		2	
Marks for each question		2		5		10	
Total marks for each		10		10		20	

CIA-I :: Distribution of Section-wise Marks with K levels

K Levels	Section A (No choice)	Section B (Either/ or)	Section C (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	5	-	9	15	55%
K2	4	10	10	24	40	
K3	2	5	20	27	45	45%
K4	-	-	-	-	-	-
K5	-	-	-	-	-	-
Total Marks	10	20	30	60	100	100%

CIA-II Blue Print

Units	CLOs	K- Level	Section A		Section B		Section C	
			Short Answers		(Either/or Choice)		(Open Choice)	
			No. of Questions	K- Level	No. of Questions	K- Level	No. of Questions	K- Level
1	CLO 3	Up to K3	2	K1 , K2	2	K2, K3	2	K2, K3
2	CLO 4	Up to K4	3	K1, K2,K3	2	K3, K4	1	K4
No. of Questions to be asked			5		4		3	
No. of Questions to be answered			5		2		2	
Marks for each question			2		5		10	
Total Marks for each section			10		10		20	

CIA-II :: Distribution of section wise marks with K levels.

K Levels	Section B (Short Answers)	Section C (Either/or)	Section D (Open choice)	Total marks	% of marks without choice	Consolidated
K1	4	-	-	4	6.67	38.33%
K2	4	5	10	19	31.66	
K3	2	10	10	22	36.67	36.67%
K4	-	5	10	15	25	25%
K5	-	-	-	-	-	-
Total marks	10	20	30	60		

Summative Examination Blue Print

Units	CLOs	K-level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)	Total
			MCQs		Short Answers				
			No. of Questions	K-Level	No. of Questions	K- Level			
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2(K1& K1)	1(K2)	
2	CLO 2	Up to K3	2	K2& K3	1	K1	2(K2 & K2)	1(K3)	
3	CLO 3	Up to K3	2	K2 & K3	1	K2	2(K3 & K3)	1(K3)	
4	CLO 4	Up to K4	2	K3 & K4	1	K2	2(K4& K4)	1(K4)	
5	CLO 5	Up to K4	2	K3& K4	1	K3	2(K4& K4)	1(K4)	
No. of Questions to be asked			10		5		10	5	30
No. of Questions to be answered			10		5		5	3	23
Marks for each question			1		2		5	10	
Total Marks for each Section			10		10		25	30	75

Distribution of section wise marks with K levels for Summative Examination

K – Level	Section A (MCQ)	Section B (Short Answer Questions)	Section C (Either / Or Choice)	Section D (Open Choice)	Total Marks	% of (Marks without Choice)	Consolidated
K1	2	4	10	-	16	13.33	33.33
K2	2	2	10	10	24	20.00	
K3	4	4	10	20	38	31.67	31.67
K4	2	-	20	20	42	35	35
K5	-	-		-			
Total	10	10	50	50	120	100	100

Course Designers:

1. Dr. M. Venkateswaran
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