**P.R.GOVT. COLLEGE (AUTONOMOUS), KAKINADA.**

**II B.SC, ACTUARIAL SCIENCE/ FOURTH SEMESTER (2018-19)**

**II B.Sc, (MSAS) PAPER-IV**

**COURSE: SURVIVAL MODELS**

**SEMESTER-IV**

**Total Hrs. of Teaching-Learning:60 @ 4 h/Week \_\_\_\_ Total Credits:03**

**UNIT-1**

**Principles of modeling:** Need, benefits and limitations of models. (2L)

**UNIT-2**

**Concepts of Survival Models** (10L)

The distribution and density functions of the random future lifetime, the survival

function, the force of mortality or hazard rate and derive relationships between

them, Laws of mortality like Gompertz and Makeham, the distribution and density

functions of the curtate future lifetime random variable.

**UNIT-3**

**Estimating the future lifetime distribution**  (10L)

Truncation, Right censoring, Left or interval censoring, Likelihood construction for

censored and truncated data, Kaplan-Meier model, Nelson Aalen model, Cox

proportional hazard model, Breslow’s approximations to the partial likelihood

estimator.

**UNIT-4**

**Binomial and Poisson Model** (10L)

Maximum likelihood estimator of transitions intensities in Binomial and Poisson

model and their mean-variances, advantages and disadvantages of multiple state

models and the binomial models, including consistency, efficiency, simplicity of the

actuarial estimators and their distributions, application to practical observations and

generality.

**UNIT-5**

**Graduation** (10L)

Initial and central exposed to risks, graduation, purpose and methods of graduation,

testing goodness of fit and testing smoothness of a set of graduated estimates,

statistical test for comparing a set of crude estimates and a standard table or a set

of crude estimates and a set of graduated estimates, effect of duplicate policies on

estimates.

**References**

UK Institute of Actuaries core reading for subject CT4-Models.

Klein J.P. and Moeschberger, M.L.(2003) Survival Analysis: Techniques for

Censored and Truncated Data 2nd Edition, Springer Verlag, New York,.

Klugman, S.A.(June 2003), "Estimation, Evaluation, and Selection of Actuarial

Models”.

Dick London (1997), Survival Models and their Estimation, second edition, ACTEX

publications.

Cox, D.R. and Oakes, D.(1984) Analysis of Survival Data, Chapman and Hall, NewYork.

**BLUE PRINT FOR THE QUESTION PAPER SETTERPAPER - IV**

**SURVIVAL MODELS (FOR II B.Sc ACTUARIAL SCIENCE) SEMESTER-IV**

**Max.Marks:60 Time :2 ½ Hours**

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| --- | --- | --- | --- |
| **CHAPTER NAME** | **ESSAY QUESTIONS****10 MARKS** | **SHORT QUESTIONS****05 MARKS** | **MARKS ALLOTTED****TO CHAPTER** |
| **I.Principles of** **Modeling** | **02** | **01** | **25** |
| **II.Concepts of**  **Survival Models** | **02** | **01** | **25** |
| **III. Estimating the**  **future lifetime**  **distribution** | **01** | **01** | **15** |
| **IV. Binomial and** **Poisson Model** | **02** | **02** | **30** |
| **V. Graduation** | **01** | **01** | **15** |
| **TOTAL MARKS INCLUDING CHOICE** | **08** | **06** | **110** |

**SAQ=Short answer questions (5M), EQ=Essay questions (10M)**

 **Internal Assessment for 40 Marks*:***

 Short Answer Questions : 10 x 2 = 20M

 Essay Type Questions : 4 x 5 = 20M

 ------------------- Total : 40M

**P.R.GOVERNMENT COLLEGE (AUTONOMOUS), KAKINADA**

**MODEL PAPERS FOR THE YEAR 2018-2019**

**II YEAR B.Sc. (MSAS)-PAPER-IV**

**MODEL PAPER**

**SURVIVAL MODELS**

**SEMESTER-IV**

**DATE: Max. Marks: 60**

**TIME:**

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 **SECTION-A**

Answer any **Four**of the following: **4x5=20M**

1. Define complete and curtate expectation of life. Derive the relation between them.
2. Define survival function. In a certain population, the force of mortality is given by

µx

60<x<70 0.01

70<x<80 0.015

x>80 0.025

calculate the probability that a life aged exactly 65 will die between exact ages 80 and 83.

1. Relationship between the Kaplan-meier and nelson Aalen estimates.
2. Explain estimating $q\_{x}$ from the data by using binomial data.
3. Define poisson distribution and its model.
4. Explain the need for graduation.

**SECTION-B**

Answer any **TWO**of the following: **2x10=20M**

1. state gompertz and makeham laws of mortality.
2. A mortality table, which obeys gompertz law for older ages, has $μ\_{70}$= 0.025330

 and $μ\_{90}$=0.126255. find the probability that a life aged 60 will survive for 20 years.

1. Write a brief note on censoring.
2. Calculate nelson-aalen estimate F(t) for the following data.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| J : 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| $t\_{j }$: 4 | 5 | 10 | 11 | 13 | 15 | 17 | 18 | 21 | 22 |
| $$d\_{j}:1 $$ | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 |
| $$n\_{j}:20$$ | 19 | 15 | 13 | 12 | 10 | 8 | 6 | 2 | 1 |

**SECTION-C**

Answer any **TWO** of the following: **2x10=20M**

1. Derive the maximum likelihood estimator for the rate of mortality in the binomial model and its mean and variance. ?
2. Write statistical properties of maximum likelihood estimates and extending the models?
3. Describe a test for smoothness of a set of graduated estimates ?
4. Describe the reasons for graduating crude estimates of transition probabilities and state the desirable properties of a set of graduated estimates.?

**II B.Sc. – Actuarial Science**

**Practical Paper - IV: Survival Models**

(Total Hours of Laboratory Exercises: 45 @ 3 h / Week in 15 Sessions)

1. Plotting of utility functions.

2. Life table using analytical laws of mortality.

3. Estimation of the empirical survival functions in the absence of censoring.

4. Kaplan-Meier (or product limit) estimate and Nelson-Aalen estimate of the

survival function in the presence of censoring.

5. Find the actuarial estimates of Initial and Central Exposed to risk under Binomial

and Poisson models of number of deaths observed.