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**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**SCHOOL OF MATHEMATICS AND ACTUARIAL SCIENCE**

**UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE**

**ACTUARIAL SCIENCE**

**4TH YEAR 1ST SEMESTER 2016/2017 ACADEMIC YEAR**

**MAIN CAMPUS**

**COURSE CODE: SAC 415**

**COURSE TITLE: SURVIVAL ANALYSIS**

**EXAM VENUE: STREAM: Bsc. ACTUARIAL SCIENCE**

DATE: EXAM SESSION:

TIME: 2.00 HOURS

**Instructions:**

1. **Answer ANY 3 questions**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

**Question One (Compulsory 30 marks)**

1. Express each of the following integrals in terms of gamma and beta functions using the substitution 
2.  (3 marks)
3.  where m>1 n>1 and  (3 marks)
4. For a certain survival mode:



Calculate

1.  (3marks)
2.  (3 marks)
3. An exponential mixture is given  If 

Find *f(x),* *S(x)* and *h(x)* (6marks)

1. Mr Bunn the baker made 12 pies to sell in his shop. He placed the pies in the shop at 9.00 Am. During the rest of the day the following events took place.

|  |  |
| --- | --- |
| Time | Event |
| 10 am | A boy bought two pies |
| 11 am  | A man bought three pies |
| 12 am | Mr Bunn accidentally sat on one pie and squashed it. So it could not be sold. |
| 1 pm | A woman bought two pies |
| 2 pm | A dog from across the street ran into Mr Bunns’s Shop and stole two pies.  |
| 3 pm  | A girl on her way home from school bought one pie. |
| 5 pm | Mr Bunn closed for the day and remaining pie was still in the shop. |

 Estimate the time it takes Mr Bunn to sell 40% of pies he makes using Nelson-Allen technique. (6 marks)

1. Five hundred losses are observed. Five of the losses are: 1100, 3200, 3300 and 3900. All that is known about the other 495 losses is that they exceed 4000. Determine the maximum likelihood estimate of the mean of an exponential model. (6 marks)

QUESTION TWO (20 MARKS)

Continuous Weibull mixture is given by where  and is a mixing distribution. If .

find a) *f(x)* (5 marks)

1.  (5 marks)
2.  (5 marks)
3. Var *X.* (5 marks)

**QUESTION THREE (20 marks)**

A study was made of a group of people seeking jobs. Seven hundred (700) people who just starting to look for work were followed for a period of eight months in a series of interviews after exactly one month, two months, etc. If the job seeker found a job during a month the job was assumed to have started at the end of the month. Unfortunately, the study was unable to maintain contact with all the job-seekers. The data from the study are shown in the table below.

|  |  |  |
| --- | --- | --- |
| Months since start of the study | Found employment | Contact lost |
| 1 | 100 | 50 |
| 2 | 70 | 0 |
| 3 | 50 | 20 |
| 4 | 40 | 20 |
| 5 | 20 | 30 |
| 6 | 20 | 60 |
| 7 | 12 | 38 |
| 8 | 6 | 0 |

1. Describe two types of censoring present in the investigation. (2 marks)
2. Describe an example of a person to whom each type applies. (4 marks)
3. Calculate the Kaplan-Meier estimate of functions for “remaining without employment”. (14 marks)

**QUESTION FOUR (20 marks)**

Suppose at a university over a period of several years, 44 faculty members (20 females and 24 males) | were recruited below the rank of full professor and the accompanying table gives their waiting period (in years) for promotion to the full professor rank.

Females

6, 6, 6, 6+, 8, 9+, 10+, 11, 12+, 13, 16, 17, 18+, 19, 20+, 22, 23, 25+, 32+, 32+

Males

5, 5, 5, 5, 5, 5, 5, 5, 5+, 5+, 6, 6, 8,8,8,8,11, 11, 12, 12+, 15, 17, 22+, 23+

A plus sign indicates censoring (which in this case may mean that the faculty member had not been promoted to the full professor rank as of the end of the observation period or that he/she had left the University while at a rank below that of a full professor. Test the hypothesis that there is no sex difference in the waiting time for promotion to the full professor rank. Use the log-rank test statistic or Generalized Wilcoxon test statitistic.

**QUESTION FIVE (20 marks)**

The table below gives the data for a small sample of employees in a factory. It shows the time in months until the first absence from work. Observations marked + show the time of leaving for those employees who left employment without being absent from work.

Male employees: 6+ , 11, 13+ , 15, 16+ , 19+, 20

Female employees: 2+ , 4, 7, 8+, 10+, 12+ , 17, 21+

A cox proportional Hazards model

$$h\left({t}/{x}\right)=λ\_{0}\left(t\right)exp⁡(βx)$$

is to be fitted to these data where t is the time until the first absence from work, $λ\_{0}\left(t\right)$ is the baseline hazard and $x=0 $for males, $x=1$ for females.

1. Find the partial likelihood function. (10marks)
2. Calculate the maximum partial likelihood estimate of $β.$ (10marks)