

Maternal Age	Respiratory tract illness	
	Yes	No
< 26	42	118
≥ 26	60	275

(8,5)

7. Suppose (Y_1, Y_2) represent the lifetimes associated with two dependent competing risks R_1 and R_2 , following a bivariate Normal distribution $BVN(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho)$ with $\rho\sigma_2 \neq \sigma_1$. Derive the expression for the death density function for death due to a specific cause R_1 . (13)

(1000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 9735

K

Unique Paper Code : 2373010017

Name of the Paper : Advanced Theory of
Biostatistics (NEP)

Name of the Course : B.Sc. (H) Statistics

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. 1 is compulsory.
3. Attempt any **five** questions from the remaining **seven** questions.
4. Use of scientific non-programmable calculator is allowed.
5. Please mention null and alternative hypotheses wherever applicable.

P.T.O.

1. Attempt any five parts :

(a) Explain a retrospective study with a suitable example. Write one merit and one demerit of this study design.

(b) Explain Weiss's carrier borne epidemic model. Obtain expected number of susceptible at time t , i.e. $m(t)$.

(c) Define Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of a diagnostic test. Using the data given below, calculate the PPV and NPV for the ECG test. Among 425 ECG-positive subjects, 416 were confirmed to have myocardial infraction (MI). Among 275 ECG-negative subjects, 104 were confirmed to have MI.

6. (a) Using Bayes' theorem, calculate the Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of the ECG test conducted on 700 subjects suffering from prolonged acute chest pain. Assume that the prevalence of myocardial infraction (MI) is 15% in Country A and 25% in Country B. Based on your calculations, discuss how differences in disease prevalence influences the predictive accuracy of the ECG test.

ECG	MI	
	Present	Absent
Positive	420	8
Negative	100	172

(b) Calculate the 95% confidence interval for the relative risk of respiratory tract illness in the boys born to the younger women using the following data :

T_1 : 17, 20+, 20+, 21+, 22+

T_2 : 25+, 18, 20, 22, 26

Apply Cox-Mantel test to test whether the two treatment protocols are equally effective at 5% level of significance. (6,7)

5. (a) Define simple stochastic epidemic model and its duration. Derive the expression for the r th cumulant of the total duration of the simple epidemic model.

- (b) Derive the expression for the probability that all n individuals remain susceptible at time t given that there are n susceptible and one infective at time $t=0$ under the simple stochastic epidemic model. (6,7)

- (d) Let $\lambda_1, \lambda_2, \dots, \lambda_k$ be the death intensities corresponding to risks $R_1, R_2, \dots, R_k$ respectively then show that the probability of dying from the

specific cause $R_i (i = 1, 2, \dots, k)$ is $\pi_i = \frac{\lambda_i}{\lambda}$ where

$$\lambda = \sum_{i=1}^k \lambda_i \text{ for all } i.$$

- (e) What is the primary objective of each phase of Clinical trials?
- (f) What are the two main differences between prospective and cross-sectional studies?

(5×5=25)

2. (a) Discuss the Cox's F-test for comparing the two exponential distributions with parameters λ_1 and λ_2 respectively for testing the null hypothesis against both one sided alternatives as well as two sided alternative hypotheses.

P.T.O.

9735

4

- (b) 19 patients were divided into experimental group and control group. The survival times (in weeks) were recorded as follows :

Experimental group: 1, 2, 6, 8, 9, 13, 2+, 9+, 22+,
43+, 45+

Control group: 2, 5, 7, 12, 12+, 19+, 22+,
39+

Assuming that the experimental and control group observations are coming from exponential distributions with parameters λ_1 and λ_2 respectively, test for $H_0 : \lambda_1 = \lambda_2$ against $H_1 : \lambda_1 < \lambda_2$ using Cox's F-test. What do you infer from your result? (Use $F_{12,8,0.05} = 2.34$)

(5,8)

3. (a) Ten patients with cancer are randomized to receive two different treatments. The following remission times (in months) are recorded:

9735

5

Treatment A: 28+, 22+, 24+, 20+, 27

Treatment B: 22, 23, 24, 23, 19

Test that treatment A is more effective than treatment B using the Gehan's Generalized Wilcoxon test at 5% level of significance. Also explain the steps of the test clearly.

- (b) Discuss the log-likelihood ratio test for comparing two Weibull distributions with parameters (A^Vx) and (λ_2, v_2) respectively where $\lambda_1 = \lambda_2 = \lambda_0$ is known. (9,4)

4. (a) Discuss log-rank test for comparison of two survival distributions.

- (b) Ten cancer patients were randomly allocated two treatment protocols T_1 and T_2 . The following survival times (in weeks) were obtained:

P.T.O.