Comilla University
Department of Statistics
3rd Year 2nd Semester B.Sc. (Hon's) Final Examination 2021
Course Title: Statistical Inference - II
Course Code: Stat -321, Session: 2018-19

Full Marks: 60 **Time: 3 hours**

(Answer any five of the following question)

1. a. Define best regular unbiased estimator (BRUE). Write down the condition of regular distribution. 4

b. Let X be $U[0, \theta]$. Then 5

$$f_\theta(x) = \begin{cases} \frac{1}{\theta} & \text{if } 0 \le x \le \theta \\ 0 & \text{otherwise} \end{cases}$$

Thus, we get $E_\theta\left[\frac{\partial \ln f_\theta(X)}{\partial \theta}\right]^2 = \frac{1}{\theta^2}$, Find the lower bound of the Rao-Cramer inequality.

c. Explain Cramer-Rao inequality is a method for finding uniformly minimum variance unbiased estimator. 3

2. a. Define minimal sufficient statistic and James-Stein estimator. 3

b. Suppose we have $n = 2$ independent observation from the Cauchy distribution with $p.d.f.$ 5

$$f_X(x) = \frac{1}{\pi} \cdot \frac{1}{1+(x-\theta)^2} \quad ; \quad -\infty < x < \infty$$

Show that no nontrivial sufficient statistic exists.

c. State the Bhattacharya inequality. 3

3. a. Define complete sufficient statistics and ancillary statistics. State and prove Basus theorem. Cite a practical example of this theorem. 6

b. Distinguish between: i) Unbiased and biased estimators; ii) Sufficient and minimal sufficient statistic; and iii) estimator and minimax estimator. 6

4. a. What is a sequential analysis? Compare sequential analysis with classical approach. Show that $A=\frac{1-\beta}{\alpha}$ and $B=\frac{\beta}{1-\alpha}$, Where α and β are the probabilities of the type-I error and type-II error respectively. 6

b. Develop asymptotic SPRT for testing $H_0: \theta = \theta_0$ against $H_1: \theta = \theta_1$; When sampling form N (θ, σ^2). Find OC and ASN functions of the test. 6

5. a. Discuss James-Stein estimator technique in a statistical inference. 4

b. Let, $X_1, X_2, \cdots, X_n$ be a random sample from the uniform distribution with probability density function $f(x; \theta) = 1$; $\theta < x < \theta + 1$. Find minimal sufficient statistics for θ and show that sample range is an ancillary statistic. 8

6. a. What do you mean by pivotal quantity? Write its importance in determination of confidence interval. Determine a confidence interval for the mean of a normal distribution when its variance is unknown. 4

b. Let, $X_1, X_2, \cdots, X_n$ be a random sample from a normal population N (μ, 20). Find 95% fidence interval for μ using pivotal quantity method when $\sum x$=160 and n=10. 4

c) Distinguish between Bayesian interval and confidence interval. 4

7. a. Define likelihood ratio test. Write down the properties of LRT Statistic (λ). 3

b. Suppose $x_1, \cdots, x_n$ be a random sample from $f(x;\theta) = \theta e^{-\theta x} I_{(0,\infty)}(x)$ where $\bar{\Theta} = \{\theta, \theta > 0\}$. 5
Derive likelihood ratio test (LRT) criterion for testing $H_0 : \theta \le \theta_0$ against $H_1 : \theta > \theta_0$.

c. Show that under certain regularity condition $-2\ln\lambda \sim \chi^2$ with 1 *d.f.* where λ is LR 4

8. a. State some asymmetric loss function used in point estimation. Define MLINEX loss function. 3

b. Let $X_1, X_2, \cdots, X_n$ be independent $N(\mu, \sigma^2)$ variables where μ is unknown but σ^2 is known. Let the prior distribution of μ be $N(\theta, \sigma^2)$. Find the Bayes estimate of μ. 5

c. Prove that for squared error loss function, Bayes estimator is the mean of posterior density function. 4

Comilla University
Department of Statistics
3rd Year 2nd Semester Final Examination-2021
Session: 2018-19
Course Code: STAT-322 (Old syllabus: STAT-323)
Course Title: Order Statistics and Nonparametric Methods

Marks-60 **Time-03 hours**

(Answer any five questions from the following questions)

1. a. Define order statistics. Establish the marginal probability distribution function of ith order statistics. Also find the pdf of highest and lowest order statistics. 5
   b. Let $x_1, x_2, x_3, \dots x_n$ be a random sample from $f(x) = 1, 0 < x < 1$, find $f(x_{(1)})$ and $f((x_{(n)}))$. Also the mean and variance of $x_{(1)}$ and $x_{(n)}$. 4
   c. Let $x_1, x_2, x_3, \dots x_n$ be a random sample from $f(x) = 1, o < x < 1$, find the cdf of $x_{(r)}, x_{(1)}$ and $x_{(n)}$ 3

2. a. Mention some applications of order statistics. Find the sampling distribution sample range. 6
   b. Let $X_1, X_2, \dots, X_n$ be a random sample from the following density function: 6
   $f(x) = \frac{1}{\theta} e^{-x/\theta}, 0 \le x < \infty$
   Find the density function of sample range.

3. a. Let $x_1, x_2, x_3, \dots x_n$ be a randomsample from a population with continuous density $Y_1 = \min(X_1, X_2, \dots X_n)$ is exponential with parameter $n\lambda$ if nad only if each x_i is exponential with parameter λ. 5
   b. Compute the probability that, the smaller of X_1, X_2, X_3 exceeds median of the distribution $f(x) = 2x; 0 < x < 1$ 4
   c. If $Y1 \le Y2 \le Y3$ are the order statistics, find the correlation between Y2 and Y3. 3

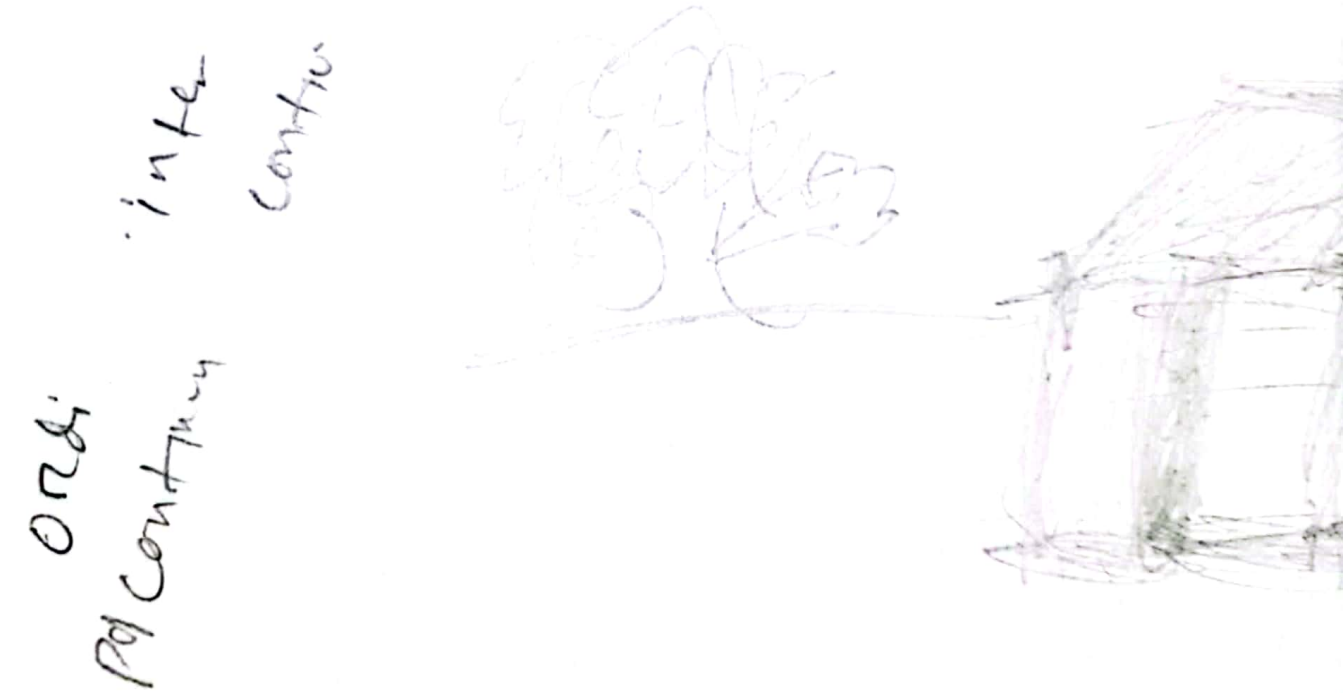
4. a. Derive the distribution of median for both odd and even sample size. 6
   b. Suppose that a sample of size n (n is odd) drawn from a standard population. Find the mth moment of sample median, also find the mean and variance of it. 6

5. a. What do you mean by parametric and non-parametric test? Make a comparative study between both types of test. 5
   b. What is randomness? Why is it important in statistical decision making? Suppose R_1 and R_2 denote the respective number of runs of n_1 objects of type I and n_2 objects of type II in a random sample of size $n = n_1 + n_2$. Find the marginal probability distribution of R_1 and R_2. 7

6. a. Derive the Kolmogorov-Smirnov goodness of fit test. How does Kolmogorov-Smirnov test differ from chi-square test? 5
   b. If X be a random variable and its rank is r, show that the coefficient of correlation between X and r can be expressed by $\left[\frac{12(N-1)}{N+1}\{E[XF_X(X)] - 1/2\}\right]$. 7

7. a. What is run's up and down? How can it be helpful in the test of randomness? Mention the advantages of run test over other tests. 4
   b. Define Empirical distribution function. Why it is called a distribution function? State some properties of this distribution function. 5
   c. Distinguish between sign test and Wilcoxon signed-rank test. 3

8. a. Discuss Mood test for scale parameter. When mood test is preferred to its parametric counterparts? 7
   b. Distinguish between Mann-Whitney U test and parametric t-test. 3
   c. Why Kruskal-Wallis test is more powerful than median test? 2



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Comilla University

Department of Statistics

3^{rd} Year 2^{nd} Semester B.Sc. (Hon's) Final Examination-2021

Course Title: Linear Programming and Operation Research

Course Code: Stat-323, Session: 2018-2019

(For Old Syllabus Course Code: Stat-324)

Full Marks: 60 **Time :3 hours**

Answer any five (05) of the following questions

1. a) What is operations research? What is the characteristics of operations research? 3
   b) Discuss the significance and scope of operations research in modern management. 4
   c) What is the role of operations research in decision making? State the different types of models used in operations research. 5

2. a) Define the following: Convex set, Convex polyhedron, Convex and Concave functions, Non-degenerate and Degenerate basic solution. 6
   b) A small manufacture employs 5 skilled men and 10 semi-skilled men and makes an article in two qualities, a delux model and an ordinary model. The making of a delux model requires 2 hours work by a skilled man and 2 hours work by a semi-skilled man. The ordinary model requires 1 hour work by a skilled man and 3 hours work by a semi-skilled man. By union rules no man can work more than 8 hours per day. The manufacturer's clear profit of the delux model is Tk 25 and of the ordinary model is Tk 20. Formulate the model of the problem. 6

3. a) Define the following terms: 3
   i) Basic matrix ii) Optimum basic feasible solution iii) Degenerate solution
   b) Along with essential characteristics write down the standard form of a linear programming problem. Also express the following linear programming problem in standard form: 6

   Maximize, $z = 2x_1 - x_2 + x_3$

   Subject to constraints:

   - $x_1 + 3x_2 - x_3 \leq 20$

     $2x_1 - x_2 + x_3 \leq 12$

   - $x_1 - 4x_2 - 4x_3 \geq 2$

     and $x_j \geq 0$; j=1(1)6

   c) Show that the set of feasible solution of linear programming problem is a convex set. 3

4. a) Define transportation problem with industrial example. 3
   b) Explain row minima method for obtaining an initial basic feasible solution of a transportation problem. 5

c) Determine an initial basic feasible solution to the transportation problem using north-west corner rule method: 4

Origin \ Destination	D_1	D_2	D_3	Supply
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
O_4	1	6	2	14
Demand	7	9	18	

Also calculate the minimum cost of transportation.

5. a) Discuss the basic steps in the simplex procedure for maximization case of LPP. 4

b) What is simplex method? Define slack and surplus variable with example. 3

c) Solve the following LPP by simplex method- 5

Minimize, $Z=x_1 - 3x_2+2x_3$

Subject to the constraint:

$3x_1 - x_2+2x_3 \leq 7$

$-2x_1 + 4x_2 \leq 12$

$-4x_1 +3x_2+8x_3 \leq 10$

$x_1, x_2, x_3 \geq 0$

6. a) Discuss the method of graphical solution of 2×n games. 6

b) Solve graphically the game whose payoff matrix is 6

$$\begin{matrix} 2 & 3 & 11 \\ 7 & 5 & 2 \end{matrix}$$

7. a) Explain the term 'artificial variable' and its use in linear programming. 4

b) Use Big-M method to

Maximize $Z = 6x_1 +4x_2$

Subject to $2x_1 +3x_2 \leq 30$

$3x_1 +2x_2 \leq 24$

$x_1 +x_2 \geq 3$

$x_1, x_2 \geq 0$

Is the solution unique? If not, give two different solutions.

c) Discuss the graphical method of solving linear programming problem. 3

8. a) Define the following terms: 4

a) Pay-off matrix b) Mixed strategy c) Saddle point of the game d) Two-person zero-sum game

b) Discuss the maximin and minimax principle of solving a game problem. 5

c) Solve the following two-person zero sum game with 3×4 payoff matrix for player A and player B and find the value of game of the matrix 3

	Player B			
	−5	2	0	7
Player A	5	6	4	8
	4	0	2	−3

Comilla University
Department of Statistics
B.Sc. 3rd year 2nd Semester Final Examination-2021
Session: 2018-2019
Course Title: Environmental Statistics, Course Code: Stat-324

Marks-60 **Time-03 hours**

(Answer any five questions from the following questions)

1. a) What is meant by environmental statistics? Write down the uses of environmental statistics. 03

   b) What is pollutant? Why does pollutant matters? What are the different sources of pollutant? Discuss these sources of pollutant very briefly. 07

   c) What are the effects of the pollutants on the environment? 02

2. a) What is Bernoulli process? What are the conditions for Bernoulli process? How can you use Bernoulli process to environmental problems? 05

   b) Discuss the application of Binomial Distribution to environmental problem with example for 3 year time period and list out the probability distribution for the number of excedances. 07

3 a) Briefly discuss about Diffusion and Dispersion of Pollutants. 04

   b) What do you mean about Plume Model? 03

   c) What is wedge machine? Suppose that a wedge machine is constructed and it has 4 rows of wedges at the bottom. Find the probability distribution of the particle arrival in each channel at the bottom of the machine. If $n_0 = 100$ particles are released from the source one at a time, what will be the expected number of particles arrivals in each channel of the bottom of the machine? 05

4 a) What do you mean about Environmental Sampling? What are the types of Environmental Sampling? 03

   b) Write down a short note on Transect sampling and adaptive sampling. 04

c) Briefly discuss about Capture-recapture or mark-recapture sampling. Also estimate the Petersen and Chapman Estimator with example for Capture-recapture or mark-recapture sampling. 05

5 a) Write a short note on Composite Sampling and Ranked-Set Sampling. 04

b) What is Poisson process? What are the conditions for Poisson process? 04

c) Develop a model for Poisson process. 04

6 a) What do you understand about Spatial Point Process Models and Methods? 02

b) Discuss the general spatial process: prediction, interpolation and kriging. 06

c) Write down short note about spatial sampling and spatial design. 04

7 a) Briefly discuss about Statistical Theory of Rollback. 02

b) Show that, if $X = QD$, and Q and D are independent random variables that are modified in such a manner that $CV(Q)$ does not change and $CV(D)$ does not change, then $CV(X)$ also does not change. 05

c) Proof that, if the random variable representing the source is correlated with the random variable representing dilution-diffusion phenomena, and if the source variable is multiplied by the rollback factor r, then the assumed correlation between the source and the dilution- diffusion phenomena in the post-control state will be the same as in the pre-control state. 05

8 a) What do you mean by dilution of pollutants? Why do we need to study dilution of pollutants? 06

b). Discuss Deterministic Successive Dilution Process with example. 06

Comilla University
Department of Statistics
3rd Year 2nd Semester B. Sc. (Hon's) Final Examination – 2021
Course Title: Research Methodology
Course Code: Stat – 325 Session: 2018 – 19

Time: 03 hours Marks: 60

Answer any ***five*** questions from the following

01. a) What is research? What are its significances? Give some practical examples of research activities. 06
b) What are the factors that motivate one to undertake research? Enumerate some of the important characteristics and desirable qualities of research. 06

02. a) Define research method. Why do we study research method? Distinguish between research method and research methodology. 06
b) What is qualitative research? Give two typical examples of qualitative research. How does it differ from quantitative research? 06

03. a) Cite the research design with its broad classification. What are the main objectives of conceiving a research design. 06
b) Name some important sources of secondary data. Discuss in brief the advantages and limitations of secondary data in an explanatory research. 06

04. a) Enumerate the objectives, phase and types of case study. Illustrate your answer with suitable examples. 06
b) Case study concerns with past, present and future. Elaborate this statement. 06

05. a) What is sample design? How does it differ from a survey design? Enumerate the desirable qualities of a good sample design. 06
b) A nutrition survey is to be conducted in a refugee camp. Assume that 40% children suffer from malnutrition. How large a sample would be needed in order to be 95% certain that the estimated prevalence by more than 0.05%? 06

06. a) Write the definition of Focus Group Discuss (FGD). Also mention its procedure for planning and conducting. 06
b) Broadly describe the advantages and disadvantages of FGD. 06

07. a) Define reliability and distinguish it from validity. Explain the concept of reliability in the context of stability, equivalence and internal consistency. 07
b) Enumerate the importance of scaling in social science research. 05

08. a) Explain monitoring. How does it differ from evaluation? Discuss in brief the common characteristics of monitoring and evaluation. 06
b) Display core objectives of evaluation in a schematic diagram. Elaborate the terms 'efficiency' , 'effectiveness' and 'impact' as used in monitoring and evaluation. 06