(Pages : 6) **N – 1397**

Reg. No. : ....

Name : ....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Statistics

Core Course

ST 1643 : OPERATION RESEARCH AND STATISTICAL QUALITY CONTROL

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 80

Instructions : Statistical tables and calculator are allowed.

SECTION – A

Answer **all** questions. **Each** question carries **1** mark.

1. Define unbounded solution.

2. Define optimum basic feasible solution.

3. When do we say that a basic feasible solution is non-degenerate?

4. What is the use of least cost method?

5. Write any method for statistical process control.

6. Write the modern definition of quality.

7. Give an example for chance cause of variation.

P.T.O.

8. When do we use p chart?

9. Write the distribution based on which the statistical principle of c chart are underlying.

10. Write the average sample number of single sampling plan when the sample size is 100.

(10 × 1 = 10 Marks)

SECTION – B

Answer **any eight** questions. Each question carries **2** marks.

11. List the assumptions of a linear programming problem.

12. Explain the significance of artificial variable.

13. Discuss degeneracy in TPP?

14. Distinguish between slack variables and surplus variables.

15. What is meant by transportation problem?

16. Define feasible solution.

17. Write the dual of the LPP:

Maximise $Z = x_1 - x_2 + 3x_3$

Subject to

$$x_1 + x_2 + x_3 \leq 10$$
$$2x_1 - x_2 - x_3 \leq 2$$
$$2x_1 - 2x_2 - 3x_3 \leq 6$$
$$\text{and } x_1, x_2, x_3 \geq 0$$

18. Describe an OC curve. Write any one use of OC curve.

19. What is meant by natural tolerance limits?

20. Define statistical quality control.

21. Write the control limits of range chart when the parameter values are known.

22. Describe any method to construct rational subgroups.

23. Define assignable cause of variation.

24. Define acceptance sampling.

25. Define AOQ and AOQL.

26. Distinguish between AQL and LTPD.

(8 × 2 = 16 Marks)

SECTION – C

Answer **any six** questions. Each question carries **4** marks.

27. Solve the following LPP using graphical method.

Minimize $Z = -x_1 + 2x_2$

Subject to

$-x_1 + 3x_2 \leq 10$
$x_1 + x_2 \leq 6$
$x_1 - x_2 \leq 2$ and
$x_1, x_2 \geq 0$

28. Discuss the mathematical formulation of a linear programming model.

29. Prove that the dual of the dual is primal.

30. Describe two phase method for solving an LPP.

31. Write the steps for solving an LPP using Big M method.

32. Compare consumer's risk and producers' risk. How do they influence the selection of control limits?

33. Discuss the statistical principle of a control chart.

34. Discuss the applications of statistical quality control techniques in industry.

35. 12 samples of 200 bulbs each were examined and the number of defective bulbs in each sample are given. Set up a control chart for fraction nonconformities using these data.

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12
Number of defectives	3	2	4	3	2	0	3	1	1	2	4	0

36. Discuss the construction and applications of *d* chart.

37. Derive the OC function of single sampling plan. Discuss the effect of sample size and acceptance number on the OC curve of SSP.

38. Discuss the multiple sampling plan.

(6 × 4 = 24 Marks)

SECTION – D

Answer **any two** questions. Each question carries **15** marks.

39. Solve by simplex method

    Max $Z = 3x_1 + 5x_2 + 4x_3$

    Subject to

    $2x_1 + 3x_2 \le 8$
    $2x_2 + 5x_3 \le 10$
    $3x_1 + 2x_2 + 4x_3 \le 15$ and
    $x_1, x_2, x_3 \ge 0$

40. Describe assignment problem. Explain the Hungarian method for solving the assignment problem.

41. Explain North West corner method and Vogel's approximation method for finding the initial feasible solution of a transportation problem.

42. Construct control chart of mean and range for the following data and comment on the state of control.

Sub group	1	2	3	4	5	6	7	8	9	10	11	12	13
x_1	459	443	457	469	443	444	445	446	444	432	445	456	459
x_2	449	440	444	463	457	456	449	455	452	463	452	457	445
x_3	435	442	449	453	445	456	450	449	457	463	453	436	441
x_4	450	442	444	438	454	457	445	452	440	443	438	457	447

$(A_2 = 0.729,\ D_3 = 0,\ D_4 = 2.282)$

43. (a) Explain the construction of c chart and u chart.

    (b) Following table presents the number of nonconformities observed in 20 successive samples of 100 printed circuit boards. Draw a c chart for the data and comment on the state of control.

Sample Number	1	2	3	4	5	6	7	8	9	10
Number of non conformities	20	24	16	6	15	11	27	20	31	24
Sample Number	11	12	13	14	15	16	17	18	19	20
Number of non conformities	21	10	18	13	22	19	39	16	24	30

44. Compare single sampling and double sampling plans. Compute the probability of acceptance of a double sampling plan with acceptance numbers $c_1 = 1$, $c_2 = 3$ and sample sizes $n_1 = 50$, $n_2 = 100$ when the lot fraction defective is 0.05.

(2 × 15 = 30 Marks)

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(Pages : 4) **N – 1401**

Reg. No. : ....

Name : ....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Statistics

Elective Course

ST 1661.2 : STOCHASTIC PROCESSES

(2018 and 2019 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer all questions. Each question carries **1** mark.

1. Define the state space of a Stochastic Process.
2. When do you say that a Stochastic Process is a continuous time process?
3. Find the probability generating function of a Binomial Random variable.
4. When do you say two states of a Markov Chain are communicative?
5. Define a Markov chain.
6. When is a transition probability matrix (TPM) said to be stochastic?
7. Define a compound Poisson process.
8. Define a Branching process.
9. What is stationarity in Stochastic process?
10. What is irregular variation in a time series data?

(10 × 1 = 10 Marks)

P.T.O.

SECTION – B

Answer **any eight** questions. Each question carries **2** marks.

11. If X and Y are independent Poisson random variables with parameters λ and μ respectively, then what is the distribution of $X+Y$?

12. Establish the expression to get the variance from a probability generating function.

13. If $f(x, y) = Ae^{-(x+y)}, 0 < x,y < \infty$, is the joint probability density function of x and y, find A and also find the marginal pdfs of X and Y and check their independence.

14. Show that recurrence is a class property.

15. When do you say a Markov Chain is irreducible?.

16. Define absorbing Markov Chain with an example.

17. What is the period of a particular state in a Markov Chain?

18. What are the properties of a TPM?

19. For an irreducible Markov Chain, if the stationary distribution exists, then it is unique. Justify.

20. State the ergodic theorem.

21. Distinguish between strict sense and weak sense stationarity.

22. What are the usual Mathematical models used in time series analysis?

23. Define exponential smoothing in a time series data.

24. What is the significance of autocorrelation in time series analysis?.

25. Define the first order autoregressive model.

26. Define the probability of extinction in a branching process.

(8 × 2 = 16 Marks)

SECTION – C

Answer **any six** questions. Each question carries **4** marks.

27. Give an example of a discrete state branching process.

28. Obtain the conditional densities from the joint pdf $f(x, y) = 3 - x - y$, $0 < x, y \leq 1$. Also check the independence of X and Y.

29. Find the Probability generating function (PGF) of a Geometric random variable.

30. For an integer valued r.v X, with $P(X = n) = p_n$ and $P(X \leq n) = q_n$ so that $\sum_{i=0}^{n} p_i = q_n$, then prove that $\sum_{n=0}^{\infty} P(X \leq n)s^n = \frac{G_X(S)}{1-s}, |s| \leq 1$, where $G_X(s)$ is the PGF of X.

31. Explain the various classifications of Stochastic Processes.

32. Distinguish between recurrent and transient states of a Markov Chain.

33. A Markov Chain $\{X(t), t = 0, 1, 2, ...\}$ defined on the state space {1,2,3} has the following TPM. Find the stationary distribution of the chain.

$$P = \begin{pmatrix} 0 & \frac{2}{3} & \frac{1}{3} \\ \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & 0 \end{pmatrix}.$$

34. Show that for an irreducible Markov Chain, the stationary distribution, if exists, is unique.

35. Discuss on the components of a time series data.

36. Give the names of different methods of measuring trend in time series analysis.

37. Show that for a Gaussian Stochastic process both weak and strong stationarity are equivalent.

38. Establish the Branching process recursion formula based on the probability generating function.

(6 × 4 = 24 Marks)

SECTION – D

Answer **any two** questions. Each question carries **15** marks.

39. Let $X_1, X_2, \ldots$ be a sequence of independent and identically distributed random variables with common PGF as $G_X(S)$. Let N be a random variable independent of the random variables X_i's with PGF as $G_N(s)$ and let $T_N = \sum_{i=1}^{N} X_i$. Then show that the PGF of T_N is $G_{T_N}(s) = G_N(G_x(s))$. Also compute the mean of T_N.

40. A Markov Chain defined with state space S = {1,2,3,4,5} has the following transition probability matrix P. Find (a) all closed classes, (b) irreducible classes, (c) recurrent and (d) transient states.

$$P = \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{pmatrix} 0.3 & 0.4 & 0.4 & 0 & 0 \\ 0 & 0 & 0.3 & 0.4 & 0.4 \\ 0 & 0.3 & 0 & 0.3 & 0.4 \\ 0 & 0 & 0 & 0.4 & 0.6 \\ 0 & 0 & 0 & 0.6 & 0.4 \end{pmatrix} \end{array}$$

41. How do you fit a trend line by the method of least squares in a time series analysis? Also mention the merits and demerits of the method.

42. Define Poisson process. State the important postulates of the Poisson process. If the arrival process is Poisson, then what is the distribution of the inter arrival (waiting) times?

43. Let $\{Z_0 = 1, Z_1, Z_2, \ldots\}$ be a Branching process with family size Y having a Binomial(2, 1/4) distribution. Find the probability that the process will eventually die out.

44. Explain Galton-Watson branching process. Let μ be the expected number of offsprings in each generation in a Galton-Watson branching process. Show that, if $\mu \leq 1$, the process dies out with probability one.

(2 × 15 = 30 Marks)

(Pages : 6) **N – 1395**

Reg. No. : ....

Name : ....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Statistics

Core Course – X

ST 1642 – APPLIED STATISTICS

(2018 and 2019 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer **all** questions. Each question carries **1** mark.

1. Index numbers is a :

   (a) measure of relative changes

   (b) a special type of an average

   (c) a percentage relative

   (d) all the above

2. The price index as the arithmetic mean of Laspeyre's and Paasche's indices was expounded by

   (a) Kelly (b) Irving Fisher

   (c) Drobish and Bowley (d) Walsh

P.T.O.

3. If the index number is independent of the units measurements, then it satisfies :

(a) time reversal test

(b) factor reversal test

(c) unit test

(d) all the above

4. Trend in a time series means

(a) long-term regular movement

(b) short -term regular movement

(c) both (a) and (b)

(d) neither (a) nor (b)

5. The component of a time series which is attached to short-term fluctuations is :

(a) seasonal variation

(b) cyclic variation

(c) irregular variation

(d) all the above

6. What is NSSO?

(a) National Social Science Office

(b) National Social Study Office

(c) National Security Science Office

(d) National Sample Survey Office

7. For consumer price index, the price data should be collected from ——————.

8. The CSO is headed by ——————.

9. Given the trend equation $Y = 118.5 + 2.2X + 1.4\ X^2$ with origin 2000 the trend equation with origin 2001 is ——————.

10. Quarterly fluctuations observed in time series —————— represent variation.

(10 × 1 = 10 Marks)

SECTION – B

Answer **any eight** questions. Each question carries **2** marks.

11. What is NSO? What are its different wings?

12. Explain De-facto method.

13. What is a price relative?

14. What is splicing?

15. Give any two limitations of index numbers.

16. Explain briefly the concept of cost of living index number.

17. Explain the precautions that we have to take to fix 'base year' to calculate index number.

18. Explain the components of time series.

19. Illustrate the linear and non linear trend in time series.

20. Explain the mathematical models in time series.

21. What are the normal equations to fit a straight tine $y = a + bx$.

22. What are the merits and demerits of semi average method?

23. How can we obtain the statistics of crop yields?

24. What is circular test?

25. Explain briefly the concept of whole sale price index number.

26. Define moving average.

(8 × 2 = 16 Marks)

SECTION – C

Answer **any six** questions. Each question carries **4** marks.

27. What are the main functions of NSSO?

28. What are the types of census enumeration?

29. Elucidate the uses and limitations of time series analysis.

30. What do you mean by 'Business cycle'? Explain.

31. What is method of least squares? What are normal equations of a straight line?

32. What is a time series? Explain with examples.

33. Give two examples each to

    (a) Seasonal variation

    (b) Irregular variation.

34. Explain briefly how the index numbers are used to measure the purchasing power of money?

35. Differentiate Laspeyre's from Paasche's index number. Among these which one is superior and why?

36. Distinguish between simple index number and weighted index number. Mention any two applications of weighted index number.

37. Explain and illustrate :

    (a) Base shifting

    (b) Deflating

38. Why index numbers are called economic barometers? Explain.

(6 × 4 = 24 Marks)

SECTION – D

Answer **any two** questions. Each question carries **15** marks.

39. Describe the steps involved in Ratio to moving average method of measuring seasonal indices.

40. Explain factor reversal test and time reversal test. Show that Fishers Ideal index number satisfies both these tests.

41. Explain the role of index numbers in the socio-economical analysis. What are the main factors to be cared while constructing an index number?

42. What you mean by Statistics of Labour and Employment. What are the methods used for national income estimation?

43. Below are given the figures of production (in thousand quintals) of a sugar factory:

Year	2001	2002	2003	2004	2005	2006	2007
Production	80	90	92	83	94	99	92

    (a) Fit a straight line trend to these figures.

    (b) Plot these figures on a graph and show the trend line.

44. From the following data of wholesale prices of wheat for ten years construct index number taking

(a) 1998 as base and

(b) by chain base method

Year	Price of Wheat	Year	Price of Wheat
1998	50	2003	78
1999	60	2004	82
2000	62	2005	84
2001	65	2006	88
2002	70	2007	90

(2 × 15 = 30 Marks)

(Pages : 3) **N – 1393**

Reg. No. : ....

Name : ....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Statistics

Core Course – IX

ST 1641 : DESIGN OF EXPERIMENTS AND VITAL STATISTICS

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer **all** questions. Each question carries **1** mark.

1. Write the mathematical model for a two way Analysis of variance.
2. What are the assumptions of errors in experimental models?
3. Define a randomized design.
4. Which design do you prefer if the experimental units are homogeneous?
5. Define a LSD (Latin Square Design).
6. What effects are measured in factorial experiments?
7. Define Demography.
8. What is a cohort?
9. Define force of mortality.
10. What is crude Birth Rate?

(10 × 1 = 10 Marks)

P.T.O.

SECTION – B

Answer **any eight** questions. Each question carries **2** marks.

11. What is a Randomized Block Design(RBD)?
12. Give the statistical model(model only) for a Completely Randomized Design CRD with one observation per cell.
13. What do you mean by local control?
14. Explain the advantages of LSD over RBD.
15. What is the importance of a Latin Square Design?
16. How can you calculate the sum of squares for analysis of variance of a LSD?
17. Write the expression for the efficiency of a Randomized Block Design over CRD.
18. What are factorial experiments?
19. What are the effects measured in factorial experiments?
20. What is the function of Sample Registration System of India?
21. Distinguish between curate (curtailed) expectation and complete expectation.
22. What are the methods of standardization of data?
23. Name three methods of constructing an abridged life table.
24. Define central mortality rate.
25. Distinguish between symmetrical and asymmetrical factorials.
26. Give the important measures of fertility.

($8 \times 2 = 16$ Marks)

SECTION – C

Answer **any six** questions. Each question carries **4** marks.

27. Discuss the technique of Analysis of variance for one-way classification.
28. Explain the basic principles of experimentation.

29. Outline the analysis of a data with a single missing value of a $k \times k$ Latin square design.

30. What do you mean by mutually orthogonal Latin squares?

31. What is confounding?

32. Write the set of orthogonal contrasts for main effects and interactions in a 2^3 factorial experiment.

33. Specific Death Rate is better than Crude Death Rate. Justify.

34. Distinguish between stable and stationary population.

35. What is the significance of IMR in population studies?

36. Establish the relation between the life table functions q_x, the probability of dying within one year after attaining age x and m_x, the probability of dying a person whose exact age is not known but lies between x to $(x + 1)$ years(central mortality rate).

37. Distinguish between NRR and GRR.

38. In what way construction of a complete life table differ from that of an abridged life table?

(6 × 4 = 24 Marks)

SECTION – D

Answer **any two** questions. Each question carries **15** marks.

39. Characterize a Completely Randomized Design. What are the merits of CRD?

40. Describe the analysis of a LSD and sketch the ANOVA table.

41. Explain the Yates' method of analysis for a 2^2 factorial experiment.

42. Discuss the various uses of vital statistics for a country.

43. Given the age returns for the two ages $x = 9$ years and $x + 1 = 10$ years with the life table values as $l_9 = 75824$, $l_{10} = 75362$, $d_{10} = 418$, $T_{10} = 4953195$. Give the complete life table for the two ages 9 and 10 of the persons.

44. Explain the GFR and the information gathered by it. How the information is improved by Age Specific Fertility Rate and by Total Fertility Rate?

(2 × 15 = 30 Marks)