SYBA
SEMESTER -III

Subject: Statistics (General-I)
ST-23843: Sampling Techniques

Unit 1. Sampling: (14)

1.1 Simple Random Sampling from Finite Population of size(N) with replacement(SRSWR) and without replacement(SRSWOR). Population mean and Population total as parameters, inclusion probabilities.

1.2 (a) Sample mean $\bar{y}$ as an estimator of population mean $\bar{Y}$, derivation of its expectation and standard error.

(b) N$\bar{y}$ as an estimator of population total, derivation of its expectation and standard error of N$\bar{y}$

(c) Estimator of above standard errors, in case of SRSWR and SRSWOR.

1.3 Sampling for proportion as an application of simple random sampling with Y_i taking value zero or one.

(a) sample proportion (p)as an estimator of population proportion(P) of units possessing a certain attribute, derivation of expectation and standard error of (p).

(b) Np as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of (Np).

(c) Estimator of above standard error both in case of SRSWR and SRSWOR.

Unit2. Determination of the sample size: (8)

2.1 Determination of the sample size for variable:

(i) Margin of error and confidence coefficient.

(ii) Coefficient of variation and confidence coefficient.

2.2 Determination of the sample size for attributes:

(i) Margin of error and confidence coefficient.

(ii) Coefficient of variation and confidence coefficient.

Unit 3. Stratified Random Sampling: (16)

3.1 Stratification, basis of stratification, real life situation where stratification can be used.

3.2 Stratified sampling as a sample drawn from individual strata by SRSWOR in each stratum

(a) $\bar{y}_{st} = \frac{\sum N_i \bar{y}_i}{N}$ as an estimator of population mean $\bar{Y}$. Derivation of expectation and standard error of $\bar{y}_{st}$

(b) N$\bar{y}_{st}$ as an estimator of population total, derivation of expectation and standard error of N$\bar{y}_{st}$

(c) Estimator of standard errors of (a) and (b)

3.4 Derivation of allocation(n_i)under proportional allocation, optimum allocation with constant function $C = c_0 + \sum_i c_i n_i$ and Neyman's allocation with the expressions for the standard errors when these allocations are used.

3.5 Comparison between these three allocations (Statement Only).

Unit 4. Systematic Sampling (Population size divisible by sample size) (6)

4.1 Meaning of systematic sampling. Method of drawing a sample using systematic sampling. Real life situations where systematic sampling is appropriate.

4.2 Estimators of the population mean and population total, standard error of these estimators **(without proof).**

Unit 5. Cluster Sampling: (4)

5.1Introduction to cluster sampling, Real life situations where cluster sampling is appropriate

5.2 Comparison between systematic sampling and cluster sampling.

References:

1) D. Singh and F.S.Chaudhary : Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.

2) M.N. Murthy: Sampling methods, Indian Statistical Institute, Kolkata.

3) P.V.Sukhatme and B.V.Sukhatme: Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.

4) P. Mukhopadhyay: Sampling theory and methods of survey sampling.

5) W.G.Cochran: Sampling Techniques, Wiley Eastern Ltd., New Delhi.

SEMESTER -IV

Subject: Statistics (General –I)

ST-23844: Statistical Quality Control

Unit 1. Statistical Process Control (On line methods): **(10)**

1.1 Introduction: Concepts: quality, dimensions of quality

1.2 Seven Tools of Statistical Process Control (SPC):

(i) Check Sheet, (ii) Cause and effect diagram (CED), (iii) Pareto Diagram,

(iv) Histogram, (v) Control chart, (vi)Scatter Diagram, (vii) Design of Experiments (DOE).

1.3 Chance causes and assignable causes of variation.

1.4 Statistical basis of control charts (Connection with tests of hypotheses is NOT expected).

1.5 Probability limits, 3σ limits, justification for the use of limits based on Chebychev's inequality and large sample theory.

1.6 Criteria for detecting lack of control:

i)a point outside the control limits with justification

ii)Non-random variation within the control limits of the following type:

(a) A run of seven or more points above or below the control lines.

(b) Presence of trend and cycles. (Mathematical justification is NOT expected for (ii) only).

Unit 2. Control charts for variables: **(10)**

2.1 R chart and $\overline{X}$ chart:

2.1.1: Purpose of R and $\overline{X}$ chart, normal probability plot for checking normality assumption. Construction of R chart when the process standard deviation is specified: control limits, drawing of control chart, plotting of sample ranges, drawing conclusion, determination of state of control process, corrective action if the process is out of control.

2.1.2: Construction of $\overline{X}$ chart when the process average is specified: control limits, drawing of control chart, plotting of sample means. Drawing conclusion, determination of state of control process, corrective action if the process is out of control.

2.1.3: Construction of R chart when the process standard deviation (σ) is not given: control limits, drawing of control chart, plotting sample range values, revision of control limits if necessary, estimate of σ (σ) for future use. Construction of $\overline{X}$ chart when the process average μ is not given: control limits based on σ, drawing of control chart, plotting sample means, revision of control limits of chart $\overline{X}$, if necessary.

Note **: To find revised control limits of any control chart, delete the sample points above UCL and points below LCL (assuming a search for assignable causes at those points), in case of R and $\overline{X}$ charts, first of all, revisions of control limits of R is to be completed and then by using the observations for which R chart shows the process is under control, the control limits for $\overline{X}$ chart should be determined. Revision of control limits of $\overline{X}$ chart be continued without revising the value of $\overline{X}$ Estimate of μ and σ for further use. Determination of state of control of the process. Identification of real life situations where this technique can be used.**

2.2 Limitations of $\overline{X}$, R chart:

Unit 3. Control charts for Attributes: (10)

3.1 Construction and working of p – chart:

3.1.1: when subgroup sizes are same and value of the process fraction defective *p* is specified: control limits, drawing of control chart, plotting of sample fraction defectives, revision of control limits if necessary, estimation of *p* for future use. Determination of state of control of the process. Interpretation of high and low spots. Probability of detecting the shift in process fraction defective (or signal) using normal approximation.

3.1.2: when subgroups sizes are different and value of the process fraction defective *p* is not specified (different cases of control limits):

(i) Separate control limits, (ii) control limits based on average sample size,

(iii) stabilized (standardized P) control limits, drawing of control chart, plotting sample fraction defective, determination of state of control of the process. Identification of real life situations. Limitations of p- chart.

3.2 Construction and working of c – chart:

3.2.1: Construction of c-chart when standard is given:

control limits, justification of 3 sigma limits, drawing of control chart, plotting number of defects per unit.

3.2.2: Construction of c-chart when standard is not given:

control limits, justification for the use of 3 sigma limits, drawing of control chart. Plotting number of defects per unit, revision of control limits, if necessary, estimate of process parameter for future use. Determination of state of control, interpretation of high and low spots in above cases. Identification of real life situations. Probability of detecting shift (or signal) in parameter λ. Comparison between p and C charts. Limitations of c- chart.

Unit 4. Statistical Process Control (Off line methods): (12)

4.1 Concept, comparison between 100 percent inspection and sampling inspection. Procedure of acceptance sampling with rectification – single sampling plan, double sampling plan, Explanation of the terms – producer's risk, consumer's risk, AQL, LTPD, AOQ, AOQL, ASN, ATI, OC and AOQ curves.

4.2 Single sampling plan:

Expressions of Probability of acceptance using:

(i)Hypergeometric (ii) Binomial (iii) Poisson and (iv) Normal distributions. Expressions of the formula of AOQ and ATI, Graphical determination of AOQL, Simple problems to compute probability of acceptance by using single sampling plan

4.3 Double sampling plan:

Expressions of probability of acceptance using Poisson approximation. Statement of ASN and ATI (with complete inspection of second sample). Expressions of the approximate formula of AOQ. Simple problems to compute probability of acceptance by using double sampling plan.

4.4 Comparison of single sampling plan and double sampling plan.

Unit 5. Capability Studies: (6)

5.1 Specification limits, natural tolerance limits and their comparisons, decisions based on these comparisons, estimate of percent defective.

5.2 Capability ratio and capability indices *(Cp*), capability performance indices *Cpk* with respect to machine and process, interpretation, relationship between (i) *Cp* and *Cpk* (ii) defective parts per million and *Cp*.

References:

1) A.J.Duncan: Quality Control and Industrial Statistics, Taraporewala Sons and Co. Pvt. Ltd., Mumbai.
2) D.C. Montgomery: Statistical Quality Control, John Wiley and Sons, Inc., NewYork.
3) D.H. Besterfield, C.B. Michna etc. (3rd edition 2009): Total Quality Management, Pearson Education, Delhi.
4) E.L.Grant and Leavenworth : Statistical Quality Control, Mc-Graw Hill Kogakusha Ltd., New Delhi.
5) Johnson and Kotz : Capability Studies, Chapman and Hall Publishers