॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY
JALGAON - 425 001

Syllabus for T.Y. B.Sc.(Statistics)

(With effect form June.2004)

NORTH MAHARASHTRA UNIVERSITY, JALGAON
Syllabus for T.Y.B.Sc. (Statistics)
(With effect form June 2004)

Syllabus Structure

Paper No.	Title of the Course	Teaching Contact Periods / week	
		Theory	Practical Per Batch
I	PROBABILITY THEORY AND PROBABILITY DISTRIBUTIONS	04	--
II	STATISTICAL INFERENCE	04	--
III	INDUSTRIAL STATISTICS	04	--
IV	SAMPLING METHODS AND DESIGN OF EXPERIMENTS	04	--
V (Optional)	PAPER-V(A): OPERATIONS RESEARCH AND APPLIED STATISTICS PAPER-V(B): ELEMENTS OF STOCHASTIC PROCESSES	04	--
VI (Optional)	PAPER-VI (A): PROGRAMMING IN VISUAL BASIC PAPER-VI (B): PROGRAMMING IN VISUAL FOXPRO	04	--
VII	PRACTICAL PAPER-I	--	04
VIII	PRACTICAL PAPER-II	--	04
IX	PRACTICAL PAPER-III	--	04

INSTRUCTIONS

1. First four papers I to IV are compulsory, paper V and VI are optional papers. For papers V and VI students may choose either V(A) or V(B) and VI(A) or VI(B) respectively.

2. Students must complete all the practicals in each of the satisfaction of the teachers concerned.

3. Students must produce at the time of the practical examination the laboratory journal along with completion certificate signed by the head of the Department.

4. Total duration of practical examination shall be of 5 hours for each practical paper. There shall be two sections in the practical examination. Duration of each section shall be of 2 hours and 30 minutes with the gap of one hour between two sections.

5. For theory papers' examination use of non-programmable electronic pocket calculator is allowed.

6. For regular practical sessions and practical examination, use of private calculator is not allowed. For regular practical sessions and practical examination, college will provide model 12-digit non- programmable calculators having at the most two memories.

7. Paper VI and practical Paper III are based on computers. Therefore the college must have well equipped computer Laboratory.

8. In practical Paper III separate Project may be assigned to individual student or a group of students (group of at most five students). Each student or a group of students should write the Project report on project work and submit a copy of Project report at the Department before the practical examination.

9. In order to acquaint the students with applications statistical methods in various fields such as industries, agricultural sector, Government institutes etc. study tour for T.Y.B.Sc (Statistics) may be arranged.

10. For each theory paper concern teacher should arrange and conduct two tutorials and two seminar periods.

PAPER-I

PROBABILITY THEORY AND PROBABILITY DISTRIBUTIONS

1. PROBABILITY SPACE (10L, 10M)

1.1 Revision of set algebra, Finite unions, Finite intersections, Countable unions, Countable intersection, Complements and their interrelations (statements only), Power set.

1.2 Definition of the σ-field A of subset of Ω, simple illustrative examples, Properties of the σ-field :

(i) Φ and $\Omega \in A$

(ii) Closure under finite intersections.

1.3 Definition of measurable space, Definition of probability measure, simple illustrative examples of probability measure based on finite space. Definition of probability space, Definition of an event, probability of an event, simple illustrative examples on probability space. Construction of probability space for simple statistical experiment, Definition of occurrence of an event. Properties of the probability measure, P(.) :-

(i) $P(\Phi)=0$ (ii) Finite additivity

(iii) If $A \subset B \Rightarrow P(A) \leq P(B)$ (iv) $0 \leq P(A) \leq 1$

(v) $P(A^c) = 1 - P(A)$ (vi) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

(vii) $P(\bigcup_{i=1}^{n} A_i) \leq \sum_{i=1}^{n} P(A_i)$

1.4 Examples and Problems.

2. RANDOM VARIABLE (10L, 10M)

2.1 Definition of Borel field (B) as the smallest σ-field containing the class of all intervals of the real line. Definition of the Borel set. Examples of Borel sets. Definition of the inverse image $X^{-1}(S)$ of a subset S of the real line R under function X from Ω to R and its properties.

(i) $X^{-1}\left(\bigcup_{i=1}^{n} S_i\right) = \bigcup_{i=1}^{n} X^{-1}(S_i)$, where S_i are subset of R

(ii) If S_1 and S_2 are disjoint then $X^{-1}(S_1)$ and $X^{-1}(S_2)$ are disjoint. Definition of random variable (r.v.) in terms of the inverse image of Borel set. Illustrative examples.

2.2 Definition of probability distribution $P_X(x)$ of a random variable. Simple examples. Proof of the fact that $P_X(x)$ is a probability measure on (R, B).

2.3 Definition of the distribution function (d.f.) F(.) of a r.v. and statement of its properties. Statement of the theorem "For every function F onto (0,1) satisfying the properties of the d.f. there exist a r.v. with the given F on its d.f.". Problems involving the verification of the properties of a d.f., definition of point of discontinuity, proof of the theorem "The set of point of discontinuities of a D.F. is at most countable". Definition of a discrete and continuous type r.v.s in terms of d.f.

2.4 Definition of a r.v. with a distribution symmetric about zero and its simple properties.

2.5 Examples and problems.

3. CHEBYCHEV'S INEQUALITY AND WEAK LAW OF LARGE NUMBERS (4L, 4M)

3.1 Chebychev's theorem: If g(X) is a non- negative function of a r.v. X and if $E\{g(X)\} < \infty$ and if k>0 then

$$P\{g(X) \geq k\} \leq \frac{E\{g(X)\}}{k^2}$$

3.2 Chebychev's inequality for discrete & continuous distribution in the forms: -

$$P\{|X-\mu| \geq k\sigma\} \leq \frac{1}{k^2} \quad \text{and}$$

$$P\{|X-\mu| < k\sigma\} \geq 1-\frac{1}{k^2}, \text{ where } \mu = E(X) \text{ and } \sigma^2 = V(X).$$

3.3 Concept of convergence in probability.

3.4 Statement and proof of WLLN based on Chebychev's theorem

3.5 Examples and problems.

4. CENTRAL LIMIT THEOREM (4L, 4M)

4.1 Statement and proof of the central limit theorem for i.i.d r.v.s. based on mgf.

4.2 Examples and problems.

5. NEGATIVE BINOMIAL DISTRIBUTION (NBD) (10L, 8M)

5.1 P.m.f :

$$P(X=x) = \binom{x+r-1}{x} p^r q^x \qquad x = 0, 1, 2, \ldots, \qquad 0 < p < 1, \; q = 1-p.$$

Notation $X \sim NB(k, p)$, $k \geq 1$.

5.2 Probability Generating function (PGF), MGF, CGF, FMGF, first four moments and cumulants, factorial moments, recurrence relation for probabilities.
5.3 Additive property.
5.4 NB distribution as a waiting time distribution.
5.5 NB(k, p) as the distribution of sum of k i.i.d Geometric r.v.s. with common parameter p.
5.6 NB distribution obtained from Poisson distribution with gamma distributed parameter.
5.7 Poisson approximation to NB distribution.
5.8 Examples and problems.

6. MULTINOMIAL DISTRIBUTION (8L, 8M)

6.1 Joint p.m.f

$$P(X_1 = x_1, X_2 = x_2, \ldots, X_k = x_k) = \frac{n! p_1^{x_1} p_2^{x_2} \cdots p_k^{x_k}}{x_1! x_2! \cdots x_k!}, \quad x_i = 0, 1, 2, \ldots, n$$

$i = 1, 2, \ldots, k,$
$x_1 + x_2 + \ldots + x_k = n,$
$p_1 + p_2 + \ldots + p_k = 1$
$0 < p_i < 1, \ i = 1, 2, \ldots k$

$= 0$ otherwise

Notation $(X_1, X_2, \ldots, X_k)' \sim MD(n, p_1, p_2, \ldots p_k)$

6.2 Joint Mgf of $X_1, X_2, \ldots, X_k$
6.3 Use of 6.2 to obtain means, variances, covariances, total correlation coefficients, multiple and partial correlation coefficients for k=3, univariate marginal distributions.
6.4 Variance- covariance matrix, Rank of Variance -Covariance matrix and its interpretation.
6.5 Real life situations.
6.6 Examples and problems.

7. ORDER STATISTICS (12L, 10M)

7.1 Order statistics for a random sample from a continuous distribution, definition, and distribution of the i^{th} order statistics $X_{(i)}$ (distribution function and probability density function). Joint distribution of $(X_{(i)}, X_{(j)})$.

7.2 Distribution of the smallest order statistics $X_{(1)}$, distribution of largest order statistics $X_{(n)}$, distribution of the sample median, distribution of the sample range $X_{(n)} - X_{(1)}$, distribution of $X_{(1)}$ and $X_{(n)}$ for uniform and exponential distributions.

7.3 Examples and problems.

8. LOG-NORMAL DISTRIBUTION (6L, 6M)

8.1 P.d.f

$$f(x) = \begin{cases} \dfrac{1}{(x-a)\sigma\sqrt{2\pi}} \exp\left\{-\dfrac{1}{2\sigma^2}[\log(x-a)-\mu]^2\right\}, & a < x < \infty,\ a < \mu < \infty,\ \sigma > \\ 0 & \text{otherwise} \end{cases}$$

Notation: $X \sim LN(a, \mu, \sigma^2)$

8.2 Nature of the probability curve.

8.3 Moments (r-th moment, about x-a), first four moments, β_1 and γ_1 coefficients, quartiles.

8.4 Relation with $N(\mu, \sigma^2)$ distribution.

8.5 Examples and problems.

9. WEIBULL DISTRIBUTION (4L, 4M)

9.1 p.d.f.

$$f(x) = \begin{cases} \dfrac{\beta}{\alpha}\left(\dfrac{x-\gamma}{\alpha}\right)^{\beta-1} \exp\left\{-\left(\dfrac{x-\gamma}{\alpha}\right)^{\beta}\right\} & ; \gamma \le x < \infty, -\infty < \gamma < \infty, \alpha, \beta > 0 \\ 0 & \text{otherwise} \end{cases}$$

Notation : $X \sim W(\gamma, \alpha, \beta)$

9.1 Distribution function, quartiles.

9.2 r^{th} Moment about $x = \gamma$, mean and variance.

9.3 Relation with exponential distribution.

9.4 Examples and problems.

10. CAUCHY DISTRIBUTION (8L, 8M)

10.1 p.d.f.

$$f(x) = \begin{cases} \dfrac{\lambda}{\pi} \times \dfrac{1}{1+\left(\dfrac{x-\mu}{\lambda}\right)^2}, & -\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0 \\ 0 & \text{otherwise} \end{cases}$$

Notation: $X \sim C(\mu, \lambda)$

10.2 Nature of probability curve.
10.3 Distribution function, quartiles, non-existence of moments.
10.4 Additive property for two independent Cauchy variates (Statement only), Statement of distribution of the sample mean.
10.5 Relationship with uniform and Students 't' distribution.
10.6 Examples and problems.

11. LAPLACE DISTRIBUTION (DOUBLE EXPONENTIAL DISTRIBUTION) (6L, 6M)

11.1 P.d.f

$$f(x) = \begin{cases} \frac{\lambda}{2}\exp[-\lambda|x-\mu|]; -\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0 \\ 0 \qquad\qquad \text{otherwise} \end{cases}$$

Notation: $X \sim L(\mu, \lambda)$

11.2 Nature of probability curve.
11.3 Distribution function, quartiles.
11.4 MGF, CGF, moment and cumulants, β_1, β_2, γ_1, γ_2
11.5 Laplace distribution as the distribution of the difference of two i.i.d exponential variates with mean θ.
11.6 Examples and problems.

12. TRUNCATED DISTRIBUTIONS (10L, 10M)

12.1 Truncated distribution as conditional distribution, truncation to the right, left and on both sides.
12.2 Binomial distribution $B(n, p)$ left truncated at $X=0$ (value zero not observable), its p.m.f, mean, variance.
12.3 Poisson distribution $P(\lambda)$, left truncated at $X=0$ (value zero not observable), its p.m.f, mean, variance.
12.4 Normal distribution $N(\mu, \sigma^2)$ truncated
(i) to the left of $X = a$
(ii) to the right of $X = b$
(iii) to the left of $X = a$ and to the right of $X = b$, its p.d.f and mean.
12.5 Examples and problems.

13. BIVARIATE NORMAL DISTRIBUTION (BVN) (12L, 12M)

13.1 P.d.f of BVN Distribution

$$f(x)=\begin{cases}\dfrac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}}\exp\left\{-\dfrac{1}{2(1-\rho^2)}\left[\left(\dfrac{x-\mu_1}{\sigma_1}\right)^2+\left(\dfrac{y-\mu_2}{\sigma_2}\right)^2-2\rho\left(\dfrac{x-\mu_1}{\sigma_1}\right)\times\left(\dfrac{y-\mu_2}{\sigma_2}\right)\right]\right. \\ -\infty<x,y<\infty\ ,\ -\infty<\mu_1,\mu_2<\infty,\sigma_1,\sigma_2>0,\ -1<\rho<1 \\ 0 \qquad \textit{otherwise}\end{cases}$$

Notation: $(X,Y) \sim BN(\mu_1,\mu_2,\sigma_1^2,\sigma_2^2,\rho)$

Marginal and conditional distributions, identification of parameters, regression of Y on X and X on Y, independence and uncorrelatedness, MGF and moments

13.2 Cauchy distribution as the distribution of Z=X/Y where

$(X,Y) \sim BN(0,0,\sigma_1^2,\sigma_2^2,\rho)$

13.3 Examples and problems.

Books Recommended

1. Bhat B. R.: Modern Probability Theory(3rd Ed.), 1999.
2. Mood A.M, Graybill F. Bose D.C.: Introduction to theory of Statistics (III Edn.) Mc - Graw Hill Series, 1974.
3. Hogg R.V. and Craig A.T.: Introduction to Mathematical Statistics (5th Edn.) Low price ed., Pearson Education Asia.,2002.
4. S.C. Gupta and V.K. Kapoor : Fundamentals of Mathematical Statistics Sultan Chand and Sons ,88 Daryaganj New Delhi 2
5. V.K. Rohotagi: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd. New Delhi, 2000.

PAPER II

STATISTICAL INFERENCE

1. POINT ESTIMATION (20L, 20M)

1.1 Concept of random sample from a distribution, Notion of a Parameter, Parameter, Parameter space, general problem of estimation.
Types of estimation: Point estimation and interval estimation.
Point estimation: - Definition of estimator, distinction between estimator and estimate, illustrative examples.
Definition of Unbiased estimator, biased estimator, positive and negative biases. Illustrative examples (These should include unbiased and biased estimators for the same parameters)

Proofs of the results regarding unbiased estimator:

(a) Two distinct unbiased estimators f(θ) give rise to infinitely many Unbiased estimators of f(θ).

(b) If T is an unbiased estimator of θ, then f(T) is an unbiased estimator of f(θ) provided f(.) is linear function of T.

Discussion of the following results: -

(a) If T is an unbiased estimator of θ, then f(T) need not be an unbiased estimator of f(θ) illustrative examples.

(b) Sample standard deviation is a biased estimator of population standard deviation.

1.2 Examples and Problems.

1.3 Relative Efficiency:

Relative efficiency of unbiased estimator T_1 with respect to another unbiased estimator T_2, use of mean square error to define relative efficiency of biased estimators.

Notion of uniformly minimum variance unbiased estimator (UMVUE), uniqueness of UMVUE whenever it exists, Examples and problems.

1.4 Concept and definition of sufficiency, statement of Neyman's factorization theorem (proof for discrete case only).

Proofs of the following properties of sufficient statistics:

i. If T is sufficient for θ, $f(T)$ is also sufficient for $f(\theta)$ provided f is one to one and onto function .

ii If T is sufficient for θ then T also sufficient for $f(\theta)$.

Examples and problems.

1.5. Definition of likelihood as a function of the parameter for a random sample from (i) discrete, (ii) continuous distribution, Definition Fisher's information function. Amount of information regarding parameter contained in a statistic T and a sufficient statistic T.

1.6 Examples and problems.

2. CRAMER - RAO INEQAULITY (8L, 8M)

2.1 Statement and proof of Cramer-Rao inequality.

Definition of minimum variance bound unbiased estimator (MVBUE) of $f(\theta)$

Proofs of the following results

i. If MVBUE exists for θ, Then MVBUE exists for $\phi(\theta)$, provided f is linear Function.

ii. If is MVBUE for θ then T is sufficient for θ

2.2 Examples and problems.

3. METHODS OF ESTIMATION (16L, 16M)

3.1 Method of maximum likelihood, derivation of maximum likelihood estimators (m.l.e.) for parameters of only standard distributions: binomial, normal, exponential (case of two unknown parameters only for normal distribution) Invariance property of m.l.e., relation between m.l.e. and sufficient statistics.

3.2 (a) m.l.e of uniform distribution over (i)(a, b) , (ii) (-θ , θ).
(b) m.l.e. of in f(x, θ) = exp [- (x-θ)] x ≥ θ .

3.3 Method of moments: Derivation of moment estimators for standard distributions: binomial, Poisson, normal, exponential and uniform, illustration of situations where m.l.e. and moment estimators are distinct and their comparison using mean square error.

3.4 Examples and problems.

4. ASYMTOTIC BEHAVIOUR OF AN ESTIMATOR (6L,6M)

4.1. Consistency: Definition of consistent estimator, proof of the following theorems:
(a) Biased estimator is consistent if its bias and variance both tend to zero as the sample size tends to infinity.
(b) If T Consistent estimator of θ then $f(T)$ is also consistent estimator of $f(\theta)$, provided f is continuous function of T.

4.2 Examples and problems.

5. PARAMETRIC TESTS (16L,16M)

5.1 (a) Statistical hypothesis, problem of testing of hypothesis, Definition and Illustrations of (i) simple hypothesis, (ii) composite hypothesis, (iii) Two types of errors in testing of hypothesis (iv) sizes of two types of errors. Test function $\phi(.)$, probabilistic interpretation of test function, relation between test function and critical region.
Problem of controlling the sizes of two types of errors.
(c) Definition and illustrations of (i) level of significance (ii) observed level of significance (p value) (iii) power function of the test (iv) size of test (v) power of test.

5.2 Definition of most powerful (MP) and uniformly most powerful (UMP) tests of size α, statement of Neyman- Pearson's(NP) lemma for the construction of Most powerful test, construction of uniformly most powerful (UMP) test for one sided alternative.

5.3 Examples and problems.

6. INTERVAL ESTIMATION (10L, 10M)

6.1 Notion of interval estimation, definition of confidence interval, confidence bounds.

6.2 Relation between confidence interval and testing of hypothesis, definition of pivotal quantity and its use in obtaining confidence interval and bounds.

6.3 Interval estimation for the following cases:

(i) Mean (μ) of normal distribution (when σ known and σ unknown)

(ii) Variance (σ^2) of normal distribution (when μ known and μ unknown)

(iii) Difference of two means $\mu_1 - \mu_2$ (a) for a sample from bivariate normal population (b) for samples form two independent normal populations.

(iv) Mean of exponential distribution.

(v) Population proportion (P) and difference of two population proportions ($P_1 - P_2$) in case of two independent large samples .

(vi) Population quartiles using order statistics.

6.4 Examples and problems.

7. NON PARAMETRIC TESTS (18L, 16M)

7.1 Meaning of ordinal and nominal data.

Meaning of non-parametric problems, Distinction between parametric and non-parametric methods. Concept of distribution free statistic, advantages and disadvantages of non parametric methods.

Procedure of:

(i.) sign test for one and two samples problem

(ii.) Wilcoxon signed rank T-test for paired observations.

(iii.) Mann-Whitney U-test for two independent samples.

(iv.) Run test for randomness of given observations.

(v.) Mood test for testing variability of two populations.

(vi.) Kruskal- Wallis test for k samples problem

(vii.)Kolmogorov - Smirnov test for completely specified univariate distribution (only one sample problem)

7.2 Examples and problems.

8.SEQUENTIAL TESTS (10L, 8M)

8.1 Sequential test procedure for simple null hypothesis against simple alternative hypothesis and its comparison with fixed sample size test procedure. Definition of Wald's sequential probability ratio test (SPRT) of strength (α, β).

8.1 Illustration for standard distributions: Bernoulli, Poisson, normal and exponential distribution, graphical and tabular procedures for carrying out the test.

8.2 Examples and problems

BOOKS RECOMMENDED

1. Mood A.M., Graybill f, & Bose D.C.: Introduction to the theory of Statistics (third Edition) International student edition McGraw Hill Kogakusha Ltd.
2. Hogg P.V. and Craig A.J. : Introduction to mathematical statistics IVth Edition , collier Macmillan International Edition Macmillan Publishing Co. inc. New York .
3. Siegel S: Non Parametric Methods for the Behavioral; Sciences. International Student Edition McGraw Hill Kogakusha Ltd.
4. J. D. Gibbons: Non Parametric Statistical Inference McGraw Hill Book Company New York.
5. Daniel: Applied Non Parametric Statistics, Houghton Mifflin company Roston.
6. V.K. Rohotagi: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd. New Delhi, 2000.
7. Kale B.K.: A Fist course in Parametric Inference. Narosa Publishing House (1999).

PAPER-III

INDUSTRIAL STATISTICS

1. STATISTICAL PROCESS CONTROL (SPC) (40L, 40M)

1.1 Introduction :

Meaning and Purpose of SPC: Quality of Product, need of Process Control, Statistical Process Control, on line Process Control methods (Control Charts) and off line Process Control methods (Sampling Scheme and Plans) as lot Control methods.

1.2 Seven Process Control (PC) Tools of SPC

(i.) Check sheet (ii) Cause and Effect Diagram (CFD) (iii) Pareto Diagram (i) Histogram (v) Control chart. (vi) Scatter diagram, (vii) Designs of Experiment (DOE).

1.3 Control Charts: Chance Causes and assignable causes of variation, statistical basis of control charts, exact probability limits, k-Sigma limit. Justification for the use of 3-sigma limits for normal distribution and using Chebychev's inequality for non normal distributions. Criteria for detecting lack of Control Situations:

i. A point outside the control limits.
ii. Non random pattern of variation of the following type.
(a) Seven or more points above or below central line.
(b) Presence of cycle or linear trends.

Note: Mathematical justification for (ii) is not expected.

Use of control charts when (i) standards given (ii) standards are not given.

1.4 Control charts for continuous variables

Decisions preparatory to control charts:

(i) Choice of the variable
(ii) Basis of subgroups.
(iii) Size of subgroups.
(iv) Frequency of subgroups (Periodicity).

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

Purpose of R and $\overline{X}$ chart. 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 for future use. Construction of $\overline{X}$ chart when the process average (σ) is not given: Control limits based on σ, drawing of control chart. Plotting sample means, revision of control limits of $\overline{X}$ chart, if necessary.

Note: To find revised control limits of any control chart delete the sample points above UCL and points below LCL. In case of $\overline{X}$ and R 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 X charts should be determined. Revision of control limits of $\overline{X}$ chart be continued without revising the value of R or σ.

1.5 Control charts for Attributes:

Decisions preparatory to control charts:

(i) Size of subgroups.
(ii) Frequency of subgroups (Periodicity).

p-chart, np-chart, c-chart and u-chart

1.6 X chart, MR chart.

1.7 CUSUM chart.

1.8 Capability Studies:

Specification Limits, natural tolerance limits and their comparisons, decisions based on those comparisons, estimate of percent defective of catching shift on average, evaluation of probability of catching shift of the first sample or on the subsequent samples after the shift (when process standard deviation is fixed). Shift in the process fraction defective Evaluation of probability (using normal approximation only of catching the

shift on the first sample or on the subsequent samples after the shift. Process capability indices C_p , C_{pk} . Gage capability indices.

2. ACCEPTANCE SAMPLING FOR ATTRIBUTES (25L,25M)

2.1 Introduction :
Concept of sampling inspection plan, comparison between 100% inspection and sampling with rectification single and double sampling plans. Explanation of the terms: Producer's risk, Consumer's risk, Acceptable quality Level (AQL) Lot Tolerance Fraction Defective (LTFD), Average outgoing quality (AOQ), Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), Average Total Inspection (ATI), Operating characteristic (OC) curve AOQ curve.
Note: - Distinction between type-A OC Curve and type-B OC curve is not expected.

2.2 Single Sampling Plan :
Evaluation of probability of acceptance using
(i.) Hypergeometric (ii) Binomial (iii) Poisson and (iv) Normal distributions. Derivation of AOQ and ATI. Graphical determination of AOQL, determination of a single sampling plans by lot quality and average quality approaches (numerical problems are not expected). Description of Dodge and Roming tables (numerical problems are not expected).

2.3 Double Sampling Plan .
Evaluation of probability acceptance using Poisson approximation derivation of ASN and ATI (With complete inspection of second sample). Derivation of the approximate formula of AOQ. Description of Dodge Roming Tables, comparison of single sampling plan and double sampling plan, normal, reduced and tightened inspection.

2.4 Example and problems.

3. RELIABILITY THEORY (25L,25M)

3.1 Binary Systems: Block diagrams tree presentation. Definition of binary Coherent systems of components less than five.
(i) Series (ii) Parallel (iii) k-out-of-n:Good
Minimal cut / path structure representation of system.

3.2 Reliability of Binary Systems.
Reliability of above systems h(p) , when components are independent and identically distributed with common probability p of operating .
'S' Shapedness property of h(p) without proof and workout examples to show that using components of low values of reliabilities i.e. unreliable components, systems with higher reliabilities can be constructed.
Note: Do not introduce concept of Association of random variables.

3.3 Aging properties.
Definitions: hazard rate, hazard function and survival function.
Concept of distributions with increasing and decreasing failure rate (IFR/DFR).
Distributions with increasing and decreasing failure rate average (IFRA/DFRA).
Illustrations: Exponential, Gamma, Weibull distributions.

4. INDIAN STANDARDS (IS) AND INTERNATIONAL STANDARDS (ISO) (14L, 10M)

Introduction to IS series and ISO 9000: 2000 Series with reference to process control and statistical techniques (History, Organization Structure and different clauses), role of statistical methods.

Books Recommended

1. Duncan A.J : Quality Control & Industrial Statistics D.B. Taraporevale Sons & Co. pvt. Ltd, Bombay.
2. Grant E.L. and Leavenworth : Statistical Quality Control Mc-Graw Hill. Kogakusha, ,Ltd ,New Delhi.
3. Barlow R.E. and Prochan Frank : Statistical Theory of Reliability & life Testing. Holt Rinchart and winston Inc. New York.
4. Sinha S.K. : Reliability and testing (Second Edition) Wiley Eastern Publishers New Delhi.
5. Montgomery: Statistical Quality Control. John Wiley & Sons Inc. New York,(3rd Ed.) 1996.
6. Handbook of SQC, Bureau of Indian Standards.
7. ISO 9000-2000 Standards, 2000
8. Trivedi R. S: Probability and Statistics with Reliability and Computer Science Application. Prentice -Hall of Indian Pvt. Lt.. New Delhi 1994
9. Ross S.M.: Probability Models (5th Ed.). Academic Press.

PAPER IV

SAMPLING METHODS AND DESIGN OF EXPERIMENTS

1. SAMPLE SURVEYS (10L,8M)

1.1 Concept of distinguishable elementary units, sampling units, sampling frame.

1.2 Objective of a sample survey.
1.3 Designing questionnaire, characteristics of good questionnaire.
1.4 Planning, execution and analysis of a sample survey. Practical problems in planning, execution and analysis of a sample survey.
1.5 Sampling and non-sampling errors with illustrations.
1.6 Study of some surveys illustrating the above ideas.

2. DETERMINATION OF SAMPLE SIZE (6L,6M)

2.1 Determination of sample size for given
(i) Margin of error and confidence coefficient.
(ii) Coefficient of variation and confidence coefficient.
2.2 Examples and problems.

3. SYSTEMATIC SAMPLING (7L,6M)

3.1 Real life situation where systematic sampling is appropriate. Technique of drawing a sample using systematic sampling.
3.2 Estimation of population mean and population total, standard errors of these estimators.
3.3 Distinguishing between stratification and systematic sampling, between SRSWOR and systematic sampling through real life situations.
3.4 Examples and problems.

4. CLUSTER SAMPLING (7L,7M)

4.1 Real life situations where cluster sampling is appropriate. Technique of drawing a sample using cluster sampling method.
4.2 Estimation of population mean and population total (with equal clusters), standard errors of these estimators.
4.3 Distinguishing between stratification and clustering through real life situations.(Numerical example are not expected)

5. DESIGN OF EXPERIMENTS (6L,6M)

5.1 Introduction to basic terms of Design of Experiments, Experimental unit, Treatments, layout of an experiment.
5.2 Basic principles of Design of Experiments, Randomization, Replication and Local control.
5.3 Choice of size and shape of a plot for uniformity trials.
5.4 The empirical formula for the variance per unit area of plots.

6. STANDARD DESIGNS OF EXPERIMENTS (21L,20M)

6.1 Completely Randomized Design (CRD).
Preparation of Analysis of Variance (ANOVA) table, testing of equality of treatment effects, testing equality of two specified treatment means, critical differences.

6.2 Randomized Block Design (RBD).
Preparation of ANOVA table, testing of equality of treatment effects and block effects, testing for equality of two specific treatment means, critical differences.

6.3 Latin Square Design (LSD): Definition, model:

$$X_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \epsilon_{ijk} \qquad \begin{matrix} i = 1,2,\ldots,m; \\ j = 1,2,\ldots,m; \\ k = 1,2,\ldots,m \end{matrix} \qquad (i,j,k) \in S$$

Assumptions and interpretation, Estimation of parameters, Expected value of mean sum of squares, components of variance.

Hypothesis for the model:

$H_{01} : \alpha_1 = \alpha_2 = \ldots = \alpha_m$
$H_{02} : \beta_1 = \beta_2 = \ldots = \beta_m$
$H_{03} : \gamma_1 = \gamma_2 = \ldots = \gamma_m$

and its interpretation. Justification of use of F-test for H_{01}, H_{02} and H_{03} (independence of Chi-squares is to be assumed), Preparation of ANOVA table and F-test for H_{01}, H_{02} and H_{03}. Testing for equality of two specified treatments effects, use of critical difference, testing for equality of two row effects, two column effects and treatment effects.

6.4 Identification of real life situation where the above designs are useful.
6.5 Applications of principles of Design of Experiments in CRD, RBD and LSD.
6.6 Simple algebraic and numerical problems.

7. EFFICIENCY OF A DESIGN (7L, 7M)

7.1 Concept and definition of efficiency of a design.
7.2 Comparison of efficiencies between CRD and RBD.
7.3 Comparison of efficiencies between LSD and RBD, LSD and CRD.
7.4 Simple numerical problems.

8. MISSING PLOT TECHNIQUE (6L,6M)

8.1 Situations where missing plot technique is applicable.
8.2 Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two observations missing.

8.3 Derivation of exact treatments sum of squares, preparing analysis of variance table and writing report.

8.4 Iterative procedure in case of missing observations.

8.5 t-test for comparing any two treatment effects.

9. TWO WAY CLASSIFICATION WITH m (m>1) OBSERVATIONS PER CELL (10L,10M)

9.1 Layout, Model, derivation of least square estimators of parameters.

9.2 Partitioning of total sum of squares and degrees of freedom (d.f.), expectations of mean sum of squares.

9.3 Statement of the distributions of different sum of squares, preparing ANOVA and writing report (technical and non-technical), definitions of treatment contrasts, t-test for treatment contrasts.

10. ANALYSIS OF COVARIANCE (WITH ONE CONCOMMITANT VARIABLE) (8L,8M)

10.1 Situations where analysis of covariance is applicable, Models for covariance in CRD, RBD and LSD.

10.2 Preparing analysis of Covariance table. Test for $\beta = 0$, test for treatment sum of squares, estimation of parameters.(Only statements.)

11. BALANCED INCOMPLETE BLOCK DESIGN (B.I.B.D.) (6L,6M)

11.1 Definition and simple relations between parameters:

(i) $bk = rv$

(ii) $\lambda(v-1) = r(k-1)$

(iii) $b \geq v$

(iv) $b \geq v + r - k$

(v) $r \geq k$

11.2 Model estimation of parameters (derivation are not expected)

11.3 Analysis of variance table (intra-block analysis only) for testing significance of treatment effects and block effects.

11.4 Tests for comparing two treatment effects.

12. FACTORIAL EXPERIMENTS (10L,10M)

12.1 General description of factorial experiments, 2^2, 2^3 factorial experiments arranged in RBD.

12.2 Definitions of main effects and interactions in 2^2, 2^3 factorial experiments.

12.3 Preparation of ANOVA table by Yates procedure, test for main effects and interactions, estimation of main effects and interaction effects.

12.4General idea of confounding in factorial experiments, total confounding, analysis of variance table, testing main effects and interactions (confounding only one interaction),

12.5Partial confounding (confounding only one interaction per replicate), ANOVA table, testing of main effects and interactions

12.6Construction of layouts in total confounding and partial confounding for $2^2, 2^3$ factorial experiments.

Books Recommended

1. Cocharan W. G.; Sampling techniques, Wiley Eastern Ltd., New Delhi.
2. Sukhatme P. V., Sukhatme B. V.: Sampling theory of surveys with application: Indian Society of Agricultural Statistics, New Delhi publications.
3. Murty M. N.: Sampling Methods, Indian Statistical Institute, Calcutta.1977.
4. Daroga, Sinngh and Choudhary F. S.: Theory and Analysis of Sample survey designs, Wiley Eastern Limited, New Delhi.
5. Federer W. T. Experimental Designs: Oxford and IDH Publishing Co., New Delhi.
6. Cochran, W.G, and Cox G. M.: Experimental Designs: John Wiley and Sons, Inc., New Delhi.
7. Montgomery D. C.: Design and Analysis of Experiments, John Wiley and Sons, Inc., New Delhi.2001
8. Das M. N. and Giri N. C.: Design and Analysis of Experiments, Wiley Eastern Ltd., New Delhi.
9. Snedecor G. W.and Cochran W. G.: Statistical Methods, Affiliated East-West Press, New Delhi.
10. Goon, Gupta, Dasgupta: Fundamentals of Statistics Vol.2, The World Press Private Limited, Calcutta.1986
11. Gupta S.C. and Kapoor V. K.: Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.

PAPER-V (OPTIONAL PAPER)

PAPER-V(A):OPERATIONS RESEARCH AND APPLIED STATISTICS

1. LINEAR PROGRAMMING PROBLEMS

(20L,20M)

1.1 Statement of the linear programming problems. Simple examples and formulation of problems.

1.2 Definition of i) A Slack variable ii) Surplus variable iii) Unrestricted variable (iv) Decision variable.

1.3 Definition of i) a solution ii) feasible solution iii) a basic feasible solution (b.f.s. degenerate and non -degenerate solution) iv) Optimal v) basic and non basic variables vi) objective function vii) Constraints viii) non- negativity Conditions.

1.4 Solutions of L.P.P. by i) graphical method: Solution space unique and non-unique solutions. Obtaining on optimum solution ii) Simplex method: initial b.f.s. is readily available, obtaining the initial basic feasible solution. Criterion for deciding whether obtained solution is optimal, method of improving a solution (alternative solution). Degenerate solution.
Simplex method (initial b.f.s. is not readily available)

1.5 Introduction to artificial variable. Big M. method (or penalty method) modified objective function. Modification and applications of simplex method. L.P.P. with artificial variable.

1.6 Examples and problems.

2 THEORY OF DUALITY (5L,4M)

2.1 Writing a dual of primal problem.

2.2 Solution of L.P.P. by using its dual

2.3 Conversion of primal to dual and Dual to primal

2.4 Proof of dual of dual primal.

2.5 Examples and problems.

3 C.P.M. AND NETWORKING ANALYSIS (12L,10M)

3.1 Definition i) Event or node ii) Activity iii) critical activity iv) Project function v) Predecessor and successor activity vi) Predecessor and successor event. vii) properties of network viii) numbering by fulkersons rule.

3.2 Critical path method constructions and properties of a network.

3.3 Definition i) Earliest start time ii) Earliest finish time iii) latest time iv) Latest finish time V) Critical path

3.4 Float, Total float, Independent float interference float, their significance.

3.5 PERT. Definition of PERT, i) Pessimistic time ii) Optimistic time iii) Most likely time iv) Forward Pass Calculation v) Backward Pass calculation vi) Slack vii) Critical Path viii) Probability of meeting scheduled date.

3.6 Calculate expected time, S.D. of project duration.

3.7 Distinguish between PERT and C.P.M.

3.8 Examples and problems.

4. INDEX NUMBER (14L,14M)

4.1. Meaning and utility of Index number
4.2. Limitations of Index number
4.3. Weighted and unweighted index number.
4.4. Selection of base. Shifting of base splicing deflating purchasing power.
4.5. Fixed and chain base index number.
4.6. Types of index number Laspeyre's, Paasche's, Fisher, Kelly, Walsh, Marshall-Edgeworth's, Dorbish, Bowely, Value index number, wholesale price index number, Industrial product index number.
4.7. Testing for Adequacy of all index number using time reversal test , factor reversal test, Circular test,
4.8. Construction of consumer price index, steps to be followed in construction. Problems in construction, family-budget method aggregate expenditure method.
4.9. Examples and problems.

5. TIME SERIES (15L,14M)

5.1. Introduction meaning and usefulness.
5.2. Components: Secular trend, seasonal variations. Cyclical variations, Irregular variations.
5.3. Additive and multiplicative models.
5.4. Measurement of seasonal variations method of simple average, ratio to trend method. Ratio to moving average method.
5.5. Examples and problems.

6. DEMOGRAPHY (15L, 15M)

6.1 Vital Statistics, uses, measurement of population.
6.2 Measures of mortality: crude death rate, specific death rates (age wise, sex wise). Standardized death rates (based on age-specific death rates) direct and indirect method comparative study of these measures, infant morality rate.
6.3 Measures of fertility, Crude birth rate, specific rate (age and sex), total fertility rate, comparative study of these measures.
6.4 Reproduction rates: G.R.R., N.R.R., comparison and interpretation.
6.5 Simple numerical problems.

7. LIFE TABLES (8L,8M)

7.1 Introduction and meaning.
7.2 Construction, Functions and their interrelations Complete life table)

7.3 Expectation of life.
7.4 Numerical examples and problems.

8. REPLACEMENT MODELS (7L,7M)

8.1 Introduction
8.2 Replacement of income that deteriorates with time when
(a) Value of money remains same during the period (for time as a discrete variable and continuous variable).
(b) Value of money changes with constant rate during the period.
8.3 Examples and problems.

9. SEQUENCING (8L,8M)

9.1 Statement of a sequencing problem of two machines and n-jobs, three machines and n-jobs (reducible to 2 machines and n-jobs)
9.2 Calculation of total elapsed time, idle time of a machine, simple numerical problems.
9.3 Examples and problems.

BOOKS RECOMMENDED

1. Gass E : Linear Programming method and Applications : Narosa publishing house , New Delhi
2. Taha, R.A.: Operations Research An Introduction, fifth edition Pretice hall of India , New Delhi.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B.: Fundamentals of Statistics. Vol.2, 1986.
4. Gupta S.C. and Kapoor V. K.: Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.
5. Mukhopadhaay, P. : Applied Statistics. New Central Book Agency Pvt. Ltd. Calcutta. 1999.

PAPER-V(B): ELEMENTS OF STOCHASTIC PROCESSES

1. **Conditional Probability and Conditional Expectation with problems** (15L, 12M)

2. **Introduction: Stochastic Processes** (15L, 12M)

- Introduction to Stochastic Processes, Classification of Stochastic Processes according to state space and time domain.
- Many examples of Stochastic Processes.

3. Markov Chains (40L, 40M)

- Finite and countable state space Markov chains (Definitions and examples).
- Chapman-Kolmogorov equations, Calculation of n-step transition probability and its limit.
- Stationary distribution of Markov chains.
- Classification of states, Period of the state, Transient and recurrent Markov chain and related results.
- Random walk
- Gambler's ruin problem and its applications.
- Applications of Markov chains.
- Many problems.

4. Branching Process (14L, 15M)

- Galton-Watson branching process.
- Pgf, mean and variance of branching process.
- Probability of ultimate extinction, Distribution of population size
- Applications.
- Problems.

5.Discrete state space continuous time Markov Chain (25L, 20M)

- Definition and examples.
- Markov Pure jumps processes.
- Poisson process (Definitions, properties and applications).
- Many problems.

BOOKS RECOMMENDED

1. Medhi J.: Stochastic Processes, wiley eastern Ltd, New Delhi.
2. Hoel , Port, Stone : Introduction to Stochastic Processes ,Houghton Mifflin.
3. Ross S.M.: Probability Models (5th Ed.). Academic Press.1993

PAPER-VI (OPTIONAL PAPER)

PAPER-VI (A): PROGRAMMING IN VISUAL BASIC (VERSION 6 IS EXPECTED)

1.Introduction to Computer (10L,10M)

1.1 Parts of a computer: - input/output unit, storage unit, arithmetic and logic Unit,

control unit, central processing unit, block diagram of computer.

1.2 Meaning of data and information. Introduction to methods of data codification such as BCD system, EBCDIC system and ASCII system

1.3 Meaning of operating system, need and functions of operating system, types of operating system:- character based and graphical based

Introduction to environment of Windows-98 operating system. Methods to create a new folder, open an existing folder, delete an existing folder, copy one folder to another folder, copy and move one or more files from one folder to another folder, delete one or more files from a folder.

2. Introduction to Object Oriented Programming (5L,4M)

2.1 Elements of object oriented programming such as object, class, properties of objects, methods and events.

Principles of object oriented programming: - Encapsulation, Polymorphism and Inheritance.

3.Visual Basic Environment (10L, 10M)

3.1 Meaning of project, form, control and module

Introduction to project file, form module, class module and standard code module. Introduction to main visual basic window, form window, project-explorer window, properties window, form layout window, code window, toolbox, toolbar. Steps to load and unload visual basic software, open and save a project, open and save a form, add a new form to existing form module, load a particular form from a form module.

3.2 Standard controls

Steps to select a control, place a control on a form, deselect a control, move a control, resize a control, copy a control from one place to another place on a form. Study of frequently used controls such as label, textbox, command button, check box, option buttons, frame, combobox. Frequently used properties of these controls such as name, caption, value, text etc. Printing of project documents.

4.Elements of visual Basic programming (30L,28M)

4.1 Datatypes : Integer, Long, Single, Double, Boolean, Byte, Currency, String, Date, Variant.

4.2 Meaning of identifier, variable, constant. Rules for assigning a name to variable and constant.

Types of constant: literal, named constant, intrinsic constant. Declaration of constant and variable, types of declaration of variable: implicit and explicit declaration.

Option explicit statement. Scope and lifetime of a variable: local, module and global.
Declaration of local, module and global level variable.

4.3 Operators in Visual Basic

Meaning of operator, types of operators: arithmetic, relational and logical operators. Order of precedence of these operators.

4.4 Arrays

Meaning of array, Types of array: static and dynamic arrays. Declaration of array.

4.5 Conditions and decisions

Meaning of condition, conditional and unconditional branching. Use and syntax of the following statements:-

(i) GO TO
(ii) IF—THEN---END IF (single line and multi line)
(iii) IF---THEN---ELSE---END IF
(iv) IF—THEN----ELSEIF----END IF
(v) SELECT CASE-------END SELECT

Nesting of IF statements.

4.6 Repetition of statements

Meaning of loop. Types of loop: unconditional and conditional loops. The use and syntax of the following statements: -

(i) FOR---STEP—NEXT
(ii) FOR EACH----NEXT
(iii) DO WHILE----LOOP
(iv) DO UNTIL-----LOOP
(v) EXIT DO, EXIT FOR

4.7 Procedures

Meaning of procedure. Types of procedure: Sub procedure and function procedure. Types of Sub procedure: General and Event

Procedures: Distinction between sub procedure and function procedure. Creation and use of sub procedure and function procedure. Methods to pass values to procedures and functions.

5. Built-in functions and methods (8L,8M)

5.1 Use and syntax of the following functions :-

ABS(), INT(), RND(), SQR(), LOG(), SIN(), COS(), TAN(), ATN(), EXP(), FIX(), RIGHT(), LEFT(), MID(), LEN(), INSTR(), SPACE(), STR(), STRREVERSE(), VAL(), LCASE(), UCASE(), ASC(), CHR(), STRING(), PMT(), RATE(), FV(), PV(), NPV(), DATE(), NOW(), CDATE(), DATEPART(), DATEDIFF(), MONTH(), MONTHNAME(), DAY(), TAB(), INPUTBOX(), MSGBOX()

5.2 Use and syntax of the following built-in methods and events:
PRINT, CLICK, LOAD, GOTFOCUS, LOSTFOCUS

6 Accessing database files (8L,8M)

6.1 Meaning of database, field, record, table, key field.
Use of Access software for Creation of table, addition of data in a table, modification of data in a table, deletion of data from a table, sorting of data.

6.2 Use of data control to connect to a table of database.
Study of ADDNEW, UPDATE, DELETE, MOVENEXT, MOVEPREVIOUS methods.
Simple programs to store data in a table, read data from a table.

7 Accessing Excel worksheet files (5L,4M)

7.1 Basic elements of a worksheet such as cell, cell address, types of data, range

7.2 Use of data control to add and read data from a worksheet.

7.3 Simple programs to store and retrieve data from a worksheet.

8 Graphics in Visual Basic (8L,8M)

8.1 Graphics controls :- Form and Picturebox, Coordinate system, scale properties and methods :- ScaleLeft, ScaleTop, ScaleRight, ScaleWidth, ScaleHeight, Scale , Scalex , Scaley methods. Graphics methods :- Print, Line, Circle, Pset.

9. The following programs are expected to be discussed in the class (20L,20M)

(1) To find the area of triangle when lengths of its sides are specified.
(2) To determine whether a given number is prime or not.
(3) To determine whether a given number is even or odd.
(4) To find the sum of digits of given natural number.
(5) To find the addition of two given matrices.
(6) To find the product of two given matrices.
(7) To find the transpose of given matrix.
(8) To find the maximum, minimum and their locations in given set of numbers.
(9) To find the value of definite integral by using Simpson's 3/8 rule.
(10) To find the solution of an equation by Newton Raphson method.
(11) To find the value of a combination by using user defined function for factorial.

(12) To determine whether a given natural number is perfect square or not.
(13) To arrange a given set of numbers in ascending and descending order. by using bubble sort method.
(14) To find the present worth of a given series of equal payments.
(15) To find the future value of a given series of equal payments.
(16) To find the value of a percentile for given set of numbers.
(17) To compare the amount received by simple and compound interests on given principal for specified time and rate of interest.
(18) To draw histogram and pie diagram for given data.
(19) To draw normal curve for specified values of mean and standard deviation.
(20) To store and retrieve the data from a database table.
(21) To find the sum of following series upto first n terms:

(a) $3/8 - 5/11 + 7/14 - 9/17 + \ldots\ldots$
(b) $1/3 + 1.2/3.5 + 1.2.3/3.5.7 + \ldots\ldots$
(c) $1 + x^2/2! + x^3/3! + x^4/4! + \ldots\ldots$
(d) $x/2 + 2x^2/2^2 + 3x^3/2^3 + \ldots\ldots$
(e) $x - x^3/3! + x^5/5! - x^7/7! + \ldots\ldots$

(22) To find the mean deviation about mean for a given set of raw data.

BOOKS RECOMMENDED

1. Oreg P. and Sanjaya H.: SAMS Teach Yourself Visual Basic 6 in 24 Hours. Techmedia 1998.
2. Millspaugh, Anita: Programming in Visual Basic 6.0 (Update Ed.).
3. John Smiley: Learn in Program Visual Basic-Examples.2002

PAPER-VI (B): PROGRAMMING IN VISUAL FOXPRO

(Version 6 is expected)

1. Introduction to Computer (10L,10M)

1.1 Parts of a computer: - input/output unit, storage unit, arithmetic and logic. Unit, control unit, central processing unit, block diagram of computer.

1.2 Meaning of data and information. Introduction to methods of data codification such as BCD system, EBCDIC system and ASCII system

1.3 Operating System

Meaning of operating system, need and functions of operating system, types of operating system:- character based and graphical based Introduction to environment of Windows-98 operating system. Methods to create a new folder, open an existing folder, delete an existing folder, copy one folder to another folder, copy and move one or more files from one folder to another folder, delete one or more files from a folder.

2. **Working with Project Manager** (6L,4M)

2.1 Meaning of project, Opening and closing project manager, add a file to a Project, Modify and delete a file in a project.
2.1 Working with a database
2.2 Meaning of database, table, field, primary key field, cnadidate key field, Record.
2.3 Create a new database, Open an existing database, Modify a database, Delete an existing database.
2.4 The following commands are expected to be studied:-
CREATE DATABASE, OPEN DTABASE, DELETE DATABASE, CLOSE DATABASE.

3 **Datatypes used in Visual FoxPro** (2L,2M)

Discussion on the following datatypes
Character, integer, numeric, date, datatime, currency, logical.

4 **Working with Tables** (6L,4M)

4.1 Meaning of table, field, primary key field, candidate key field, reord.
4.2 Relationship between tables: - one-to-one, one-to-many, many-to-one, many-to-many.
4.3 Distinction between database table and free table.
4.4 Types of fields: - character, integer, numeric, date, datetime, logical, memo and general.
4.5 Creation of a new table, Opening a table, Modification in structure of a table, Deletion of a table, Closing a table, Copying structure of a table.
4.6 The following commands are expected to be studied :-

CREATE, CREATE TABLE, MODIFY STRUCTURE, ALTER TABLE USE, REMOVE TABLE, CLOSE TABLES, DELETE FILE, COPY STRUCTURE.

5 **Working with Records of a Table** (5L,5M)

5.1 Addition of records to a table, Editing of records, Viewing of records, deletion of records, Copying records from one table to another table.
5.2 The following commands are expected to be studied:
APPEND, APPEND FROM, APPEND BLANK, INSERT-SQL, UPDATE-SQL, SELECT-SQL, BROWSE, DELETE-SQL, PACK, RECALL, ZAP.

6. Arrangement of Records (6L,6M)

6.1 Sorting of records, Meaning of index and index file, Types of index file :- elementary index file and compound index file (structural and non-structural), Creation and Opening of an index file.

6.2 The following commands are expected to be studied :-
INDEX, REINDEX, SET INDEX, DELETE TAG.

7. Searching of Records (2L,2M)

7.1 Use of LOCATE and SEEK commands to search desired record.

8. Elements of Programming (20L,20M)

8.1 Meaning of command, syntax, keyword, literal, constant, memory variable. Creation of memory variable, Types of memoey variable, Scope of memory variable :- local, private, public.

8.2 MeaningOperator, Types of operators :-arithmetic operators, relational operators, logical operators, date operators, string operators.

8.3 Condition and decision making: Meaning of condition, unconditional and conditional branching. The use and syntax of the following commands :-

- GOTO, GO TOP, GO BOTTOM
- IF----ELSE----ENDIF
- DO CASE-----ENDCASE

8.4 Repetition of commands: Meaning of loop, unconditional and conditional loop. The use and syntax of the following commands :

- FOR-----ENDFOR
- FOR EACH——ENDFOR
- DO WHILE ———— ENDDO
- SCAN——ENDSCAN
- EXIT
- LOOP

8.5 Procedures and user-defined functions
Meaning of procedure and user defined function, Creation of a procedure and an user defined function, use of procedure and user defined function in a program. Methods of passing values to parameters. Distinction between procedure and function. The following commands are expected to be studied :-

PROCEDURE-----ENDPROC, FUNCTION-------ENDFUNC, RETURN. Simple examples on procedure and functions.

8.6 Program files: Creation of a new program file, Modification in existing program file, Execution of a program, Creation of executable file.
The following commands are expected to be studied: MODIFY COMMAND, DO and BUILD.

9. Built-in functions (7L,7M)

The use and syntax of the following functions:
Numeric functions: ABS( ), INT( ), CEILING( ), FLOOR( ), MOD( ), EXP( ), LOG( ), LOG10( ), PI( ), SIN( ), COS( ), TAN( ), ATAN( ), SQR( ).

String functions: LEN( ), VAL( ), STR( ), RIGHT( ), LEFT( ), SUBSTR( ), UPPER( ), LOWER( ), ALLTRIM( ), ASC( ), CHR( ), REPLICATE( ).

Date and time functions: DATE( ), DMY( ), DTOC( ), CTOD( ), DAY( ), MONTH( ), YEAR( ), CMONTH( ), TIME( ), HOUR( ), MINUTE( ), SEC( ).

Miscellaneous functions: EMPTY( ), RECNO( ), RAND( ), FV(), PV( ), ALEN( ), ASCAN( ), ASORT( ), INLIST( ), EOF( ), FOUND( ).

10. Miscellaneous Commands (7L,7M)

The following miscellaneous commands are expected to be studied:
SAY, GET, READ, ?, ??, SET TALK, SET DATE, SET CENTURY, SET FILTER, SET RELATION, CLEAR, CLEAR TO, CLEAR ALL, STORE, DIMENSION, DO, RETURN, QUIT, CALCULATE.

11. Introduction to Object Oriented Programming (6L,6M)

11.1 Elements of object oriented programming such as object, class, Properties of objects, methods and events.
Principles of object oriented programming: Encapsulation, Polymorphism and Inheritance.

11.2 Forms and Controls
Meaning of form and control, procedure to select, deselect, place, resize, move, delete and copy a control on a form. Use of standard controls such as label, textbox, command button, check box, option button. Frequently used properties of standard controls. Writing methods for different frequently used events associated with standard controls. Creation of form. The following commands are expected: MODIFY FORM, DO FORM.

11. Report writing (7L,7M)

11.1 Study of various parts of report designer, creation of custom report, modification in the report layout, printing of report. Use of the following commands are expected: CREATE REPORT, MODIFY REPORT, REPORT FORM.

11.2 Simple example on Preparation and printing of a report.

12. The following programs to be discussed in the class. While writing programs, students are expected to make frequent use of user defined procedures and functions as far as possible. (20L, 20M)

(1) To calculate area of triangle when lengths of its sides are specified.
(2) To find the sum of two matrices.
(3) To find the product of two matrices.
(4) To find the transpose of a matrix.
(5) To find the sum of digits in a given natural number.
(6) To find the mean and standard deviation of random numbers between two specified values.
(7) To find specified percentile for a given raw data.
(8) To find the maximum, minimum and their locations for a given raw data.
(9) To arrange the given observations in increasing or decreasing order by using bubble sort method.
(10) To find the present value of a series of payments without using built-in-function.
(11) To find the statistical ranks of a series of observations.
(12) To find the combined mean for given groups when size and average of each group are given.
(13) To find the value of a permutation (n P r) and combination (n C r).
(14) To draw a sample of specified size from Poisson distribution for given parameter.
(15) To find sum of following series to first n terms:-
  (a) Geometric series with first term a and common ratio r upto first n terms.
  (b) $3/8 - 5/11 + 7/14 - 9/17 + \ldots\ldots$
  (c) $1/3 + 1.2/3.5 + 1.2.3/3.5.7 + \ldots\ldots\ldots\ldots$
  (d) $1 + x^2/2! + x^3/3! + x^4/4! + \ldots\ldots\ldots$
  (e) $x/2 + 2x^2/2^2 + 3x^3/2^3 + \ldots\ldots\ldots$
  (f) $x - x^3/3! + x^5/5! - x^7/7! + \ldots\ldots\ldots$
(16) To find the mean deviation about mean for a given set of raw data.
(17) To determine whether a given number is prime or not.
(18) To determine whether a given number is even or odd.
(19) To simulate the average demand of a product when the past data on actual demand of the product is given.

(20) To calculate the income tax when the taxable income and rates of income tax are specified.
(21) To find the value of definite integral by using Simpson's 3/8 rule.
(22) To find the solution of an equation by Newton Raphson method.

BOOKS RECOMMENDED

1. Steve Sawyer, et al. :EffectiveTechiques for Application Development with Visual FoxPro 6.0
2. Menachem Bezian: Special Edition Using Visual FoxPro 6.
3. Microsoft Visual FoxPro 6.0 Programmer's Guide.

PAPER-VII

PRACTICAL PAPER-I

Sr. No.	Title
01	Fitting of Negative Binomial Distribution.
02	Fitting of Log-normal Distribution.
03	Fitting of truncated binomial and truncated Poisson distributions.
04	Model sampling from Negative Binomial Distribution and Cauchy Distribution.
05	Estimation of parameters [Maximum likelihood estimation, method of moments].
06	Construction of confidence intervals for parameters and difference of proportions.
07	Construction of confidence intervals for proportion(s) of normal Distribution.
08	Testing of hypothesis-I [Probabilities of errors of two kinds]
09	Testing of hypothesis-II [MP test and power of the test]
10	Testing of hypothesis-III [Construction of UMP test for simple null hypothesis against composite hypothesis for Binomial, Poisson, Normal and Exponential Distributions]
11	Non-parametric tests-I [Sign test, Wilcoxon's signed rank test].
12	Non-parametric tests-II [Median test, Mann-Whitney test, Run test for one sample and two sample problems].
13	Non-parametric tests-III [Kolmogorov-Smirnov test].
14	Non-parametric tests-IV [Mood test for testing variability of two population, Kruskal-Wallis test for k sample problems].
15	SPRT for Binomial and Poisson Distributions.
16	SPRT for Normal and Exponential Distributions.
17	Determination of seasonal variation by moving average method and ratio to trend method. **OR** Applications of Markov chain, Random Walk and Gambler's ruin problem.
18	Demography **OR** Model sampling from a given Markov chain.

Marks Distribution

Section	Praticals Sr. No.	Nature of Exam.	Marks	Time
I	1 to 9	Practical	40	2 Hrs. 30 Min.
II	10 to 18	Practical	40	2 Hrs. 30 Min.
		Viva	10	During Practical Examination
		Verification of Journal	10	

PAPER-VIII

PRACTICAL PAPER-II

Sr. No.	Title
01	Determination of sample size.
02	Systematic Sampling [Drawing sample, Estimation of population mean and population total, standard errors of these estimators].
03	Plotting X-Chart, MR-Chart.
04	Plotting CUSUM Chart.
05	Computation of Process Capabilities Indices.
06	Single and Double Sampling Plans for attributes [OC, AOQ, AOQL, ATI].
07	Determination of Single Sampling Plan for attributes.
08	Determination of minimal cut and minimal path set of specified system for system containing less than or equal to five components.
09	Analysis of C.R.D. [Testing of significance of linear treatment contrasts].
10	Analysis of R.B.D. [Testing of significance of linear treatment contrasts, efficiency of R.B.D. w.r.t. corresponding C.R.D.].
11	Analysis of L.S.D. [Testing of significance of linear treatment contrasts, efficiency of L.S.D. w.r.t. corresponding C.R.D. and R.B.D.]
12	Analysis of covariance in C.R.D. and R.B.D.
13	Missing plot(s) in R.B.D.
14	Missing plot(s) in L.S.D.
15	Analysis of B.I.B.D.
16	Analysis of 2^3 factorial experiment arranged in R.B.D.
17	Analysis of 2^3 factorial experiment with total and partial confounding.

Marks Distribution

Section	Praticals Sr. No.	Nature of Exam.	Marks	Time
I	1 to 8	Practical	40	2 Hrs. 30 Min.
II	9 to 17	Practical	40	2 Hrs. 30 Min.
		Viva	10	During Practical Examination
		Verification of Journal	10	

PAPER-IX

PRACTICAL PAPER-III

(Using Computer Programming in VISUAL FOXPRO/ VISUAL BASIC)

Sr. No.	Title
01	Presentation of raw data by frequency and cumulative frequency tables.
02	Calculation of measures of central tendency, dispersion, skewness and kurtosis.
03	Calculation of correlation coefficient.
04	Regression upto three variables.
05	Fitting of Binomial, Poisson and Negative Binomial Distributions and test of goodness of fit.
06	Fitting of Normal Distribution and test of goodness of fit.
07	ANOVA of C.R.D. and R.B.D.
08	Drawing random samples from standard univariate discrete and continuous distributions such as Binomial, Poisson, Normal and Exponential.
09	Determination of optimum period of replacement of an item when money value is not constant
10	Non-parametric test [Mann-Whitney U test]

Practical No. 11 to 18 are devoted for Project work

11	Identification of real life problems where statistical techniques can be used.
12-14	Planning and data collection.
15-16	Analysis of data collected.
17-18	Report writing.

Marks Distribution

Section	Praticals Sr. No.	Nature of Exam.	Marks	Time
I	1 to 10	Practical	40	2 Hrs. 30 Min.
II	11 to 18	Project Report and Project Viva	40	2 Hrs. 30 Min. (for a batch)
		Viva based on Section I	10	During Practical Examination of Section I
		Verification of Journal	10	

NORTH MAHARASHTRA UNIVERSITY, JALGAON
Syllabus for T.Y. B. Sc. (Statistics)
(With effect from June 2004)

Correction on page number 3

1. **Read the instruction number 2 as:**

   Students must complete all the practicals in each of the Practical paper as per the satisfaction of the concerned teacher.

2. **Read the instruction number 8 as:**

   In practical Paper III separate Project should be assigned to individual student. Each student should write the Project report on project work and submit a copy of Project report at the Department before the practical examination.

3. **Read the instruction number 10 as:**

   For each theory paper, concern teacher should arrange and conduct two tutorials and two seminars.