St. Xavier's College (Autonomous), Ahmedabad
Syllabus of Semester – VI of the following departments under Faculty of Science
based on Under Graduate Curriculum Framework – 2023 (NEP)
to be implemented from the Academic Year 2026-27.

FACULTY OF SCIENCE

DEPARTMENT OF STATISTICS

Course	Title	Content	Hours/week	Credit
STMC661C	**Probability theory- II**	Unit 01: Probability Inequalities Unit 02: Weak Law of Large Numbers and Central Limit Theorem Unit 03: Characteristic Function Unit 04: Truncated Distributions	4 hrs	4
STMC662C	**Design of Experiment**	Unit 01: Analysis of Variance Unit 02: Design of Experiment-I Unit 03: Design of Experiment-II Unit 04: Factorial Experiment	4 hrs	4
STMC663L	**Statistics Practical – VI**	Practical using manual calculation, R software and experiential learning	8 hrs	4
STMN661C	**Industrial Quality Control**	Unit 01: Introduction of Quality Control and Charts Unit 02: Modern Trends in Quality Control Unit 03: Practical based on Above units	6 hrs.	4

BSc. Statistics

STMC661C Probability Theory – II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course (Total - 04 Credit)			Prerequisite(s) of the Course (if any)
	Lecture	Practical	Experiential Lab	
Probability Theory - II & STMC661C	4	0	0	Basic Mathematics, Observation & Analytical Skills

Course Outcomes:

CO-1 Identify the Truncated Probability distribution and Truncated probability distributions in real - life studies and sustainability values.

CO-2 Apply the characteristic function of different distributions in real-life problem.

CO-3 Demonstrate the skills of different probability inequality to find upper and lower bounds of probabilities of some events based on different distributions.

CO-4 Demonstrate the skills of convergence in probability using weak law of large numbers and central limit theorem.

Learning Outcomes: After completion of this course, the students will be able to

(1) Identify the truncated probability distributions and apply them effectively in real-life studies and sustainability values.

(2) Apply the characteristic function of different probability distributions to solve complex, real-life problems.

(3) Demonstrate the skills of different probability inequalities to find the upper and lower bounds of probabilities for specific events.

(4) Demonstrate the skills of convergence in probability by utilizing the Weak Law of Large Numbers (WLLN) and the Central Limit Theorem (CLT).

Course Content:

Unit 1: Probability Inequalities (15L)

- Chebychev's inequality(for continuous random variable)
- Generalized form of Bienayme-Chebychev's inequality
- Examples of Chebychev's inequality
- Examples of generalized form of Chebychev's inequality
- Examples to find upper and lower bounds of probabilities of some events based on different Distributions
- Cauchy-Schawartz inequality
- Boole's inequality
- Bonferroni's inequality
- Jensen's inequality

Unit 2: Weak Law of Large Numbers and Central Limit Theorem (15L)

- Convergence in Probability
- Weak law of large numbers
- Condition for applying Weak law of large numbers
- Bernoulli's law of large numbers
- Examples of Weak law of large numbers
- Central limit theorems
    - Linderberg-Levy form of central limit theorem
    - Liapounoff form of central limit theorem (only statement)
    - Different particular cases of central limit theorem
- Applications of central limit theorem

Unit 3: Characteristic Function **(15L)**

- Definition and properties of characteristic function
- Effect of change of origin and scale on characteristic function
- Theorems of characteristic function
- Cumulant generating function and relation between moments and cumulants
- Examples of characteristic function and cumulant generating function
- Inversion theorem (Levy theorem) of characteristic function
- Uniqueness theorem of characteristic function
- Kendall's form of Inversion theorem
- Criterion to determine whether the distribution is discrete or continuous
- Characteristic function of Binomial, Poisson, Normal, Gamma and Chi-square distributions.
- Examples of uniqueness theorem

Unit 4: Truncated Distributions **(15L)**

- Definition of truncated distributions from left, right and both sides
- Binomial Distribution truncated at X=0 and its properties
- Poisson Distribution truncated at X=0 and its properties
- Standard Normal Distribution truncated from both sides and its properties
- Normal Distribution truncated from both sides and its properties
- Standard Cauchy Distribution truncated at both ends with relevant range of variation and its properties
- One variate Gamma distribution truncated at X=A from left and its pdf and expression for r^{th}moment about origin and right-side truncation
- Derivation and definition of Geometric distribution truncated at X = a from left, mean, variance and expressions for its m.g.f. and c.g.f. and right-side truncation
- Derivation and definition of Exponential distribution truncated at X = a from left, mean, variance and expressions for its m.g.f. and c.g.f. and right-side truncation

Teaching methodology: Apart from the conventional blackboard teaching, other modes of teaching that will be adopted are power points, group discussions, quizzes, class test, problem solving and assignments.

References:

1. Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Pub. Co.
2. Mood, A. M. Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
3. Mukhopadhyay, P. (1999): Mathematical Statistics, New Central Book Agency.
4. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Pub. House.
5. Gupta, S.C., and Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan Chand publications.

6. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics Vol. I, World Press, Calcutta.
7. Gupta, S.C., and Kapoor, V.K. : Fundamentals of Applied Statistics, Sultan Chand Publications.
8. Mathematical Statistics (VI Edition) - John E. Freund.

STMC662C Design of Experiment

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course (Total - 04 Credit)			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Practical	Experiential Lab		
Design of Experiment & STMC662C	4	0	0	10 + 2 from a recognized board in any stream	Basic Mathematics, Observation & Analytical Skills

Course Outcomes:

CO-1 Identify the need of analysis of variance using one way classification and two-way classification.

CO-2 Apply the idea of design of experiment, demonstrate the skills of designing the experiments using CRD in real-life situations.

CO-3 Demonstrate the skills of designing the experiments using RBD, LSD in real-life situations.

CO-4 Identify the need of factorial experimentation with main and interaction effects, total and partial confounding design.

Learning Outcomes: After completion of this course, the students will be able to

(1) Identify the need for analysis of variance (ANOVA) using both one-way and two-way classification systems.

(2) Apply the fundamental principles of design of experiments and demonstrate the skills to design and execute Completely Randomized Designs (CRD) in real-life situations.

(3) Demonstrate the skills to design and implement Randomized Block Designs (RBD) and Latin Square Designs (LSD) to control error in real-world scenarios.

(4) Identify the need for factorial experimentation, including the analysis of main and interaction effects, as well as total and partial confounding designs.

Course Content:

Unit-1 Analysis of Variance (15L)

- Introduction of analysis of variance
- Assumptions of ANOVA
- One-way classification
- Analysis of one-way classification
- Critical difference
- Two-way classification
- Analysis of two-way classification

Unit-2 Designs of Experiment-I (15L)

- Basic idea and terminology of design of experiment
- Principles of experimental design
- Completely Randomized Design
- Merits and demerits of CRD
- Analysis of CRD
- Post-hoc (HSD) test

Unit-3 Designs of experiment-II (15L)

- Layout of Randomized Block Design
- Merits and demerits of RBD
- Statistical analysis of RBD
- Estimation of missing observation/s and its analysis
- Layout of Latin square design
- Merits and demerits of LSD
- Statistical analysis of LSD
- Estimation of missing observation/s and its analysis
- Efficiencies of design.

Unit-4 Factorial Experiment (15L)

- Concept and need of factorial experiments
- Idea of terms – main and interaction effect, confounding – total and partial,
- Yates' Procedure and Yates' table
- 2^2 and 2^3 factorial experiment
- Main effects and interactions, their best estimates and testing the significance when underlying design is RBD
- Concept of confounding – Total and Partial Confounding
- Confounding in 2^3 factorial experiment

Teaching methodology: Apart from the conventional blackboard teaching, other modes of teaching that will be adopted are power points, group discussions, quizzes, class test, problem solving and assignments.

References:

1. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
2. M.N. Das & N. Giri: Design of experiments, (Wiley Eastern Ltd)
3. Kempthorne: Design of Experiments,
4. Montgomery D.C. (1976): Design and Analysis of Experiments, John Wiley
5. Cochran W.G. & Cox G.M. (1957): Experimental Designs, John Wiley
6. Federer W.T. (1975): Experimental Designs – Theory and Application, Oxford & IBH
7. Mukhopadhyay P. (1999): Applied Statistics

STMC663L Statistics Practical-VI

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Practical	Activity / Case study analysis		
Statistics Practical-VI & STMC663L	0	4	4	10 + 2 from a recognized board in any stream	Basic maths, Observation & Analytical Skills

Course Outcomes:

CO-1 Identify and justify the need for Analysis of Variance (ANOVA) using both one-way and two-way classification systems.

CO-2 Apply fundamental principles of experimental design to implement Completely Randomized Designs (CRD) in real-life scenarios.

CO-3 Demonstrate practical skills in designing and executing Randomized Block Designs (RBD) and Latin Square Designs (LSD) for real-world applications.

CO-4 Evaluate the necessity of factorial experimentation by analyzing main and interaction effects, including total and partial confounding structures.

Learning Outcomes: After completion of this course, the students will be able to

(1) Implement the statistical fitting of Truncated Binomial and Truncated Poisson distributions and apply simulation techniques to draw random samples from these restricted models.

(2) Formulate and execute Analysis of Variance (ANOVA) using both one-way and two-way classification models to interpret structural data variations.

(3) Design and analyze basic experimental structures—including Completely Randomized Designs (CRD), Randomized Block Designs (RBD), and Latin Square Designs (LSD)—and statistically estimate up to two missing observations in RBD and LSD frameworks.

(4) Conduct and evaluate 2^2 and 2^3 factorial experiments, managing main and interaction effects while implementing total and partial confounding strategies in 2^3 designs.

Course Content:

- Fitting of Truncated Binomial Distributions
- Fitting of Truncated Poisson Distributions
- Drawing a random sample from Truncated Binomial Distributions
- Drawing a random sample from Truncated Poisson Distributions
- One-way classification
- Two-way classification
- Completely Randomized Design
- Randomized Block Design
- Estimation of missing observations(one/Two) in RBD
- Latin Square Design
- Estimation of missing observations (one/Two) in LSD
- 2^2 factorial experiments
- 2^3 factorial experiments
- Total confounding in 2^3 factorial designs
- Partial confounding in 2^3 factorial designs

STMN661C Industrial Quality Control

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credit Distribution of The Course (Total - 02 Credit)			Prerequisite(s) of the Course (if any)
	Lecture	Practical	Experiential Lab	
Industrial Quality Control & STMN661C	2	4	0	Basic Mathematics, Observation & Analytical Skills

Course Objectives:

CO-1 Reflect the skill of identifying the application of statistical quality control in industry.

CO-2 Apply the idea of 3-sigma limits in business and industry to solve the problems related to quality control via process control

CO-3 Extend the technique of 'process control' to 'product control' in the statistical quality control analysis and design acceptance sampling plans for attributes.

CO-4 Extend the technique of 'process control' to 'product control' in the statistical quality control analysis and design acceptance sampling plans for variables.

Learning Outcomes: After completion of this course, the students will be able to

(1) Identify and explain the applications of Statistical Quality Control (SQC) in industrial and manufacturing environments to ensure product and process quality.

(2) Apply the concept of 3-sigma control limits in business and industrial contexts to analyze and solve quality control problems using process control techniques.

(3) Extend process control methods to product control by designing and analyzing acceptance sampling plans for attributes in statistical quality control.

(4) Further extend product control techniques by designing and evaluating acceptance sampling plans for variables to support effective quality assurance decisions.

Unit 1: Introduction of Quality Control and Charts **(20L)**

- Introduction and importance of SQC.
- Chance and assignable causes of variation in quality.
- Determination of tolerance limits. (3σ limits)
- Theory of runs and criteria for detecting lack of control in the process.
- Rational subgroups, natural tolerance of process and specification limits.
- Control charts for Variables.
- Construction of $\bar{X}$, R and S charts with their interpretations.
- OC function of $\bar{X}$ chart only.
- Control charts for attributes.
- Construction of p, np, c, u charts and their interpretations.

Unit-2: Modern trends in Quality Control **(20L)**

- Introduction of acceptance sampling
- Concepts of AQL, LTPD, Producer's risk and Consumer's risk,
- OC curve, AOQ, AOQL, ASN, ATI for SSP

- Construction of single sampling plan by fixing two points on the OC curve.
- Double sampling plan
- Introduction of acceptance sampling plans for variables
- Advantages and disadvantages of sampling plans for variables compared to sampling inspection plans for attributes
- Design of acceptance sampling plans for variable when LCL is specified and
    1. σ is known
    2. σ is unknown
- Design of acceptance sampling plans for variable when UCL is specified and
    1. σ is known
    2. σ is unknown

Unit-3: Computing all the practical manually and R **(20L)**

1. Construction of control charts for variable (Mean, range and standard deviation)
2. Construction of control charts for attributes (p, np, c and u)
3. Single sampling plan: AQL, LTPD, Producer's risk and Consumer's risk
4. Single sampling plan: OC curve, AOQ, AOQL, ASN, ATI for SSP only
5. Single sampling plan: OC curve, AOQ, AOQL, ASN, ATI for SSP only

References:

1. Mukhopadhyay, P.: Applied Statistics, New Central Book Agency (1999)
2. Montgomery, D.C. (2001): Introduction to Statistical Quality Control, Wiley.
3. Grant, E.L. (2000): Statistical Quality Control, 7th Ed., Tata McGraw Hill.
4. Ott, E.R. (1975): Process Quality Control, McGraw Hill.
5. Wetherill, G.B. (1977): Sampling Inspection and Quality Control, Halsted Press.
6. Wetherill, G.B. and Brown, D.W.: Statistical Process Control, Theory and Practice, Chapman and Hall.