Darrang College (Autonomous), Tezpur-784001

Syllabus for FYUGP

Sub: STATISTICS

Approved by :

Board of Studies meeting held on 09-06-2026 &
Academic Council vide Resolution no. DC/AC/3/2026/02 dated-29th June, 2026

DARRANG COLLEGE (AUTONOMOUS)
TEZPUR, ASSAM

FYUGP Structure as per UGC Credit Framework

DEPARTMENT OF STATISTICS

(Courses effective from Academic Year 2025-2026)

SYLLABUS OF COURSES OFFERED

(Major)

AIMS OF FOUR-YEAR UNDER GRADUATE PROGRAMME (FYUGP) IN STATISTICS:

The aims of Four-Year under Graduate Programme (FYUGP) in Statistics are:

- The UG Programme in Statistics is structured to develop analytical, critical, and logical thinking skills in students.
- It emphasizes the application of mathematical reasoning in solving real-world problems.
- Students are introduced to diverse and practical statistical concepts throughout the course.
- The programme prepares students for roles like data scientist, statistician, strategic banker, researcher, and biostatistician.
- Graduates can pursue careers in industries, government agencies, public sector units, finance, business, and research.
- The curriculum includes both mathematical and applied statistics topics for well-rounded learning.
- Practical training is provided through hands-on sessions in the Computer Lab.
- Students gain experience using statistical software such as MS Excel, C/C++, R, and SPSS.
- Coding skills and software usage are integrated to deepen understanding of statistical methods.
- The programme aims to equip students with the necessary tools for success in research and industry.

Programme Outcome:

By the end of the programme a UG student of Statistics should be able to know about:

- **Statistical Knowledge**: Gain a strong foundation in theoretical and applied statistics to analyze and interpret data effectively.
- **Mathematical Reasoning**: Develop the ability to use mathematical tools and logical thinking for solving real-life and research-oriented problems.
- **Data Handling Skills**: Acquire skills in data collection, cleaning, visualization, and analysis using modern software and statistical techniques.

- **Computational Proficiency**: Learn to use programming languages and statistical software such as R, Python, SPSS, and C/C++ for data analysis and modeling.
- **Critical Thinking**: Enhance the ability to critically evaluate data sources, methods, and interpretations in a wide range of applications.
- **Research Competence**: Build capability to design and conduct statistical investigations and contribute to interdisciplinary research.
- **Problem Solving**: Apply statistical methods to solve practical problems in domains such as business, health, economics, environment, and public policy.
- **Communication Skills**: Develop effective written and verbal communication skills to present statistical findings clearly to both technical and non-technical audiences.
- **Ethics and Responsibility**: Understand the ethical issues in data handling, privacy, and responsible use of statistical results.
- **Career Readiness**: Prepare for careers in data science, analytics, government services, research institutions, finance, and further academic studies.

Teaching Learning Process:

The programme supports the application of multiple pedagogical approaches in both classroom and computer lab environments.

- Focus on learner-centric and outcome-based teaching methods.
- Use of both traditional lectures and digital tools for content delivery.
- Emphasis on conceptual clarity and practical application.
- Interactive sessions including discussions, quizzes, and problem-solving.
- Regular hands-on training using statistical software like R, SPSS, and Excel.
- Continuous internal assessment through tests, assignments, and presentations.
- Integration of project-based learning for real-life data analysis.
- Opportunities for internships and field work for practical exposure.
- Interdisciplinary approach connecting statistics with other domains.
- Inclusion of soft skill development and ethical value-based activities.

Teaching Learning Tools:

- Blackboard and Whiteboard Teaching – For explaining concepts, formulas, and derivations.

- Power Point Presentations – To visually present data, graphs, and theoretical concepts.
- Statistical Softwares – Tools like R, SPSS, Python, Excel for data analysis and practical's.
- ICT Tools – Projectors, Google Classroom
- Graphs and Charts – Manual and digital graph plotting for visualization.
- Problem-Solving Sessions – Interactive numerical sessions to enhance analytical skills.
- Case Studies – Real-life statistical data applications to encourage critical thinking.
- Group Discussions

Assessment/Evaluation Methods:

- A variety of subject-specific assessment procedures will be used to monitor student progress.
- Continuous evaluation will determine the final grade.
- Evaluation includes both In-semester assessment and End semester examination.
- In-semester evaluation methods include:
    - Class tests
    - In-semester Sessional exams
    - Home Assignments
    - Group Discussions
    - Attendance
- Assessment techniques include:
    - Tutorials
    - In-semester assessment
    - Problem-based assignments
    - Lab reports for practicals
    - Individual project reports
    - Oral presentations (including seminars)
    - Viva-voce
    - End Semester examinations (Theory and Practical)

Darrang College (Autonomous), Tezpur, Assam, 784001

FYUGP Structure as per UGC Credit Framework

Year	Semester	Course Code	Title of the Course	Total Credit
1st Year	**1st Semester**	STA-MJ-01014	Introductory Statistics and Probability	4
		STA-MN-01014	Introductory Statistics and Probability	4
		STA-SEC-01013	Statistical Data Analysis Using Excel	3
		VAC		4
		MDC		3
		AEC		2
	Total			**20**
	2nd Semester	STA-MJ-02014	Intermediate Probability Theory	4
		STA-MN-02014	Intermediate Probability Theory	4
		STA-SEC-02013	Statistical Data Analysis Using SPSS	3
		VAC		4
		MDC		3
		AEC		2
	Total			**20**
2nd Year	**3rd Semester**	STA-MJ-03014	Statistical Inference	4
		STA-MJ-03024	Mathematical Analysis	4
		STA-MN-03014	Basics of Statistical Inference	4
		STA-SEC-01013	Statistical Data Analysis Using R	3
		MDC		3
		AEC		2

	Total			**20**
	4th Semester	STA-MJ-04014	Probability Laws and Linear Models	4
		STA-MJ-04024	Linear Algebra	4
		STA-MJ-04034	Sampling Distributions	4
		STA-MJ-04044	Applied Statistics	4
		STA-MN-04014	Applied Statistics	4
		AEC		2
	Total			**22**
3rd Year	**5th Semester**	STA-MJ-05014	Survey Sampling-I	4
		STA-MJ-05024	Analysis of Variance and Design of Experiments	4
		STA-MJ-05034	Operations Research	4
		STA-INT-05044	Internship	4
		STA-MN-05014	Survey Sampling & Design of Experiments	4
	Total			**20**
	6th Semester	STA-MJ-06014	Stochastic Process and Queuing Theory	4
		STA-MJ-06024	Multivariate Analysis and Non-Parametric Inference	4
		STA-MJ-06034	Demography and Indian Official Statistics	4
		STA-MJ-06044	Application of Statistics with C programming	4
		STA-MN-06014	Demography and Vital Statistics	4
	Total			**20**
4th Year	**7th Semester**	STA-MJ-07014	Advanced Mathematical Analysis	4
		STA-MJ-07024	Advanced Probability Distributions	4
		STA-MJ-07034	Survey Sampling- II	4

		STA-MJ-07044	Research Methodology	4
		STA-MN-07014	Linear Models	4
	Total			**20**
	8th Semester	STA-MJ-08014	Time Series Analysis	4
		STA-MJ-08024	Advanced Statistical Inference	4
		STA-MJ-08034	Queuing Theory	4
		STA-MJ-08044	Dissertation	4
		STA-MN-08014	Operations Research	4
	Total			**20**

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 1st SEMESTER

Title of the Course	Introductory Statistics and Probability
Course Code	STA-MJ-01014
Nature of Course	Major
Total Credit	4 (Theory - 03 + Practical - 01)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	100-199

Course Objectives: The objective is to give students foundational ideas about the various statistical methods, measures of central tendency and basics of probability. The students are introduced to the methods of collecting data, their representational formats and basic statistical tools.

Learning Outcomes: At the end of the course, students will be able to analyse a data set, represent the data in tabular and diagrammatic form, prepare the frequency distribution, find the summary measures viz. the measures of central tendency, measure of dispersion, measures of skewness and kurtosis of a univariate data.

Course Outcomes:

CO1: Recall and define fundamental concepts in descriptive statistics and probability, such as mean, median, mode, variance, standard deviation and basic rules of probability.

CO2: Interpret and explain the significance of descriptive statistical measures and probability concepts in real-world contexts. Describe the relationship between descriptive statistics and probability and how they are used to analyze and interpret data.

CO3: Apply descriptive statistical techniques to summarize and analyze data sets, including calculating measures of central tendency, dispersion, and constructing frequency distributions.

CO4: Analyze and interpret data using descriptive statistics and probability techniques, identifying patterns, trends, and relationships within datasets.

CO5: Assess the strengths and limitations of descriptive statistics and probability in addressing real life questions and making informed decisions, and propose improvements or alternative approaches when necessary.

Unit	Content	L	T	P	Total hrs
I	**Statistical Data and its representations:** Definition and scope of Statistics, concepts of statistical population and sample. Types of Data: quantitative and qualitative, primary and secondary data, attributes, variables, scales of measurement-nominal, ordinal, interval and ratio. Data visualization. Presentation & Classification of Data: tabular and frequency distribution, Collection and Scrutiny of Data: Primary data-designing a questionnaire and a schedule; Secondary data- their Major sources including some government publications. Idea of National Surveys (ASER, NFHS etc)	05	03	-	08
II	**Descriptive Statistics:** Mathematical measures of central tendency: Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean, Trimmed Mean, Winsorised Mean and their properties and applications. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, Sheppard's corrections, skewness and kurtosis, Partition Values: Quartiles, Deciles, percentiles.	10	05	-	15
III	**Bivariate Data:** Representation of Bivariate Data, scatter diagram, simple, partial and multiple correlation (three variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curve	07	03	-	10
IV	**Introductory Probability**: Introduction, random experiments, sample space, events, algebra of events. Definitions of Probability: classical, statistical and axiomatic. Computational Probability: Conditional	08	04	-	12

	Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.				
V	**Practical:** **Note**: Students can use calculators / Ms Excel programming as convenient**.** 1. Graphical representation of data. 2. Problems based on measures of central tendency & dispersion. 3. Problems based on measures of location. 4. Problems based on moments, skewness and kurtosis. 5. Karl Pearson correlation coefficient 6. Correlation coefficient for a bivariate frequency distribution 7. Lines of regression, angle between lines and estimated values of variables. 8. Estimation of parameters by Method of Least Square 9. Spearman rank correlation with and without ties. 10. Partial and multiple correlations.	-	-	15	30

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I &II, 8th Edn. The World Press, Kolkata.

2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Mood, A.M. Graybill, F.A.and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.

4. Medhi, J., Statistical Methods (2000): An Introductory text (New Age International (P) Ltd.

5. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi. (12th Edition).

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 2nd SEMESTER

Title of the Course	Intermediate Probability Theory
Course Code	STA-MJ-02014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	100-199

Course Objective: This course has the objective of providing exposure to random variable and large scale properties of probability distributions. This is a fundamental course on probability theory, random variables and their distributions to make further progress on statistical analysis. This course also introduces the ideas of Statistical Inference and its importance in real world applications

Learning Outcomes: At the end of the course, students shall be able to appreciate the large sample implications of various statistical measures and also learn about a number of statistical distributions. They will be able to determine whether or not moments exist of any given random variable and if so, to determine them. They will also be able to use tools like Probability Generating function and Moment generating functions to study distributions in addition to learning several univariate discrete and continuous distributions and their characterizations.

Course outcomes:

CO1: Define the concepts of two dimensional random variables, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations.

CO3: Define expectation of single and bivariate random variables and its properties, conditional expectations, conditional variance, moments, factorial moments.

CO3: Explain the properties of generating functions. cumulants, cumulant generating function,

characteristic function

CO4: Illustrate the various probability distributions such as Discrete uniform, Bernoulli, Binomial, Poisson, geometric, negative binomial, hyper-geometric, Multinomial, Exponential, Cauchy, Beta and Gamma distributions, Lognormal, their properties and limiting cases and utilize these ideas to solve numerical problems.

Unit	Content	L	T	P	Total hrs
I	**Random variables:** Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, transformation of random variables, Idea of discretisation of continuous random variable.	10	02	-	12
II	**Mathematical Expectation and Generating Functions:** Expectation of single and bivariate random variables and its properties, Computational Expectations of conditional, conditional variance, Theorems on sums and product of expectation of random variables, Inequalities involving expectation. Moment generating function (mgf), cumulants, cumulant generating function (cgf) and characteristic function (cf), probability generating function (pgf) their properties and related problems. Distribution of CDF, Uniqueness and Inversion theorem (without proof) along with applications	09	02	-	11
III	**Discrete Probability Distributions:** Discrete uniform, Bernoulli, Binomial, Poisson, geometric, negative binomial, hyper-geometric, logarithmic distribution along with their properties and limiting/approximation cases	09	01	-	10

IV	**Continuous Probability Distributions:** Normal, Exponential, Uniform and lognormal distributions along with their characteristic properties and limiting/approximation cases.	11	01	-	12
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** 1. Fitting of binomial distributions for n and p = q = ½. 2. Fitting of binomial distributions for given n and p. 3. Fitting of binomial distributions after computing mean and variance. 4. Fitting of Poisson distributions for given value of lambda. 5. Fitting of Poisson distributions after computing mean. 6. Fitting of negative binomial. 7. Fitting of suitable distribution. 8. Application problems based on binomial distribution. 9. Application problems based on Poisson distribution. 10. Application problems based on negative binomial distribution.	-	-	15	30

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi

4. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi. (12th Edition).

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 3rd SEMESTER

Title of the Course	Statistical Inference
Course Code	STA-MJ-03014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Point Estimation:** Definitions of random sample, parameter and statistic, Concepts of Estimation, Unbiasedness, Sufficiency, Consistency and Efficiency. Factorization theorem, Complete statistic, Minimum variance unbiased estimator (MVUE), construction of UMVUE, Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators. Idea of Interval Estimation.	13	02	-	15
II	**Methods of Estimation:** Method of moments, method of maximum likelihood estimation, method of minimum Chi-Square.	09	02	-	11

III	**Hypothesis Testing:** Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test).	09	01	-	10
IV	**Categorical data:** Tests of proportions (one and two samples), Chi-square test for independent of Attributes, Chi-square test for goodness-of-fit.	08	01	-	09
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** Based on Unit II, III & IV	-	-	15	30

SUGGESTED READING:

1. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi. (12^{th} Edition).
2. Goon A.M., Gupta M.K.: Das Gupta.B. (2005): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Mood A.M, Graybill F.A. and Boes D.C: Introduction to the Theory of Statistics, McGraw Hill.
4. Rohatgi V. K. and Saleh, A.K. Md. E. (2015): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.
5. Casella, George, and Roger Berger. *Statistical inference*. Chapman and Hall/CRC, 2024.
6. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 3rd SEMESTER

Title of the Course	Mathematical Analysis
Course Code	STA-MJ-03024
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Real Analysis:** Sets, Bounded and unbounded sets, neighborhoods and limit points, Supremum and infimum, open and closed sets, sequences and their convergence and Cauchy's general principle of convergence Infinite series, positive termed series and their convergence; Comparison test, D'Alembert's ratio test, Leibnitz's test for the convergence of alternating series,	10	02	-	12
II	**Calculus:** Limits of function, continuous functions, partial differentiation and total differentiation (Revision only). Indeterminate forms: L-Hospital's rule, Maxima and minima of functions of one variable and two variable, constrained optimization techniques (with Lagrange's multiplier) along with some problems. Beta and Gamma functions: properties and relationship between them.	09	02	-	11

	Taylor's and Maclaurin's series expansions of $sin(x)$, $cos(x)$, e^x , $(1+x)^n$, $log(1+x)$, $\log(1-x)$ (without proof).				
III	**Finite Difference:** Operators, E, Δ and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Central differences, Gauss, Stirling and Bessel's interpolation formulae	09	01	-	10
IV	**Numerical Integration:** Idea of Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's one-third rule, three-eighth rule, Weddle rule with error terms, Stirling's approximation to factorial n. Solution of Transcendental equations: Bisection method, Regula-Falsi method, Newton Raphson method.	11	01	-	12
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** Based on Unit III & IV	-	-	15	30

SUGGESTED READING:

1. Malik, S.C. and Arora, S. (1994): Mathematical Analysis, 2nd Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
2. Bartle, Robert G., and Donald R. Sherbert. *Introduction to real analysis*. Vol. 2. New York: Wiley, 2000.
3. Apostol T.M. (1987): Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi.
4. Shanti Narayan (1987): A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi.
5. Gupta PP, Malik GS and Chauhan JP (Revised edition): Calculus of Finite Differences & Numerical Analysis, Krishna Publications.
6. Mukherjee, K.K. (1990): Numerical Analysis, New Central Book Agency.
7. Saxena, H.C. (2010): Finite Differences & Numerical Analysis, S Chand, New Delhi.
8. Scarborough, J.B. (2017): Numerical Mathematical Analysis, 6th Edition, Oxford & IBH Publishing Co Pvt. Ltd, London.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 4th SEMESTER

Title of the Course	Probability Laws and Linear Models
Course Code	STA-MJ-04014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Probability Laws:** Chebyshev's inequality, Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their interrelations, Khinchin's law of large number, Weak law of large numbers., Strong law of large numbers, and their applications. Central Limit Theorem, De-Moivre Laplace theorem, Lindeberg Levy Central Limit Theorem and Liapunoff Theorem (without proof), Applications of Central Limit Theorem.	10	02		12
II	**Gauss-Markov set-up:** Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance. **Simple Regression Model:** Estimation of parameters	10	01	-	11

	and hypothesis testing in case of simple regression models, Concept of model matrix and its use in estimation.				
III	**Multiple regression model:** Estimation of model parameters, Hypothesis Testing in multiple linear regression, Regression with and without intercept terms. standardized regression coefficients and interpretations, use of R^2 & adjusted R^2. Overview of Heteroscedasticity, Autocorrelation and Multicollinearity.	20	02	-	22
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** Based on unit II & III	-	-	15	30

SUGGESTED READING:

1. Gupta, S.C. and Kapoor, V.K. (2020). Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi. (12^{th} Edition).
2. Weisberg, S. (2005). Applied Linear Regression (Third edition).Wiley.
3. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
4. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
5. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). *Introduction to linear regression analysis*. John Wiley & Sons.
6. Goon, A.M. and Gupta, M.K. and Dasgupta, B.(1991): An Outline of Statistical Theory, World Press Private Limited.
7. Johnson, M. M. (1971). Simple Linear Regression. *Journal of Quality Technology*, *3*(3), 138-143.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 4th SEMESTER

Title of the Course	Linear Algebra
Course Code	STA-MJ-04024
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Introductory concepts:** Idea of Group, Ring and Field. Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem (statement only)	10	02	-	12
II	**Determinants:** Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Van der monde determinants for nth order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.	09	01		10

III	**Algebra of Matrices:** A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.	09	02	-	11
IV	**Rank and Eigenvalues:** Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem.	11	01	-	12
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** **Based on Unit II, III & IV**	-	-	15	30

SUGGESTED READING:

1. Schaum's Outlines. (2006). Linear Algebra, 3rd Edition. Tata McGraw-Hill Edition.
2. Vasishtha, A. R. (1982). Matrices, 9th Edition. Krishna Prakashan Mandir.
3. Gupta, S. C. (2008). An Introduction to Matrices, Reprint. Sultan Chand & Sons.
4. Biswas, S. (1997). A Textbook of Matrix Algebra. New Age International.
5. Hohn, F. E. (2002). *Elementary matrix algebra*. Courier Corporation.
6. Rao, A. R., & Bhimasankaram, P. (2000). *Linear algebra* (Vol. 19). Springer.
7. Gallian, J. (2021). *Contemporary abstract algebra*. Chapman and Hall/CRC.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 4th SEMESTER

Title of the Course	Sampling Distributions
Course Code	STA-MJ-04034
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Large Sample Theory:** Sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Large sample tests for single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.	10	02	-	12
II	**Chi Square Distribution:** Definition and derivation of p.d.f. of $\chi 2$ with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on distribution.	09	02	-	11
III	**Exact Sampling Distributions:** Student's and Fishers t-distribution, Derivation of its pdf., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Test of	09	01	-	10

	significance and confidence Intervals based on t distribution. Snedecor's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Relationship between t, F and χ^2distributions. Test of significance and confidence Intervals based on t and F distributions				
IV	**Order Statistics:** Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and sth order statistics, distribution of sample median and sample range.	11	01	-	12
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS Based on Unit I, II & III	-	-	15	30

SUGGESTED READING:

1.Goon, A.M., Gupta, M.K., and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edition. World Press, Kolkata.

2.Goon, A.M., Gupta, M.K., and Dasgupta, B. (2019): Fundamentals of Statistics, Vol. I & II, 9th Edition. The World Press, Kolkata.

3.Gupta, S.C., and Kapoor, V.K. (2020): Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons.

4.Hogg, R.V., and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.

5.Johnson, R.A., and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edition. John Wiley and Sons.

6.Mood, A.M., Graybill, F.A., and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edition (Reprint). Tata McGraw-Hill Pub. Co. Ltd.

7.Mukhopadhyay, P. (2011): Applied Statistics, 2nd Edition Revised Reprint. Books and Allied (P) Ltd.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 4th SEMESTER

Title of the Course	Applied Statistics
Course Code	STA-MJ-04044
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Time Series:** Components of time series, Decomposition of time series: Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, moving average method, method of semi-averages and method of least squares (linear, quadratic and exponential), Detrending, Measurement of seasonal variations by method of ratio to trend, ratio to moving average. Effect of elimination of trend on other components of the time series. Estimation of cyclical fluctuations.	10	02	-	12
II	**Index Numbers:** Definition, Uses and limitations of index numbers. Criteria/tests for a good index number, different types of index numbers- price, quantity, value. Wholesale price index number. Construction of index numbers of prices and quantities – Laspeyres', Paasche's, Fisher's and Marshal-Edgeworth's Index numbers. Consumer price	09	02	-	11

	index number. Base shifting, splicing, and deflating of index numbers. Idea of inflation.				
III	**Statistical Quality Control:** Importance of statistical methods in industrial research and practice. Rational subgroup., Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X bar, R-charts and sigma chart. Control charts for attributes: np charts, p charts, c charts and u-charts. Comparison between control charts for variables and control charts for attributes. Product control – basic ideas of Single sampling and double sampling plans. Deming's contribution to quality control.	09	01	-	10
IV	**Demand Analysis:** Theory of consumption and demand, demand function, elasticity of demand, determination of elasticity of demand by family budget method, Lorentz curve and Gini's coefficient, Engel's law and Engel's curve, Idea of Pareto's law of income distribution.	11	01	-	12
V	**Practical:** Based on Unit I, II, III & IV	-	-	15	30

SUGGESTED READING:

1. Mukhopadhyay,P.(1999): Applied Statistics, New Central Book Agency, Calcutta.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II,9th Edition World Press, Kolkata.

3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons.

4. Montogomery,D.C.(2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

5. Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied(P)Ltd.

6. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 5th SEMESTER

Title of the Course	Survey Sampling-I
Course Code	STA-MJ-05014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	200-299

Unit	Content	L	T	P	Total hrs
I	**Introduction:** Role and importance of surveys in statistical analysis, Key terminologies used in sample survey, Sampling vs Complete enumeration- advantages and limitations, Principles of sample survey, sampling and non-sampling errors-factors and remedial measures, Types of sampling: Probability and non-probability sampling. Determination of sample size.	07	01	-	08
II	**Simple Random Sampling:** Simple Random Sampling with and without Replacement, Definition and Procedure for Selecting a Sample, Use of random number tables, Estimates of Population Mean, Total and its variances, Variances of these estimates.	12	01	-	13
III	**Stratified Random Sampling:** Stratification, Allocation and Sampling from Strata, Estimation of population, mean, total, and its variances. Estimates of the variances of these	09	02	-	11

	estimates, estimation of gain in precision, two-way stratification, construction of strata, number of strata.				
IV	**Systematic Sampling:** Concept and Procedure of Systematic Sampling- Linear and circular systematic sampling, Linear systematic sampling: estimates of population mean, variances of the estimates. Comparison between SRS, Stratified and Systematic Sampling in terms of efficiency.	11	02		13
V	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** Based on Unit II, III & IV	-	-	15	30

SUGGESTED READING:

1. Chaudhari, A. and Stenger, H. (2005): Survey Sampling Theory and Methods, 2nd Edition, Chapman and Hall.

2. Chaudhari, A. and Vos, J.W.E. (1988): Unified Theory and Strategies of Survey Sampling, North –Holland, Amsterdam.

3. Cochran, W.G. (1977): Sampling Techniques, John Wiley & Sons, New York.

4. Levy, P.S. and Lemeshow, S. (2008): Sampling of Populations-Methods and Applications, Wiley.

5. Mukhopadhyay, P. (2009): Theory and Methods of Survey Sampling, 2nd Edition, Prentice Hall of India, New Delhi.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 5th SEMESTER

Title of the Course	Analysis of Variance and Design of Experiments
Course Code	STA-MJ-05024
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Analysis of Variance:** Definitions of fixed, random and mixed effect models, analysis of variance in one-way classified data for fixed effect models, analysis of variance in two-way classified data with one observation per cell for fixed effect models, Analysis of Covariance, idea of Random Effect model.	11	01	-	12
II	**Basics of Design of Experiments:** Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, choice of size and shape of plots and blocks. Cochran's theorem (without proof) and its relation to DoE, Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations, Idea of Orthogonal Latin Square,	10	02	-	12

	Greaco Latin Square Design.				
III	**Factorial experiments:** advantages, notations and concepts, 2^2, $2^3 \ldots 2^n$ and 3^2 factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$), idea of 3^2 experiment.	09	01	-	10
IV	Idea of Split Plot Design, Strip Plot Design, Incomplete Block Designs, Introduction to Balanced Incomplete Block Design (BIBD) (without analysis)	09	02	-	11
V	**Practical/Lab** Based on Unit I, II, III & IV	-	-	15	30

SUGGESTED READING:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.

2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.

3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn.

World Press, Kolkata.

4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.

5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

6. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edition (Reprint), Sultan Chand & Sons.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 5th SEMESTER

Title of the Course	Operations Research
Course Code	STA-MJ-05034
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Linear Programming Problem (LPP):** Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Idea of Concave and Convex sets, Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P, the artificial variable techniques - Charne's Big M-technique. Duality in linear programming.	10	02	-	12
II	**Transportation Problem:** Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM).	09	02	-	11
III	**Game theory:** Introduction, Two person Zero sum game, The Minimax-Maximin Principle; saddle points; Game	09	01	-	10

	without saddle point; Pure and Mixed strategies; Solution procedure of 2x2 game.				
IV	**Network Analysis:** Conception of network, idea of network node, activities, dummy activity, construction of network diagram. Network scheduling using C.P.M, PERT: determination of different types of floats and slacks, determination of critical path.	11	01	-	12
V	**Practical/Lab** **List of Practical** Based on Unit I, II, III & IV	-	-	15	30

SUGGESTED READING:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.

2. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.

3. Hadley, G: (2002) : Linear Programming, Narosa Publications

4. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research- Concepts and cases, 9th Edition, Tata McGraw Hill.

5. J. K Sharma, Operations Research: Theory and Applications (9^{th} Ed)

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 5th SEMESTER

Title of the Course	Internship
Course Code	STA-MJ-05044
Nature of Course	Major
Total Credit	4
Contact Hours	120
Distribution of Marks	100
Course Level	300-399

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 6th SEMESTER

Title of the Course	Stochastic Process and Queuing theory
Course Code	STA-MJ-06014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Probability Distributions:** Idea of Power series and radius of convergence. Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process, Evolutionary Process, Idea of Martingale.	10	02	-	12
II	**Markov Chains**: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, Stability of Markov System, Graph theoretic approach, Markov chain with denumerable number of states.	09	02	-	11
III	**Poisson Process:** Postulates of Poisson process, properties of Poisson process, Time dependent Poisson Process, Arrival, Inter arrival and Conditional Arrival Distributions.	09	01	-	10

IV	**Queuing System**: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity.	11	01	-	12
V	**Practical/Lab** Based on Unit II, III & IV	-	-	15	30

SUGGESTED READING:

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.

2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.

3. Bhat, B.R.(2000): Stochastic Models: Analysis and Applications, New Age International Publishers.

4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.

5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I, 3rd Edition, Wiley International.

6. J. K Sarma, Operations Research: Theory and Applicatios (9^{th} Edition)

7. S. S Sharma, Operations Research: Theory, Methods and Techniques.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 6th SEMESTER

Title of the Course	Multivariate Analysis and Nonparametric Methods
Course Code	STA-MJ-06024
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Bivariate and Multivariate Distributions:** Bivariate Normal Distribution (BVN): pdf. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN and the related theorems and problems.	10	02	-	12
II	**Multivariate Data:** Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.	09	02	-	11
III	**Multivariate Normal Distributions:** Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix. Multiple and partial correlation coefficient and their properties, Basic idea of Principal Component Analysis, Hotelling T^2 – concept and applications (one sample and two sample).	09	01	-	10

IV	**Non-parametric Tests:** Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function, Kolmogorov Smirnov test for one and two samples, Sign tests- one sample and two samples, Wilcoxon signed rank test, Wilcoxon Matched pair signed rank test, Mann-Whitney test, Kruskal-Wallis test.	11	01	-	12
V	Practical: Based on Unit I, III & IV	-	-	15	30

SUGGESTED READING:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley

2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.

3. Kshirsagar, A.M. (1972) :Multivariate Analysis, 1stEdn. Marcel Dekker.

4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall.

5. Mukhopadhyay, P. : Mathematical Statistics.

6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 6th SEMESTER

Title of the Course	Demography and Indian Official Statistics
Course Code	STA-MJ-06034
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	**Population Theories:** Coverage and content errors in demographic data, use of balancing equations, Population composition, dependency ratio. **Measurement of Mortality:** Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.	10	02	-	12
II	**Life Table:** Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) tables: Assumption, description. Abridged Life Tables: Concept and construction of abridged life tables by Reed-Merrell method.	09	02	-	11

III	**Measurements of Fertility:** Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).	10	02	-	12
IV	**Indian Statistical System:** Ministry of Statistics and Programme Implementation and its different wings, National Statistical Commission, National Statistics Office, census and large sample surveys. Contributions of P C Mahalanobis, P V Sukhatme, R C Bose, S N Roy, C R Rao, and other prominent Indian Statisticians.	09	01		10
V	**PRACTICAL/LAB. WORK:** Based on Unit I, II & III	-	-	15	30

SUGGESTED READING:

SUGGESTED READING:

1. Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied (P) Ltd.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9 th

3. Edition, World Press.

4. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.

5. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.

6. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag New York.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 6th SEMESTER

Title of the Course	Application of Statistics with C programming
Course Code	STA-MJ-06044
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	300-399

Unit	Content	L	T	P	Total hrs
I	Basic idea of algorithms and flowcharts, compilers, history and importance of C. Components, basic structure programming, character set, C tokens, Keywords and Identifiers and execution of a C program. Data types: Basic data types, enumerated data types, derived data types. Constants and variables: declaration and assignment of variables.	12	03		15
II	**Operators and Expressions**: Arithmetic, relational, logical, assignment, increment/decrement operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data.	12	03		15
III	**Decision making and branching:** if…else, nesting of if…else, else if ladder, switch, conditional (?) operator. Looping in C: for, nested for, while, do…while, jumps in and out of loops. Character	12	03		15

	arrays and strings: Declaring and initializing string variables, reading, and writing strings from Terminal (using scanf and printf only).				
IV	**PRACTICAL/LAB. WORK:** Based on Unit II & III	-	-	15	30

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 7th SEMESTER

Title of the Course	Advanced Mathematical Analysis
Course Code	STA-MJ-07014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Real Analysis:** Convergence of Improper Integrals, Double integral over rectangle, Concept of Multiple integrals simple examples involving change of variables in multiple integrals, Dirichlet integral, Extremum of one and two variable. Laplace and Fourier transformations.	10	02	-	12
II	**Complex Analysis:** Properties of complex numbers. Region in complex plane. Analytic function. Contour integration: Taylor's and Laurent's series, Cauchy's theorem, Cauchy integral formula.	09	02	-	11
III	**Linear Algebra:** Linear Transformations, Kernel and Image of a linear transformation, Rank and Nullity, Change of Basis. Revision of Cayley Hamilton Theorem, Eigen values and eigen vectors, Spectral decomposition of a symmetrical	20	02	-	22

	matrix with examples, Algebraic and geometric multiplicity of characteristic roots, Diagonalization of matrices. Real quadratic form, Linear transformation of quadratic forms, Index and signature, Reduction of quadratic form into sum of squares, Idea of matrix polynomials and minimum polynomial of a matrix.				
IV	PRACTICAL / LAB WORK Based on Unit III & IV	-	-	15	30

SUGGESTED READING:

1. Graybill, F.A. (1983). Matrices with applications in statistics, 2nd Ed. Wadsworth.

2. Dass, H. K. (2010). *Mathematical physics*. S. Chand Publishing.

3. Searle, S.R. (1982). Matrix Algebra useful for Statistics. John Wiley and Sons. Inc.

4. Rajput, BS : *Mathematical physics*. S. Chand Publishing.

5. Bartle, R. G., & Sherbert, D. R. (2000). *Introduction to real analysis* (Vol. 2). New York: Wiley.

6. Hohn, F. E. (2002). *Elementary matrix algebra*. Courier Corporation.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 7th SEMESTER

Title of the Course	Advanced Probability Distributions
Course Code	STA-MJ-07024
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Probability distributions:** Beta, Gamma, Cauchy, Logarithmic, positive and negative multinomial, Weibull distribution and their properties. Symmetric distributions, Idea of Univariate Pearsonian distributions.	10	02	-	12
II	**Truncated and Weighted distributions:** Truncated Binomial, Poisson, Normal and Cauchy distributions. Idea of censoring and Weighted distributions.	09	02	-	11
III	**Mixture distributions:** Definition, finite mixtures, Zero modified or inflated binomial and Poisson distribution, Mixed Poisson distributions and its properties and examples of Poisson mixtures, Mixtures of Binomial distributions with examples.	09	01	-	10
IV	**Sampling Distributions:** Non-central chi-square, t, and F distributions, their properties and the related distributions.	09	01	-	10

V	PRACTICAL / LAB WORK Based on Unit II, III & IV	-	-	15	30

SUGGESTED READING:

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rd Edition, John Wiley and Sons.

2. Biswas, S. (2007): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2nd Central Edition, New Central Book Agency.

3. Kleinbaum, D.G. (1996): Survival Analysis, Springer.

4. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.

6. Indrayan, A. (2008): Medical Biostatistics, 2nd Edition Chapman and Hall/CRC.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 7th SEMESTER

Title of the Course	Survey Sampling-II
Course Code	STA-MJ-07034
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**PPS Sampling:** Overview of Simple Random Sampling with and without Replacement, Estimates of Population Mean, Total and its variances, Variances of these estimates. Probability Proportional to Size Sampling: Need for unequal probability sampling, Selection of units with and without replacement, Estimation of population mean and population total and their variances, PPSWR- cumulative total method, Lahiri's method, Idea of PPSWOR.	15	02	-	17
II	**Ratio and regression estimators:** Introduction to Ratio and regression methods of estimation, Idea of auxiliary variable, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS.	10	02	-	12

III	**Cluster sampling:** Cluster sampling (equal clusters), estimation of population mean and its variance, Optimum cluster size, Relative efficiency of equal cluster sampling. **Double Sampling:** Definition and procedure of selecting a sample. **Multi-Stage Sampling:** Idea of multistage sampling, two stage sampling with equal and varying sizes of first stage units, estimation techniques employed in two stage sampling.	14	02	-	16
IV	**Practical:** **Note**: Students can use calculators / Ms Excel/SPSS programming as convenient**.** Based on Unit I, II & III	-	-	15	30

SUGGESTED READING:

1. Chaudhari, A. and Stenger, H. (2005): Survey Sampling Theory and Methods, 2nd Edition, Chapman and Hall.

2. Chaudhari, A. and Vos, J.W.E. (1988): Unified Theory and Strategies of Survey Sampling, North –Holland, Amsterdam.

3. Cochran, W.G. (1977): Sampling Techniques, John Wiley & Sons, New York.

4. Levy, P.S. and Lemeshow, S. (2008): Sampling of Populations-Methods and Applications, Wiley.

5. Mukhopadhyay, P. (2009): Theory and Methods of Survey Sampling, 2nd Edition, Prentice Hall of India, New Delhi.

6. Murthy, M.N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.

7. Raj, D. and Chandhok, P. (1998): Sample Survey Theory. Narosa Publishing House.

8. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984): Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa, USA.

9.Thompson, S. K. (2002): Sampling, John Wiley and Sons, New York.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 7th SEMESTER

Title of the Course	Research Methodology
Course Code	STA-MJ-07044
Nature of Course	Major
Total Credit	4
Contact Hours	120
Distribution of Marks	End Semester (100)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Introduction to research**: Meaning, objectives and basics of scientific research, types of scientific research: fundamental or basic research, applied research, qualitative research, quantitative research, exploratory research, descriptive research, cross-sectional research, action research	10	02	-	12
II	**Research design and research design methods:** Descriptive, experimental, correlational, diagnostic and explanatory, preparing research proposals by selection of the topic, review of literature, identification of objectives of the study, preparation of research questions and formulation of the hypotheses.	09	02	-	11

III	**Sampling and data collection:** Concepts of population and sample, parameters and statistics, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, determining size of the sample, Practical considerations in sampling and sample size, sources of data.	09	01	-	10
IV	**Data analysis and report writing:** Cross-checking of data and validation, graphical and descriptive tools for data analysis, significance of report writing, different steps in report writing, formulation of the research report in a proper scientific format, style of referencing, bibliography.	09	01	-	10

1. Kothari, C.K. [2004], 2.e, Research Methodology – Methods and Techniques [New Age International, New Delhi]
2. Gruijter, J., de Brus, Bierkens, M. F. P. amd Knotters, M. (2006): Sampling for natural resource monitoring. Springer.
3. Thompson, S. K. (2002): Sampling, 2nd Edition. Wiley.
4. Hastie, T., Tibshirani, R. and Friedman, J. (2009): Elements of statistical learning, 2nd Edition. Springer.
5. Myers, R. H., Montgomery, D. C., and Anderson-Cook, C. M. (2009): Response surface methodology, 3rd Edition. Wiley
6. Cresswell, J. W. & Cresswell, J. D. (2017): Research Design, New Delhi: Sage.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 8th SEMESTER

Title of the Course	Time Series Analysis
Course Code	STA-MJ-08014
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Discrete parametric Stochastic processes:** Introduction to Stationary processes, Autocovariance, Auto-correlation and Auto-regressive process, Properties of Auto-covariance function, Concept of Weak Stationarity, Autoregressive (AR), Moving Average (MA), Linear processes, White noise process, Cointegration.	12	03	-	15
II	**ARMA Models:** ARMA (p,q) processes, The auto-correlation function and partial auto-correlation function of an ARMA (p,q) process, Partial auto-correlation function, Forecasting ARMA processes.	12	03	-	15
III	**Nonstationary and seasonal time series models:** Auto-regressive integrated moving average (ARIMA) models for nonstationary time series, Identification techniques, Forecasting ARIMA models, seasonal ARIMA models.	12	03	-	15

IV	Practical Based on Unit I, II & III	-	-	15	30

SUGGESTED READING:

1. Anderson, T.W. (1971): Statistical Analysis of Time Series, Wiley, NY

2. Box, G.E.P and Jenkins, G.M.(1976): Time series Analysis-Forecasting and Control, Holden-day, San Francisco.

3. Brockwell, P.J. and Davis, R.A.(1996): Introduction to Time Series and Forecasting, Springer, New York.

4. Enders, W.,(2008): Applied Econometric Time Series, 2nd Edition, Wiley

5. Medhi, J. (2009): Stochastic Processes, 3rd Ed., New Age International Publishers, New Delhi, India.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 8th SEMESTER

Title of the Course	Advanced Statistical Inference
Course Code	STA-MJ-08024
Nature of Course	Major
Total Credit	4 (Theory – 4)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Elements of Decision Theory:** Introduction, Basic Concepts, Bayes and Minimax Decision rules. Different types of loss function. Estimation of Parameters: Bayes estimate and Minimax estimate. Point estimation as Decision Problem.	10	02	-	12
II	**Bayesian Inference:** Recap of conditional distribution, Subjective and Frequentist Probability, Advantages, Bayes theorem, Subjective prior distribution of a parameter, Uniform Prior, Non informative, improper and invariant priors, Computation of posterior distributions.	09	02	-	11
III	**Sufficiency:** Neyman Factorisation theorem with proof, minimal sufficient statistic and ancillary statistic, Completeness, confidence level, Sampling from normal population, pivotal quantity method.	09	01	-	10
IV	**Advanced Hypothesis Testing:** Likelihood Ratio Test, Introduction to BAN and CAN estimators and related	09	01	-	10

	theorems. UMPU- tests, Type A and Type A_1 critical regions, Similar Regions. Consistency and monotonicity of power function.				

SUGGESTED READING:

1. An outline of Statistical Theory Vol.II: AM Gun, MK Gupta, B Dasgupta. World Press.

2. Mathematical Statistics: Parimal Mukhopadhyay: New Central Book Agency

3. Statistical Decision Theory and Bayesian Analysis: JO Berger, Springer Verlag

4. Bayesian Parametirc Inference. A K Bansal. Narosa Publishing House

5. An Introduction to Bayesian Analysis Theory and Methods. J K Ghosh, M Delampady and T. Samanta

6. Bayesian Statistics: An Introduction. Peter Lee. Arnold, London.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 8th SEMESTER

Title of the Course	Queuing Theory
Course Code	STA-MJ-08034
Nature of Course	Major
Total Credit	4 (Theory - 3 + Practical - 1)
Contact Hours	45 (Theory) + 30 (Practical)
Distribution of Marks	End Semester (45) + In Semester (30) + End sem Practical (25)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Introduction to Queue:** Basic Characteristics of a Queue, Notations, Transient and Steady state, Little's formula (without proof), idea of PASTA. Revision of M/M/1 and M/M/1/k models, Derivation of Steady state distributions and Waiting time distributions of M/M/1 and M/M/1/k models.	12	03	-	15
II	**M/M/c model:** Steady state distribution, Steady state distribution of the following models: M/M/c/c, M/M/c//m (m>c).	12	03		15
III	**M/G/1 model:** Pollaczek Khinchin and Pollaczek Khinchin Transform Formulae; Steady, State Distribution of M/D/1 model.	12	03	-	15
IV	Practical based on Unit I, II, III.			15	30

SUGGESTED READING:

1. Medhi, J, Stochastic Models in Queuing Theory, Academic Press.

2. Gross, D and Harris, C. M. Fundamental of Queuing Theory, Wiley

3. Kashyap, B. R.K and Chaudhry, M. L. An Introduction to Queuing Theory.

4. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.

2. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.

B.A./B.Sc. IN STATISTICS PROGRAMME (FYUGP)

DETAILED SYLLABUS OF FYUGP 8th SEMESTER

Title of the Course	Dissertation
Course Code	STA-MJ-08044
Nature of Course	Major
Total Credit	4
Contact Hours	120
Distribution of Marks	End Semester (100)
Course Level	400-499

Unit	Content	L	T	P	Total hrs
I	**Dissertation**				