K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2024

NOTIFICATION

Sub :- CBCS Syllabi of B. Sc. in Statistics (Sem. III & IV)

Ref. :- Decision of the Academic Council at its meeting held on 27/07/2024.

The Syllabi of B. Sc. in Statistics (Third and Fourth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2023 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2024-25.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

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समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७-२२३७३६३, २२३४२८१ । ई-मेल: mjcollege@kces.in । वेबसाईट: mjcollege.kces.in

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Structure and Syllabus

B.Sc. Honours/Honours with Research

(SYBSc Statistics)

Under Choice Based Credit System (CBCS)
and
as per NEP-2020 Guidelines

[w.e.f. AcademicYear: 2024-25]

Preface

Welcome to the Bachelor of Science in Statistics program! This syllabus serves as your guide to understand the curriculum and objectives of the program. The field of statistics plays a crucial role in today's data-driven world, and this program is designed to equip you with the necessary knowledge and skills to navigate the ever-expanding realm of statistical analysis. The BSc in Statistics program offers a comprehensive and rigorous study of statistical theory, methodology, and applications. It aims to develop your critical thinking abilities, analytical skills, and problem-solving capabilities, all of which are essential for making informed decisions based on data. Whether you aspire to work in industry, academia, research, or any other sector where data analysis is vital, this program will provide you with a solid foundation in statistical principles and techniques.

The syllabus is structured to cover a wide range of statistical topics, including probability theory, mathematical statistics, statistical modeling, experimental design, regression analysis, multivariate analysis, time series analysis, and more. Throughout the program, you will also have opportunities to enhance your computational skills through the use of statistical software packages widely used in the field.As you progress through this program, you will not only develop a strong statistical foundation but also cultivate essential skills in data collection, data cleaning, data visualization, and effective communication of statistical findings. These skills are highly valued in today's job market, where organizations across industries are seeking professionals who can harness the power of data to drive evidence-based decision-making.

Program Outcomes (PO) for B.Sc. Program:

Program outcomes associated with a B.Sc. degree are as follows:

No.	PO
1	Graduates should have a comprehensive knowledge and understanding of the fundamental principles, theories, and concepts in their chosen field of study.
2	Graduates should possess the necessary technical skills and competencies related to their discipline, including laboratory techniques and data analysis.
3	Graduates should be able to identify, analyze, and solve complex problems using logical and critical thinking skills. They should be able to apply scientific methods and principles to investigate and find solutions.
4	Graduates should be proficient in effectively communicating scientific information, both orally and in writing.
5	Graduates should have a basic foundation in research methods and be capable of designing and conducting scientific investigations.
6	Graduates should be able to work effectively as part of a team, demonstrating the ability to collaborate with others, respect diverse perspectives, and contribute to group projects.
7	Graduates should recognize the importance of ongoing learning and professional development. They should be equipped with the skills and motivation to engage in continuous learning, adapt to new technologies and advancements in their field, and stay updated with current research.

Program Specific Outcome PSO (B.Sc. Statistics):

After completion of this course, students are expected to:

No.	PSO
1	Serve as a statistician with sound theoretical, practical and computational skills.
2	Work as researcher for formulation and solution of mathematical, scientific, societal and industrial problems.
3	Understand the role of statistics in science, society and for National Development.
4	Apply some discrete and continuous distributions which are highly useful in modelling real life.
5	Investigate the relationship between a variable of interest (the response) and a set of related predictor variables and formulate and fit the appropriate regression model to the given dataset.
6	Serve as Administrators/Investigators in the private as well as government sectors and worked as Analyst in Manufacturing (SQC Unit), Pharmaceutical industries.

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

Credit distribution structure for Three/ Four year Honors/ Honors with Research Degree Programme with Multiple Entry and Exit

F.Y. B.Sc.

Year (Level)	Sem	Major (Core). Subjects		Minor Subjects (MIN)	GE/ OE	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)							
1 (4.5)	I	DSC-1 (2T) DSC-2 (2T) DSC-3 (2P)	—	MIN-1 (2T) MIN-2 (2P)	OE-1 (2T)	SEC-1 (2T) SEC-2(1P)	AEC-1 (2T) (ENG) VEC-1 (2T) (ES) IKS (1T)	CC-1 (2)	22	**UG Certificate**
	II	DSC-4 (2T) DSC-5 (2T) DSC-6 (2P)	...	MIN-3 (2T) MIN-4 (2P)	OE-2 (2T)	SEC-3(2T) SEC-4(1P)	AEC-2 (2T) (ENG) VEC-2 (2T) (CI) IKS (1T)	CC-2 (2)	22	
	Cum. Cr.	**12**	**...**	**8**	**4**	**6**	**10**	**4**	**44**	
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor.										

S.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1) Major*		Subject-II (M-2) Minor #	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	Elective (DSE)	(MIN)							
2 (5.0)	III	DSC-7(2T) DSC-8(2T) DSC-9(2P) DSC-10(2P)	---	MIN-5(2T) MIN-6(2T) MIN-7(2P)	---	OE-3(2T)		AEC-3(2T) (MIL)	CC-3(2T) CEP(2)	22	**UG Diploma**
	IV	DSC-11(2T) DSC-12(2T) DSC-13(2P) DSC-14(2P)	---	MIN-8(2T) MIN-9(2P)	---	OE-4(2T) OE-5(2P)		AEC-4(2T) (MIL)	CC-4(2T) ۞ FP(2)	22	
	Cum. Cr.	**12**	**---**	**10**	**---**	**4**	**6**	**4**	**8**	**44**	
	Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major & Minor.										

***** Student must choose one subject as a Major subject out of M-1, M-2 and M-3 that he/she has chosen at First year

#Student must choose one subject as a Minor subject out of M-1, M-2 and M-3 that he/she has chosen at First year (Minor must be other than Major)

۞ OJT/Internship/CEP should be completed in the summer vacation after 4th semester

T.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1) Major		Subject-II (M-2) Minor	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	Elective (DSE)	(MIN)							
3 (5.5)	V	DSC-15(2T) DSC-16(2T) DSC-17(2T) DSC-18(2P) DSC-19(2P)	DSE-1A/B (2T) DSE-2A/B (2P)	---	---	---	VSC-1(2T) VSC-2(2P)	---	OJT/Int (4)	22	UG Degree
	VI	DSC-20(2T) DSC-21(2T) DSC-22(2T) DSC-23(2T) DSC-24(2T) IKS DSC-25(2P) DSC-26(2P)	DSE-3A/B (2T) DSE-4A/B (2P)	---	---	---	VSC-3(2T) VSC-4(2P)	---	---	22	
	Cum. Cr.	**24**	**8**	---	---	---	**8**	---	**4**	**44**	
	Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										

Fourth Year B.Sc. (Honours)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-27(4T) DSC-28(4T) DSC-29(4T) DSC-30(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	---	22	UG Honours Degree
	VIII	DSC-31(4T) DSC-32(4T) DSC-33(4T) DSC-34(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	OJT/Int (4)	22	
	Cum. Cr.	**28**	**8**	**4**	---	---	---	**4**	**44**	
Four Year UG Honors Degree in Major and Minor with 176 credits										

Fourth Year B.Sc. (Honours with Research)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-27(4T) DSC-28(4T) DSC-30(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	RP(4)	22	UG Honours with Research Degree
	VIII	DSC-31(4T) DSC-32(4T) DSC-34(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	RP(8)	22	
	Cum. Cr.	**20**	**8**	**4**	---	---	---	**12**	**44**	
Four Year UG Honours with Research Degree in Major and Minor with 176 credits										

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **OE/GE**- Open/Generic elective, **VSC**- Vocational Skill Course, **SEC**- Skill Enhancement Course, **VSEC**- Vocation and Skill Enhancement Course, **AEC**- Ability Enhancement Course, **IKS**- Indian Knowledge System, **VEC**- Value Education Course, **T**- Theory, **P**- Practical,**CC**-Co-curricular **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project, **CEP**- Community Extension Programme, **ENG**- English, **CI**- Constitution of India, **MIL**- Modern Indian Laguage

- Number in bracket indicate credit
- The courses which do not have practical 'P' will be treated as theory 'T'
- If student select subject other than faculty in the subjects M-1, M-2 and M-3, then that subject will be treated as Minor subject, and cannot be selected as Major at second year.

Details of S.Y. B.Sc. (Statistics)

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
Semester III, Level – 5.0											
DSC-7	DSC	STA-DSC-231	Probability Distributions-I	2	2	---	2	20	---	30	---
DSC-8	DSC	STA-DSC-232	Statistical Methods-I	2	2	---	2	20	---	30	---
DSC-9	DSC	STA-DSC-233	Statistics Practical-III	2	---	4	4	---	20	---	30
DSC-10	DSC	STA-DSC-234	Statistics Practical-IV	2	---	4	4	---	20	---	30
MIN-5	MIN	STA-MIN-231	R Programming	2	2	---	2	20	---	30	---
MIN-6	MIN	STA-MIN-232	Mathematical Statistics	2	2	---	2	20	---	30	---
MIN-7	MIN	STA-MIN-233	Practical on STA-MIN-231 & 232	2	---	4	4	---	20	---	30
OE-3	OE	STA-OE-231	Applied Statistics	2	2	---	2	20	---	30	---
CEP	CEP	STA-CEP-231	Community Engagement Program	2	---	4	4	50	---	---	---
Semester IV, Level – 5.0											
DSC-11	DSC	STA-DSC-241	Probability Distributions-II	2	2	---	2	20	---	30	---
DSC-12	DSC	STA-DSC-242	Statistical Methods-II	2	2	---	2	20	---	30	---
DSC-13	DSC	STA-DSC-243	Statistics Practical-V	2	---	4	4	---	20	---	30
DSC-14	DSC	STA-DSC-244	Statistics Practical-VI	2	---	4	4	---	20	---	30
MIN-8	MIN	STA-MIN-241	Applied Statistics	2	2	---	2	20	---	30	---
MIN-9	MIN	STA-MIN-242	Practical on STA-MIN-241	2	---	4	4	---	20	---	30
OE-4	OE	STA-OE-241	Data Analysis Using SPSS	2	2	---	2	20	---	30	---
OE-5	OE	STA-OE-242	Practical on Applied Statistics	2	---	4	4	---	20	---	30
FP	FP	STA-FP-241	Field Project	2	---	4	4	50	---	---	---

Examination Pattern

Theory Question Paper Pattern:

- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions: Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. The tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
    - Q 2 and Q3 Attempt any 3 out of 4 sub-question; each 4 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation

x. Any other academic activity

xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- Practical examination shall be conducted for 2 consecutive days for 2 hr/ day where incubation conditionis required.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.
- External practical examination of SEC will be of 25 marks and there will be no internal exam for SEC practical.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

SEMESTER-III

S.Y. B.Sc. Statistics (Major)
Semester III
STA-DSC-231: Probability Distributions-I

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce general univariate continuous probability distributions. • To introduce some standard univariate distributions. • To know moment generating function, cumulant generating functions with utility.	
Course outcomes	Students will be able to • Apply geometric and normal probability distribution in real life situations. • Identify discrete and continuous distribution. • Understand underlying assumptions for common probability distributions. • Make transformation of random variables.	
Unit	**Contents**	**Hours**
Unit I	**Geometric distribution** • Probability mass function of the form $P(X=x) = \begin{cases} pq^{x-1} \\ 0 \end{cases}$ x= 1,2,3; 0<p<1, q = 1-p • Recurrence relation for probabilities. • Real life situations. • Distribution function. • Mean, variance, mgf, cgf, pgf and hence moments. • Geometric distribution as a waiting time distribution. • Lack of memory property. • Examples and problems.	5
Unit II	**Univariate continuous probability distributions** • Definition of continuous sample space, continuous random variable (r. v.), functions of continuous r. v., probability density function (pdf), distribution function, statement of properties of distribution function. • Expectation of a random variable, expectation of a function of a r. v. • Moments, raw and central moments, evaluation of mgf, cgf. • Mode, median and quartiles. • Transformation of variables, statement of theorem, pdf of simple monotone functions and pdf of only $Y = X^2$ • Examples and problems.	7
Unit III	**Normal distribution** • Normal distribution: pdf	9

	$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma} \right)^2 \right) \quad -\infty < x, \mu < \infty, \sigma > 0$$ Notation: $X \sim N(\mu, \sigma^2)$ • Identification of parameters μ and σ^2, nature of probability curve, symmetry of the distribution, point of inflexion. Standard normal distribution. • Definition of gamma function and different forms of gamma function. • Mean, median, mode and variance. • Mgf, cgf, moments, recurrence relation for central moments, cumulants, $\beta_1, \beta_2, \gamma_1, \gamma_2$ • Real life situations. • Additive property, computation of probabilities using normal probability tables. • Normal approximation to binomial and Poisson, distribution of of X^2 where, $X \sim N(0,1)$. • Examples and problems.	
Unit IV	**Exponential and gamma distribution** • Pdf of exponential distribution $$f(x) = \begin{cases} \frac{1}{\theta} \exp\left(-\frac{x}{\theta} \right), & x \geq 0, \theta > 0 \\ 0 & otherwise \end{cases}$$ • Identification of the parameter, nature of the probability curve. • Moments, mgf, cgf, distribution function, median, quartiles. • Lack of memory property of exponential distribution. • Pdf of gamma distribution $$f(x) = \frac{\alpha^\lambda}{\Gamma\lambda} x^{\lambda-1} e^{-\alpha x} \qquad x > 0, \qquad 0 < \alpha, \lambda < \infty$$ Notation: X ~G (α , λ) • Nature of the probability curve. Special cases when (i)α = 1 (ii) λ = 1 • Mgf, cgf, moments, cumulants, mode, γ_1 and γ_2, • Distribution of the sum of n i. i. d. exponential variates, • Additive property of gamma distribution • Examples and problems. .	9
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Rohatgi V. K. (1976). An Introduction to Probability theory and Mathematical Statistics. John Wiley and Sons, New York. • Hogg. R. V., M. McKean J. W. and Craig. A. J. (2019). Introduction	

	to Mathematical Statistics. Pearson Education, Inc. • Weatherburn C. E. (1968). A first course in Mathematical Statistics. Cambridge University Press. • Kulkarni M.B. and Ghatpande S.B. (2007). Introduction to Discrete Probability and Probability Distributions. SIPF Academy. Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

Semester III
STA-DSC-232: Statistical Methods-I

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce multiple linear regression model. • To introduce introductory part of time series. • To present introductory part of statistical process control.	
Course outcomes	Students will be able to • Understand multiple linear regression models and its utility in real life situations. • Apply time series models in real life situations. • Understand chance causes of variation and assignable causes of variation. • Apply statistical process control techniques in real life situations.	
Unit	**Contents**	**Hours**
Unit I	**Multiple Linear Regression Model** • Definition of multiple correlation coefficient $R_{Y.X_1X_2}$. Derivation of the expression for the multiple correlation coefficient. Properties of multiple correlation coefficient i) $0 \le R_{Y.X_1X_2} \le 1$, ii) $R_{Y.X_1X_2} \ge \min\left(r_{YX_1}, r_{YX_2}\right)$. • Interpretation of coefficient of multiple determination $R^2_{Y.X_1X_2}$ as i) proportion of variation explained by the linear regression ii) $R^2_{Y.X_1X_2} = 1$, iii) $R^2_{Y.X_1X_2} = 0$. • Definition of partial correlation coefficient $r_{YX_1.X_2}$ and $r_{YX_2.X_1}$. • Notion of multiple linear regression, Yule's notation (trivariate case). • Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$, by the method of least squares; obtaining normal equations, solutions of normal equations. • Residuals: Definition, order, derivation of variance, properties. • Definition and interpretation of partial regression coefficients $b_{YX_1.X_2}$ and $b_{YX_2.X_1}$. • Properties of partial correlation coefficient: i) $-1 \le r_{YX_1.X_2} \le 1$ and $-1 \le r_{YX_2.X_1} \le 1$, ii) $b_{YX_1.X_2} b_{YX_2.X_1} = r^2_{YX_1.X_2}$ • Examples and problems.	8
Unit II	**Time Series** • Introduction: meaning and usefulness. • Components: Secular trend, seasonal variations. Cyclical variations, Irregular Variations • Additive and multiplicative models. • Measurement of trend, Moving average method, Least square	8

	method. • Measurement of seasonal variations, method of simple average, ratio to trend method, ratio to moving average method. • Examples and problems.	
Unit III	**Basics of Statistical Process Control** • Introduction: Meaning and purpose of Statistical Process Control, quality of a product, need of quality control, chance and assignable causes of variation. • Control chart: Statistical basis of control chart, 3σ limits, justification of 3σ limits and criteria for detecting lack of control. • Control charts for variables: Preliminary decisions, construction of control chart for the mean and range when (i) standards are given and (ii) no standard given. Revised control limits, interpretation from the charts and determination of process mean and standard deviation from the charts. Application of control charts. • Examples and problems.	8
Unit IV	**Control Charts for Attributes** • Control chart for fraction defective (p-chart for fixed sample size): Preliminary decisions, construction of control chart when (i) standards are given and (ii) no standard given. Revised control limits, interpretation from the chart and standardized control chart for variable sample size. • Control chart for number of defects per unit: Preliminary decisions, construction of control chart when (i) standards are given and (ii) no standard given. Revised control limits, interpretation from the charts and applications of control chart. • Examples and problems.	6
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Montgomery D.C. (2013). Introduction to Statistical Quality Control. John Wiley and Sons. • Snedecor G.W and Cochran W.G. (1991). Statistical Methods. Wiley • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning. • Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

Semester III
STA-DSC-233: Statistics Practical-III

Total Hours: 60 **Credits: 2**

General Instructions	• All practicals must be carried out by using computers based on R software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. • The total duration of external practical examination shall be 3(three) hours.
Course Objectives	• To become familiar with using R for statistical analysis. • To introduce applications and model sampling of learned distributions. • To develop skills of statistical computations.
Course Outcomes	Students will be able to • To apply Geometric and Normal distribution in the real life situations. • To obtain model sample from geometric and Normal distribution. • To fit regression equation, to compute and interpret multiple and partial correlation coefficient. • To construct and interpret control charts for quality control purposes.

Unit	Contents	Hours
1	Model sampling and applications of geometric distribution	4
2	Fitting of geometric distribution	4
3	Multiple linear regression	4
4	Multiple and Partial Correlation coefficient	4
5	Univariate probability distribution	4
6	Measurement of trend	4
7	Measurement of Seasonal Variations-I	4
8	Measurement of Seasonal Variations-II	4
9	Model sampling and applications of normal distribution	4
10	Fitting of normal distribution	4
11	X bar and R chart	4
12	Model sampling and applications of exponential distribution	4
13	p chart and c chart	4
14	Real Life Data Analysis-I	4
15	Real Life Data Analysis-II	4

Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning • Purohit S.G., Gore S.D. and Deshmukh S.R. (2008). Statistics Using R. Narosa Pub. • Peter Dalgaard. (2002). Statistics and computing: Introductory Statistics with R. Springer • Gardener, M. (2012). Beginning R: The Statistical Programming Language. Wiley & Sons • Acharya, S. (2018). Data Analytics using R. McGraw Hill Education.	

Semester III
STA-DSC-234: Statistics Practical-IV

Total Hours: 60 **Credits: 2**

General Instructions	• All practicals must be carried out by using computers based on SPSS software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. The total duration of external practical examination shall be 3(three) hours.
Course Objectives	• To make student aware about introduction to SPSS software. • To explain computations of descriptive statistics using SPSS software. • To introduce statistical testing to solve real life problems using SPSS software.
Course Outcomes	Students will be able to • Apply SPSS software to compute descriptive statistics. • To fit regression equation, to compute and interpret multiple and partial correlation coefficient. • To construct and interpret control charts for quality control purposes. • Write SPSS commands to analyze data.

Unit	Contents	Hours
1	Introduction to SPSS software-I.	4
2	Introduction to SPSS software-II.	4
3	Data import and Export from MS-Excel.	4
4	Data objects and built in functions used in SPSS.	4
5	Diagrammatic representation of data.	4
6	Graphical representation of data.	4
7	Measures of central tendency.	4
8	Measures of dispersion.	4
9	Measures of correlation.	4
10	Simple linear regression.	4
11	Multiple linear regression.	4
12	Control chart.	4
13	Performing computations with syntax window.	4
14	Real Life Data Analysis using SPSS-I	4

15	Real Life Data Analysis using SPSS-II	4
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • A. Rajathi and Chandran (2006). SPSS for you, MJP Publishers • K. Pandya, Smruti Bulsari, Sanjay Sinha (2011). SPSS in Simple Steps, Dreamtech Press • Robert H. Carver and Jane Gradwohl Nash (2011). Doing Data Analysis with SPSS, Cengage Learning.	

Semester III
STA-MIN-231: R Programming

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce R software. • To focus on developing programming skills using R. • To familiarize with R graphics.	
Course outcomes	Students will be able to • Understand how to download and install R software. • Know various R packages with their utility. • Understand data structures in R. • Use R software for statistical computations.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to R** • Downloading and installation of R • Features of R, to start R and exit from R, Introduction to R screen. • Meaning of package, base (standard package) package, to install a package, to load a package, to delete a package, learning about a package, getting help. • Meaning of workspace, saving a workspace, loading a workspace, deleting a workspace. • Data Types (Modes) in R: numeric, character, logical. • Meaning of object, function. Types of function: built-in function and user defined function, Naming an object. • Data objects, Types of data object: scalar, vector, factor, data frame, list, array, matrix • Functions for working with objects: mode ( ), length( ), cbind( ), rbind( ), names( ), ls( ), rm( ) • Types of operators: arithmetic operators, relational operators, logical operators. • Expression: arithmetic expression, relational expression, logical expression. • Precedence rule of arithmetic operators and logical operators.	8
Unit II	**Working with data objects and using functions** • Vectors: creating a vector, modifying a vector, deleting a vector. • Working with vectors: the functions to be discussed-c( ), rep( ), rev( ), sort( ), diff( ), max( ),min( ), colon operator(:), seq( ), scan( ), cut( ), cat( ), table( ), which( ), unique( ), . • Mathematical functions: abs( ), sqrt( ), log( ), log10( ), exp( ), sin( ), cos( ), tan( ), atan( ),round( ). • Meaning of data frame, creation of data frame, modifying a data frame, deleting dataframe, extracting elements from a data frame, use of $ sign. Functions to be discussed: subset( ), transform( ),	8

	attach( ), detach( ), with( ), data.entry( ), edit( ), is.data.frame( ), as.data.frame( ).	
Unit III	**Graphics** • Low level and high level functions. • Functions to be discussed: plot( ), lines( ), points( ), smooth.spline( ), curve( ), barplot( ), pie( ), hist( ), mtext( ), legend( ).	6
Unit IV	**Statistical applications** • Diagrams and Graphs: Bar Chart (Subdivided, multiple), Pie diagram, Stem and Leaf diagram • Histogram (equal as well as unequal class intervals), Ogive curve, Frequency polygon superimposed. • Measures of Central Tendency: Mean, Mode, Median, G.M., H.M., Partition values: Quartiles, Deciles, Percentiles. • Measures of Dispersion, Range, M. D. about Mean, Mode, Median, S.D., Variance and C.V.	8
Study Resources	• Purohit S.G., Gore S.D. and Deshmukh S.R. (2008): Statistics Using R., Narosa Pub. • Peter Dalgaard. (2002). Statistics and computing: Introductory Statistics with R, Springer. • Maindonald, J. and Braum, J. (2007). Data Analysis and Graphics Using R: An example-based approach (2nd Ed. Cambridge Series in Statistical and Probabilistic Mathematics) • Hey-Jahans, C. (2012). An R Companion to Linear Statistical Models. CRC Press. • Gardener, M. (2012). Beginning R: The Statistical Programming Language Wiley & Sons. • Acharya, S. (2018). Data Analytics using R. McGraw Hill Education. • Wickham, H. and Grolemund, G. (2017). R for Data Science. O'Reilly Media. • Lander, J.P. (2017). R for Everyone: Advanced Analytics and Graphics. Addison-Wesley Professional. • Kabacoff, R.I. (2015). R in Action: Data Analysis and Graphics with R. (2nd Ed. Manning Publications)	

S.Y. B.Sc. Statistics (Minor)
Semester III
STA-MIN-232: Mathematical Statistics

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce general univariate continuous probability distributions. • To acquaint some standard univariate distributions. • To explain testing of hypothesis. • To familiarize large sample tests.	
Course outcomes	Students will be able to • Apply normal probability distribution in real life situations. • Construct null hypothesis and alternative hypothesis. • Understand types of errors in testing of hypothesis. • Apply large sample tests in real life situations.	
Unit	**Contents**	**Hours**
Unit I	**Univariate continuous probability distributions** • Definition of continuous sample space, continuous random variable (r. v.), functions of continuous r. v., probability density function (pdf), distribution function, statement of properties of distribution function. • Expectation of a random variable, expectation of a function of a r. v. • Moments, raw and central moments, evaluation of mgf, cgf. • Mode, median and quartiles. • Transformation of variables, statement of theorem, pdf of simple monotone functions and pdf of $Y = X^2$ only. • Examples and problems.	7
Unit II	**Normal distribution** • Normal distribution: pdf $f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma} \right)^2 \right) \quad -\infty < x, \mu < \infty, \sigma > 0$ Notation: $X \sim N(\mu, \sigma^2)$ • Identification of parameters μ and σ^2, nature of probability curve, symmetry of the distribution, point of inflexion. Standard normal distribution. • Definition of gamma function and different forms of gamma function. • Mean, median, mode and variance. • Mgf, cgf, moments, recurrence relation for central moments, cumulants, $\beta_1, \beta_2, \gamma_1, \gamma_2$ • Real life situations. • Additive property, computation of probabilities using normal probability tables. • Normal approximation to binomial and Poisson, distribution of of X^2	9

	where, $X \sim N(0,1)$. • Examples and problems.	
Unit III	**Testing of Hypothesis** • Introduction • Notation of hypothesis, statistical hypothesis, null hypothesis, alternative hypothesis • Two types of errors, critical region, critical value, level of significance • Test of hypothesis, one tailed and two tailed tests, general procedure of testing of hypothesis • Discussion on examples based on determination of types of error, critical region for given test • Concept of *p-value.*	6
Unit IV	**Large Sample Tests** • $H_0 : \mu = \mu_0$ verses a) $H_1 : \mu \neq \mu_0$ b) $H_1 : \mu < \mu_0$ c) $H_1 : \mu > \mu_0$ • $H_0 : \mu_1 = \mu_2$ verses a) $H_1 : \mu_1 \neq \mu_2$ b) $H_1 : \mu_1 < \mu_2$ c) $H_1 : \mu_1 > \mu_2$ • $H_0 : P = P_0$ verses a) $H_1 : P \neq P_0$ b) $H_1 : P < P_0$ c) $H_1 : P > P_0$ • $H_0 : P_1 = P_2$ verses a) $H_1 : P_1 \neq P_2$ b) $H_1 : P_1 < P_2$ c) $H_1 : P_1 > P_2$ • $H_0 : \rho = \rho_0$ verses a) $H_1 : \rho \neq \rho_0$ b) $H_1 : \rho > \rho_0$ c) $H_1 : \rho < \rho_0$ • $H_0 : \rho_1 = \rho_2$ verses a) $H_1 : \rho_1 \neq \rho_2$ b) $H_1 : \rho_1 > \rho_2$ c) $H_1 : \rho_1 < \rho_2$ • Examples and problems.	8
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Rohatgi V. K. (1976). An Introduction to Probability theory and Mathematical Statistics. John Wiley and Sons, New York. • Hogg. R. V., M. McKean J. W. and Craig. A. J. (2019). Introduction to Mathematical Statistics. Pearson Education, Inc. • Snedecor G.W and Cochran W.G., Statistical Methods. • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

S.Y. B.Sc. Statistics (Minor)
Semester III
STA-MIN-233: Practical on STA-MIN-231 & 232

Total Hours: 60 **Credits: 2**

General Instructions	• All practicals must be carried out by using computers based on R software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. • The total duration of external practical examination shall be 3(three) hours.	
Course Objectives	• To make students aware about data objects and built-in functions in R. • To illustrate approach to represent data using R. • To apply Normal distribution in the real life situations. • To develop statistical testing problem solving skills.	
Course Outcomes	After successful completion of this course, students are expected to: • Understand how to import and export data in R • Use R software for statistical computations. • Use R software for exploratory data analysis. • To apply large sample test in the real life situations.	
Unit	**Contents**	**Hours**
1	Introduction to R software	4
2	Data import and Export	4
3	Data objects and built in functions used in R	4
4	Diagrammatic representation of data	4
5	Graphical representation of data	4
6	Computations of measures of central tendency	4
7	Computations of measures of dispersion	4
8	Univariate continuous probability distribution	4
9	Model sampling and applications of normal distribution	4
10	Fitting of normal distribution	4
11	Large sample test-I	4
12	Large sample test-II	4
13	Large sample test -III	4
14	Real life data analysis-I	4

15	Real life data analysis-II	4
Study Resources	• Purohit S.G., Gore S.D. and Deshmukh S.R. (2008). Statistics Using R. Narosa Pub. • Peter Dalgaard. (2002). Statistics and computing: Introductory Statistics with R. Springer • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi.	

S.Y. B.Sc. Statistics (Open Elective)
Semester III
STA-OE-231:Applied Statistics

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce sample survey and sampling methods. • To introduce introductory part of time series. • To develop understanding of theory of attributes.	
Course outcomes	Students will be able to • Apply sample survey in real life situation. • Obtain simple random sample with replacement and without replacement. • Use time series models in real life situations. • Apply theory of attributes in real life situation.	
Unit	**Contents**	**Hours**
Unit I	**Sample Survey** • Concept of distinguishable elementary units, sampling units, sampling frame. • Objectives of a sample survey. • Designing questionnaire, characteristics of good questionnaire. • Planning, execution and analysis of a sample survey. Practical problems in planning, execution and analysis of a sample survey. • Sampling and non-sampling errors with illustrations. • Study of some surveys illustrating the above ideas.	6
Unit II	**Sampling** • Population, finite population, infinite population, statistical population, homogeneous population and heterogeneous population. • Census method and Limitations of census method. • Definitions of population mean, population total and population variance. • Sampling and objectives of sampling. • Simple random sampling with replacement (SRSWR) and simple random sampling without replacement (SRSWOR) with real life situations. • Notion of sample and random sample. Definition of sample mean, sample variance, sample standard deviation • Discussion on estimation of population mean and population variance usung random sample. • Stratified random sampling with real life situations. • Difference between SRSWR and SRSWOR • Difference between SRSWOR and stratified sampling	8
Unit III	**Time Series** • Introduction: meaning and usefulness. • Components: Secular trend, seasonal variations. cyclical variations, irregular variations • Additive and multiplicative models.	8

	• Measurement of trend, Moving average method, Least square method. • Measurement of seasonal variations, method of simple average, ratio to trend method, ratio to moving average method. • Examples and problems.	
Unit IV	**Theory of Attributes** • Concept of attribute, dichotomy, manifold classification, Notations. • Class frequency, order of class, positive class frequency, negative class frequency, contra class frequency, ultimate class frequency • Relation between class frequencies • Method of dot operator to express any class frequency in terms of positive class frequencies. • Fundamental set of class frequencies: Definition, determination whether a set of frequencies is fundamental set of or not (two attributes). • Independence and association of two attributes • Yule's coefficient of association (Q) and its interpretation. • Properties of $Q(-1 \leq Q \leq 1)$ and interpretation of (Q). • Examples and problems. **NOTE:** DERIVATIONS ARE NOT EXPECTED.	8
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Medhi J. (2009). Statistical Methods. New Age International Publishers, New Delhi. • Agarwal, B. L. (2017). Programmed Statistics, Third Edition, New Age International Publishers, New Delhi.	

S.Y. B.Sc. Statistics (Major)
Semester III
STA-CEP-231: Community Engagement Program

Total Hours: 30 **Credits: 2**

Course objectives	• To develop an appreciation of rural culture, lifestyle and wisdom amongst students. • To learn about the status of various agricultural and development programmes. • To understand the causes of distress and poverty faced by vulnerable households and explore solutions for the same. • To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.	
Course outcomes	Students will be able to • Gain an understanding of rural life, Indian culture and ethos and social realities. • Develop a sense of empathy and bonds of mutuality with the local community. • Appreciate significant contributions of local communities to Indian society and economy. • Identify opportunities for contributing to community's socio-economic improvements.	
Unit	**Contents**	**Hours***
Unit I	**Appreciation of Rural Society** • Rural lifestyle, rural society, caste and gender relations. • Rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages" (Gandhi), rural infrastructure.	6
Unit II	**Understanding rural and local economy and livelihood** • Agriculture, farming, land ownership, water management, animal husbandry. • Non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labor.	8
Unit III	**Rural and local Institutions** • Traditional rural and community organizations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees). • Nagarpalikas and municipalities, local civil society, local administration.	8
Unit IV	**Rural and National Development Programmes** • History of rural development and current national programmes in India: Sarva Shiksha Abhiyan, Beti Bachoo, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM Awaas Yojana, Skill India, Gram Panchayat Decentralized Planning, National Rural livelihood Mission (NRLM). • Mahatma Gandhi National Rural Employment Guarantee Act 2005	8

	(MGNREGA), SHRAM, Jal Jeevan Mission, Scheme of Fund for Regeneration of Traditional Industries (SFURTI), Atma Nirbhar Bharat, etc.	
Some Recommended field based practical activities	• Interaction with Self Help Groups (SHGs) women members, and study their functions and challenges; planning for their skill-building and livelihood activities • Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures • Visit Mahatma Gandhi National, Rural Employment Guarantee Act 2005 (MGNREGS) project sites, interact with beneficiaries and interview functionaries at the work site • Conduct Mission Antyodaya survey to support under Gram Panchayat Development Plan (GPDP) Teaching Methods: One credit theory and one credit field work. Reading and classroom discussions, Community dialogues, Oral History, Social and institutional mapping, interactions with elected Panchayat Leaders and government functionaries, observation of Gram Sabha, Field visit to various village institutions. * Fifty percentage classroom discussion and fifty percentage field visits.	

Assessment:

1) Readings from related literatures including e-content and reflections from field visits should be maintained by each student in the form of Field Diary (20 Marks),
2) Submission of assignments based on units (1-4) (20 Marks) and
3)Oral/Group discussion/Presentation (10 Marks)

SEMESTER-IV

S.Y. B.Sc. Statistics (Major)
Semester IV
STA-DSC-241: Probability Distributions-II

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce general bivariate continuous probability distributions. • To introduce beta distribution of first and second kind. • To present basic sampling distributions.	
Course outcomes	Students will be able to • Understand the fundamentals of bivariate continuous distributions. • Obtain mean, median, mode, mgf etc of beta, chi-square, t and F distributions. • Apply sampling distributions chi-square, t and F in real life situations. • Derive probability density functions of chi-square, t and F distributions.	
Unit	**Contents**	**Hours**
Unit I	**Bivariate Continuous Probability Distribution** • Joint *pdf*, evaluation of probability of region bounded by straight line. • Marginal and conditional probability distribution. • Expectation of $g(X,Y)$, moments of bivariate distribution, conditional expectation, regression as a conditional expectation, correlation coefficient. • Probability distribution of function of bivariate random variable using jacobian of transformation. • Independence of two r. v. s, statements of extension to n(>2) r. v. s, • Theorem on expectation 1) $\mathrm{E}(X \pm Y) = E(X) \pm E(Y)$ and 2) $E(XY) = E(X)E(Y)$, if X and Y independent variables. • Statements of extensions of above theorems to n variables. • Examples and problems.	6
Unit II	**Beta Distribution (of first and second kind)** • The *pdf* of beta distribution of first kind $$f(x) = \begin{cases} \dfrac{x^{m-1}(1-x)^{n-1}}{B(m,n)} & 0 < x < 1, m, n > 0 \\ 0 & otherwise \end{cases}$$ Notation: $X \sim B_1(m,n)$ • The *pdf* of Beta distribution of second kind $$f(x) = \begin{cases} \dfrac{1}{B(m,n)} \dfrac{x^{m-1}}{(1+x)^{m+n}} & 0 < x < \infty, m, n > 0 \end{cases}$$ Notation: $X \sim B_2(m,n)$	6

	• Definition of beta functions and its various forms. Relation between gamma function and beta function (statement only) • Relation between two kinds of variates • Mean, variance, mode, the r^{th} raw moment • Harmonic mean for both kind • Examples and Problems.	
Unit III	**Chi-Square (χ^2) Distribution** • Definition of χ^2 variate as sum of squares of n independent and identically distributed (i.i.d) standard normal variates. • Derivation of *pdf* of χ^2 with n degrees of freedom (using *mgf*) • Nature of probability curve. • Use of χ^2 tables for calculation of the probabilities. • Mean, variance, mode, moments, γ_1, γ_2 ,*mgf*, cgf. • Normal approximations: $\left(\chi_n^2 - n\right)/\sqrt{2n}$. • Fisher's normal approximations of chi square distribution. • Additive property of χ^2 distribution. • Examples and problems.	6
Unit IV	**t-Distribution and F- Distribution** • Definition of 't' statistic with n d.f. in the form $t = \frac{U\sqrt{n}}{\sqrt{\chi_n^2}}$ where $U \sim N(0,1)$ and $\chi_n^2 \sim \chi^2$ variate with n. d. f., U and χ_n^2 are independent variates. • Derivation of *pdf* of t variates. • Nature of probability curve. • Mean, variance and moments. • Statement of normal approximation to t – distribution. • Use of t probability tables for calculations of probabilities. • Definition of statistic F with n_1 and n_2 degrees of freedom as $F_{n_1,n_2} = \frac{\chi_1^2 / n_1}{\chi_2^2 / n_2}$ where χ_1^2 and χ_2^2 are independent chi-square variates with n_1 and n_2 degrees of freedom respectively. • Reciprocal property of F distribution • Derivation of *pdf* of F variate • Nature of probability curve. • Mean, Variance, Moments and Mode • Interrelations among normal, χ^2, *t* and *F* distributions. • Use of F tables for calculations of probabilities • Examples and problems.	12

Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics, S. Chand and Sons. • Rohatgi V. K. (1976). An Introduction to Probability theory and Mathematical Statistics, John Wiley and Sons. • Hogg. R. V., M. McKean J. W. and Craig. A. J. (2019). Introduction to Mathematical Statistics, 5th Ed. Pearsons Education. • Johnson N. L., Kotz. S. and Balakrishnan. (1994). Continuous Univariate Distributions Vol. I. Wiley-Interscience. • Weatherburn C. E. (1968). A first course in Mathematical Statistics. Cambridge University Press. Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

S.Y. B.Sc. Statistics (Major)
Semester IV
STA-DSC-242: Statistical Methods-II

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce statistic and its distribution. • To introduce testing of hypothesis. • To introduce large sample test and ANOVA.	
Course outcomes	Students will be able to • Understand concept of statistic, estimator and sampling distributions. • Construct null hypothesis and alternative hypothesis. • Apply large sample tests in real life situations. • Perform one way and two way ANOVA.	
Unit	**Contents**	**Hours**
Unit I	**Sampling distributions** • Random sample from a continuous distribution as iid r.vs $X_1, X_2, ...X_n$ • Concept of a statistic, estimator. • Sampling distribution of statistic $T(X_1, X_2, ...X_n)$. • Distribution of sample mean of samples drawn from normal, exponential and gamma distributions. • Statement of central limit theorem with applications related to sampling distributions and testing of hypotheses. • Joint distribution of $\bar{X}$ and $(n-1)S^2 = \sum_{i=1}^{n}(X_i - \bar{X})^2$ for a sample from normal population using orthogonal transformation. • Examples and problems.	5
Unit II	**Testing of Hypothesis** • Introduction • Notation of hypothesis, statistical hypothesis, null hypothesis, alternative hypothesis • Two types of errors, critical region, critical value, level of significance • Test of hypothesis, one tailed and two tailed tests, general procedure of testing of hypothesis • Discussion on examples based on determination of types of error, critical region for given test • Concept of *p-value*	5
Unit III	**Large Sample Tests (Tests based on normal distribution)** • $H_0 : \mu = \mu_0$ verses a) $H_1 : \mu \neq \mu_0$ b) $H_1 : \mu < \mu_0$ c) $H_1 : \mu > \mu_0$ • $H_0 : \mu_1 = \mu_2$ verses a) $H_1 : \mu_1 \neq \mu_2$ b) $H_1 : \mu_1 < \mu_2$ c) $H_1 : \mu_1 > \mu_2$	8

	• $H_0 : P = P_0$ verses a) $H_1 : P \neq P_0$ b) $H_1 : P < P_0$ c) $H_1 : P > P_0$ • $H_0 : P_1 = P_2$ verses a) $H_1 : P_1 \neq P_2$ b) $H_1 : P_1 < P_2$ c) $H_1 : P_1 > P_2$ • $H_0 : \rho = \rho_0$ verses a) $H_1 : \rho \neq \rho_0$ b) $H_1 : \rho > \rho_0$ c) $H_1 : \rho < \rho_0$ • $H_0 : \rho_1 = \rho_2$ verses a) $H_1 : \rho_1 \neq \rho_2$ b) $H_1 : \rho_1 > \rho_2$ c) $H_1 : \rho_1 < \rho_2$ • Examples and problems	
Unit IV	**Analysis of variance** • Concept of analysis of variance, chance and assignable causes of variation. • Model for one way classified data. Assumption and interpretation. • Model for two way classified data. Assumption and interpretation. • Concept of resolution of total sum of squares into components for one way and two way models. • Analysis of one way model: Estimation of parameters, expected values of mean sum of squares hypothesis and its interpretation. Preparation of Analysis of variance table. • Analysis of two way model: Estimation of parameters, expected values of mean sum of squares hypothesis and its interpretation. Preparation of Analysis of variance table. • Examples and problems. **NOTE:** DERIVATIONS ARE NOT EXPECTED.	12
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Montgomery D.C. (2013). Introduction to Statistical Quality Control. John Wiley and Sons. • Snedecor G.W and Cochran W.G. (1991). Statistical Methods. Wiley • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning. Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

S.Y. B.Sc. Statistics (Major)
Semester IV
STA-DSC-243: Statistics Practical-V

Total Hours: 60 **Credits: 2**

General Instructions	• All practicals must be carried out by using computers based on R software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. • The total duration of external practical examination shall be 3(three) hours.
Course Objectives	• To introduce built-in functions regarding to sampling distributions. • To introduce statistical testing problems and data analysis. • To develop statistical problem solving skills.
Course Outcomes	Students will be able to • To understand sampling distribution of a statistic. • To apply large sample test in the real life situations. • Set up and perform one way and two way ANOVA. • Solve problems based on beta, chi-square, t and F distribution.

Unit	Contents	Hours
1	Sampling distribution	4
2	Large sample Test-I	4
3	Large sample Test-II	4
4	Large sample Test-III	4
5	Analysis of variance (one way)	4
6	Analysis of variance (two way)	4
7	Sketching of pdf and cdf of chi-square, t and F distribution	4
8	Computational problems based on beta distribution	4
9	Computational problems based on chi-square distribution	4
10	Computational problems based on t and F distribution	4
11	Applications of t distribution	4
12	Applications of chi square distribution	4
13	Applications of F distribution	4
14	Data analysis of collected data from real life situation-I	4
15	Data analysis of collected data from real life situation-II	4

Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Montgomery D.C. (2013). Introduction to Statistical Quality Control. John Wiley and Sons. • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning • Purohit S.G., Gore S.D. and Deshmukh S.R. (2008). Statistics Using R. Narosa Pub • Peter Dalgaard. (2002). Statistics and computing: Introductory Statistics with R. Springer • Gardener, M. (2012). Beginning R: The Statistical Programming Language. Wiley & Sons • Acharya, S. (2018). Data Analytics using R. McGraw Hill Education.	

S.Y. B.Sc. Statistics (Major)
Semester IV
STA-DSC-244: Statistics Practical-VI

Total Hours: 60 **Credits: 2**

General Instructions	• All practicals must be carried out by using computers based on MINITAB software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. • The total duration of external practical examination shall be 3(three) hours.
Course Objectives	• To make student aware about introduction to MINITAB. • To explain computation of descriptive statistics using MINITAB. • To develop statistical problem solving skills using MINITAB.
Course Outcomes	Students will be able to • Apply MINITAB software to compute descriptive statistics. • Obtain model sample from discrete and continous distribution. • Construct and interpret control charts for quality control purposes. • Set up and perform ANOVA.

Unit	Contents	Hours
1	Introduction to MINITAB -I	4
2	Introduction to MINITAB-II	4
3	Graphical representation of data	4
4	Descriptive Statistics-I	4
5	Descriptive Statistics-II	4
6	Model sampling from discrete distributions	4
7	Model sampling from continous distributions	4
8	Variable control charts	4
9	Attributes control charts	4
10	Time series-I	4
11	Time series-II	4
12	Performing an ANOVA	4
13	Identification of distribution	4
14	Real life data analysis-I	4
15	Real life data analysis-II	4

Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • MINITAB User's Guide 1.(2000). Data Graphics, and Macros. • MINITAB User's Guide 2. (2000). Data Analysis and Quality Tools. • MINITAB meet 15 manual for windows. • Akers, Michael D (2018), Exploring, Analysing and Interpreting Data with Minitab 18 (1st ed.), United Kingdom, Compass Publishing	

S.Y. B.Sc. Statistics (Minor)
Semester IV
STA-MIN-241: Applied Statistics

Total Hours: 30 **Credits: 2**

Course objectives	• To introduce multiple linear regression model. • To present introductory part of time series. • To familiarize index numbers and Demography.	
Course outcomes	Students will be able to • Understand multiple linear regression models and its utility in real life situations. • Apply time series models in real life situations. • Understand methods of construction of index numbers. • Understand measures of fertility and mortality.	
Unit	**Contents**	**Hours**
Unit I	**Multiple Linear Regression Model** • Definition of multiple correlation coefficient $R_{Y.X_1X_2}$. Derivation of the expression for the multiple correlation coefficient. Properties of multiple correlation coefficient i) $0 \le R_{Y.X_1X_2} \le 1$, ii) $R_{Y.X_1X_2} \ge \min(r_{YX_1}, r_{YX_2})$. • Interpretation of coefficient of multiple determination $R^2_{Y.X_1X_2}$ as i) proportion of variation explained by the linear regression ii) $R^2_{Y.X_1X_2} = 1$, iii) $R^2_{Y.X_1X_2} = 0$. • Definition of partial correlation coefficient $r_{YX_1.X_2}$ and $r_{YX_2.X_1}$. • Notion of multiple linear regression, Yule's notation (trivariate case). • Fitting of regression plane of Y on X_1 and X_2, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$, by the method of least squares; obtaining normal equations, solutions of normal equations. • Residuals: Definition, order, derivation of variance, properties. • Definition and interpretation of partial regression coefficients $b_{YX_1.X_2}$ and $b_{YX_2.X_1}$. • Properties of partial correlation coefficient: i) $-1 \le r_{YX_1.X_2} \le 1$ and $-1 \le r_{YX_2.X_1} \le 1$, ii) $b_{YX_1.X_2} b_{YX_2.X_1} = r^2_{YX_1.X_2}$ • Examples and problems.	6
Unit II	**Time Series** • Introduction: meaning and usefulness. • Components: Secular trend, seasonal variations. cyclical variations, irregular variations • Additive and multiplicative models. • Measurement of trend, Moving average method, least square method. • Measurement of seasonal variations, method of simple average, ratio to trend method, ratio to moving average method.	8

	• Examples and problems.	
Unit III	**Index number** • Meaning and utility of index number. • Limitations of index number. • Weighted and unweighted index number. • Types of index number: Laspeyres's, Passche's, Fisher, Value index number, wholesale Price index number, Industrial product index number. • Testing for Adequacy of all index number using time reversal test, factor reversal test, circular test. • Construction of consumer price index, steps to be followed in construction. Problems in construction, family-budget method, aggregate expenditure method. • Examples and Problems	8
Unit IV	**Demography** • Vital Statistics, uses, measurement of population. • 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 mortality rate. • Measures of fertility: Crude birth rate, specific rate (age and sex), total fertility rate, comparative study of these measures. • Reproduction rates: G.R.R., N.R.R., comparison and interpretation. • Simple numerical problems	8
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Gun, Gupta and Dasgupta. (2016). Fundamentals of Statistics Vol. II. World Press. • Parimal Mukhopadhyay. (2005). Applied Statistics. Books and Allied P Ltd, Kolkata. • Snedecor G.W and Cocharan W.G. (1991). Statistical Methods. Wiley • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning. Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

S.Y. B.Sc. Statistics (Minor)
Semester IV
STA-MIN-242: Practical on STA-MIN-241

Total Hours: 60 **Credits:2**

General Instructions	• All practicals must be carried out by using computers based on R software. Student must complete all the practicals to the satisfaction of concerned teacher. • Student must produce at the time of the practical examination, the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of department. • Students must be encouraged to collect live data from real life situations for practicals. • The total duration of external practical examination shall be 3(three) hours.
Course objectives	• To present multiple linear regression equation using R. • To explain computations of measures of trend and computations of seasonal indices using R. • To illustrate computations of index numbers using R • To introduce computations of measures of mortality and measures of fertility using R.
Course Outcomes	Students will be able to • Understand multiple linear regression models and its utility in real life situations. • Apply time series models in real life situations. • Understand methods of construction of index numbers. • Compute and interpret various types of death, birth and reproduction rates.

Sr. No.	Contents	Hours
1	Multiple linear regression	4
2	Multiple and Partial Correlation coefficient	4
3	Measurement of trend-I	4
4	Measurement of trend-II	4
5	Computations of Seasonal Indices-I	4
6	Computations of Seasonal Indices-II	4
7	Computations of index numbers-I	4
8	Constructions of index numbers-II	4
9	Application of time reversal and factor reversal test	4

10	Computations of crude death rates-I	4
11	Computations of crude death rates-II	4
12	Computations of measures of fertility	4
13	Computations of G.R.R. and N.R.R	4
14	Real life data analysis-I	4
15	Real life data analysis-II	4
Study Resources	• Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Mathematical Statistics. S. Chand and Sons, New Delhi. • Gupta S.C. and Kapoor V. K. (2017). Fundamentals of Applied Statistics. S. Chand and Sons, New Delhi. • Gun, Gupta and Dasgupta. (2016). Fundamentals of Statistics Vol. II. World Press. • Parimal Mukhopadhyay. (2005). Applied Statistics. Books and Allied P Ltd, Kolkata. • Snedecor G.W and Cocharan W.G. (1991). Statistical Methods. Wiley • Roxy Peck and Jay L. Devore. (2012). Statistics: The Exploration and Analysis of Data. Cengage Learning. • Purohit S.G., Gore S.D. and Deshmukh S.R. (2008). Statistics Using R. Narosa Pub • Peter Dalgaard. (2002). Statistics and computing: Introductory Statistics with R. Springer • Gardener, M. (2012). Beginning R: The Statistical Programming Language. Wiley & Sons • Acharya, S. (2018). Data Analytics using R. McGraw Hill Education. • Teaching Methods: Interactive lecture method, Problem solving method and ICT enabled teaching method.	

S.Y. B.Sc. Statistics (Open Elective)
Semester IV
STA-OE-241: Data Analysis Using SPSS

Total Hours: 30 **Credits: 2**

Course Objectives	▪ To make student aware about introduction to SPSS. ▪ To explain computations of descriptive statistics using SPSS. ▪ To describe construction of regression lines using SPSS.	
Course Outcomes	After successful completion of this course, students are expected to: ▪ Apply SPSS software to compute descriptive statistics. ▪ Construct charts and graphs using SPSS software. ▪ Apply SPSS software to compute correlation coefficient and fit regression equation. ▪ Write SPSS commands to analyze data.	
Unit	**Contents**	**Hours**
Unit I	**An Overview of SPSS** ▪ Introduction to SPSS ▪ Opening a Data File in SPSS ▪ SPSS Data Editor Variable View Data View Entering Data into the Data Editor Saving the Data File Statistical Analysis ▪ SPSS: general description, functions, menus, commands ▪ Editing and Manipulating Data ▪ Missing Values ▪ Editing and copying SPSS output ▪ Printing from SPSS and closing SPSS ▪ Importing Data	**10**
Unit II	**Descriptive Statistics with SPSS** ▪ Descriptive Statistics: Frequencies Measure of central tendency Measure of Dispersion Skewness Kurtosis ▪ Charts and Graphs: Bar charts Pie chart	**6**

	Scatter Plots ▪ Line Graphs and Histogram ▪ Examples and problems	
Unit III	**Correlation** ▪ Correlation simple and multiple ▪ Rank correlation ▪ Simple linear regression ▪ Multiple regression ▪ Examples and problems	**6**
Unit IV	**Statistical Tests with SPSS** ▪ Testing of hypothesis ▪ Parametric Tests ▪ Students t-test One sample t-test ▪ Two sample t-Test ▪ Paired t-test ▪ One - Way ANOVA ▪ Chi - square test for independence of attributes and goodness of fit ▪ Examples and problems	**8**
Study Resources	▪ A. Rajathi and Chandran (2006). SPSS for you, MJP Publishers ▪ K. Pandya, Smruti Bulsari, Sanjay Sinha (2011). SPSS in Simple Steps, Dreamtech Press ▪ Robert H. Carver and Jane Gradwohl Nash (2011). Doing Data Analysis with SPSS, Cengage Learning. ▪ Andy Field (2009). Discovering Statistics Using SPSS, Third edition, SAGE	

S.Y. B.Sc. Statistics (Open Elective)
Semester IV
STA-OE-242: Practical on Applied Statistics

Total Hours: 60 **Credits: 2**

Course Objectives	• To make student aware about introduction to SPSS. • To explain computations of descriptive statistics using SPSS. • To describe statistical testing to solve real life problems using SPSS.
Course Outcomes	Students will be able to • Apply SPSS software to compute measures of central tendency and dispersion. • Use SPSS software to represent data graphically. • Understand statistical hypothesis testing procedure using SPSS software. • Perfom ANOVA using SPSS software.

Sr. No.	Contents	Hours
1	Introduction to SPSS software	4
2	Data Import and Export from excel	4
3	Data objects and built in functions used in SPSS	4
4	Diagrammatic representation of data	4
5	Graphical representation of data	4
6	Frequency distribution of data	4
7	Computations of measures of central tendency	4
8	Computations of measures of dispersion	4
9	Computation of correlation coefficient	4
10	Fitting of regression equation	4
11	Test based on t distributions-I	4
12	Test based on t distributions-II	4
13	Chi-square test	4
14	Performing an ANOVA	4
15	Real life analysis of data	4

Study Resources	• A. Rajathi and Chandran (2006). SPSS for you, MJP Publishers • K. Pandya, Smruti Bulsari, Sanjay Sinha (2011). SPSS in Simple Steps, Dreamtech Press • Robert H. Carver and Jane Gradwohl Nash (2011). Doing Data Analysis with SPSS, Cengage Learning. • Andy Field (2009). Discovering Statistics Using SPSS, Third edition, SAGE **Methods of Teaching**: Interactive lecture method, Problem solving method and ICT enabled teaching method.

S.Y. B.Sc. Statistics (Major)
Semester IV
STA-FP-241: Field Project

Total Hours: 30 **Credits: 2**

Course Overview	• The Field Project Paper is designed to provide undergraduate statistics students with hands-on experience and a deeper understanding of socio-economic issues in both rural and urban settings. • This project-based course will enable students to apply statistical methods to real-world problems, observe socio-economic contexts, and understand development-related issues through direct field experience.
Course objectives	• To provide students with practical exposure to socio-economic contexts in rural and urban settings. • To enhance student's understanding of development -related policies, regulations and organizational structures. • To foster critical thinking and problem-solving skills in addressing socio-economic issues. • To encourage innovative approaches to generating solutions socio-economic problems.
Course outcomes	Students will be able to • Collect and analyze socio-economic data using appropriate statistical methods. • Understand and critique policies and programs related to socio-economic development. • Identify and propose solutions to complex socio-economic problems. • Communicate findings and recommendations effectively in written and oral forms.
Unit	**Contents**
Unit I	**Orientation and Preparation** • Overview of socio-economic development issues in rural and urban contexts. • Training on data collection and analysis techniques

Unit II	**Field Work** Field visit to rural or urban areas • Observe and collect data on rural or urban socio-economic conditions. • Activities: Interviews, surveys, and observations. • Compilation and preliminary analysis of data collected.
Unit III	**Data Analysis and Report Writing** • Data cleaning and preparation for analysis. • Data analysis using statistical software. • Writing the field project report, including introduction, methodology, results, discussion and conclusion.
Unit IV	**Presentation and Evaluation** • Preparations of presentations. • Presentation of findings to peers and faculty followed by a Q & A session.

Assesment:

- Field work participation, field note book, team work etc. (10 Marks)
- Data Collection and Analysis (15 Marks)
- Field project report (15 Marks)
- Presentation of findings (10 Marks)