Deccan Education Society's

Fergusson College (Autonomous) Pune

Learning Outcomes-Based Curriculum
for 3/4 years B. Sc. /B. Sc. (Honours) Programme
as per guidelines of

NEP-2020

for

F. Y. B. Sc. (Statistics)

With effect from Academic Year
2023-2024

Program Outcomes (POs) for B. Sc.	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence:** (i) Apply the knowledge, facts, and rules of basic and applied sciences (Physics, Chemistry, Mathematics and Statistics) for understanding elements of Electronic Science. (ii) Identify basic elements and systems of the real analog world and modern digital world.
PSO2	**Personal and Professional Competence:** (i) Demonstrates the ability to build and test basic blocks of modern digital systems and computers. (ii) Operate basic and advanced tools, equipment and Instruments. (iii) Discuss performance parameters for selection of sensors, actuators, linear and digital ICs.
PSO3	**Research Competence:** (i) Design and build Electronics systems in various domains like Computers, consumer products, medical, transportation, agriculture and defence. (ii) Formulate and provide creative, innovative and effective solutions to real world problems using hardware –software co-design tools for microcontroller / embedded systems and IoTs. (ii) Develop and utilizes modern tools (like PSPICE, MATLAB, Simulink) for mathematical modelling and simulation for future ready systems.
PSO4	**Entrepreneurial and Social competence:** Employ the process of thinking independently, taking initiative, working in a team effectively, preparing project reports and developing capability to lead the team through real life projects.

Fergusson College (Autonomous), Pune
First Year Curriculum as per NEP 2020

Department of Statistics

Course Structure

Semester	Paper	Paper Code	Paper Title	Type	Credits
I	Major	STS-101	Descriptive Statistics	Theory	4
		STS-100	Statistics Practical - 1	Practical	2
	Minor	STS-111	Fundamentals of Descriptive Statistics- I	Theory	2
		STS-112	Statistics Practical - 1	Practical	2
	OE- 1	STS-120	Fundamentals of Statistics - I	Theory	2
	OE- 2	STS-121	Introduction to Probability	Theory	2
	SEC - 1	STS-140	Basics of Statistics Using R - I	Theory	2
	Minor for Computer Science Students	STS-115	Fundamental of Statistics	Theory	2
		STS-116	Statistics Practical - 1	Practical	2
	Minor for BA Students	STS-119	Introduction to Descriptive Statistics -I	Theory	2
II	Major	STS-151	Probability Theory And Distributions - I	Theory	4
		STS-150	Statistics Practical - 2	Practical	2
	Minor	STS-161	Elements Of Probability Theory And Probability Distributions	Theory	2
		STS-162	Statistics Practical - 2	Practical	2
	OE - 3	STS-170	Fundamentals Of Statistics - II	Theory	2
	OE-4	STS-171	Basics Applied Statistics	Theory	2
	Minor for Computer Science Students	STS-165	Introduction To Probability And Statistics	Theory	2
		STS-166	Statistics Practical - 2	Practical	2
	Minor for BA Students	STS-169	Introduction To Descriptive Statistics - II	Theory	2

**** OE – Open Elective, SEC- Skill Enhancement Component.***

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

F. Y. B. Sc. Semester-I		
STS-101	**Descriptive Statistics** **(Major- Theory)**	**Credits: 04** **Hours : 60**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the concepts of statistical population and sample	1
CO2	Articulate the data and its type and summarize information in the data using different summary measures. Explain simple regression models, fitting of second degree and exponential curves, computation of price, quantity indices and study of qualitative data.	2
CO3	Apply methods and procedures of summarizing information in real life situations in various fields. Apply appropriate statistical models to data generated in day to day life, Calculate various price and quantity indices and Yule's coefficient of association.	3
CO4	Analyze the bivariate quantitative data. Identify the situations for simple linear and multiple linear regression models.	4
CO5	Judge and make comparisons through the exploratory data analysis and summary measures. Compare fitted models on the basis of residual analysis and coefficient of determination.	5
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of regression analysis.	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Statistics:** 1.1 Meaning of Statistics as a science, Importance of Statistics, 1.2 Scope of Statistics: In the field of Industry, Biological sciences, Medical sciences, Economics, Social sciences, Management sciences, Agriculture, Insurance, Information Technology, Education and Psychology, Statistical organizations in India and their functions: CSO, ISI, NSSO, IIPS, Bureau of Economics and Statistics, Indian Statistical Services.	(02)

II	**Population and Sample:** 2.1 Types of characteristics: Attributes: Nominal scale, ordinal scale, Likert scale, Variables: Interval scale, ratio scale discrete and continuous variables. 2.2 Types of data: Primary data, Secondary data, Cross-sectional data, Time series data, Directional data. 2.3 Notion of a statistical population and sample: Finite population, infinite population, homogeneous population and heterogeneous population. Sample and a random sample. 2.4 Methods of sampling (description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), Stratified Random Sampling, Systematic Sampling, Cluster sampling and Two-stage sampling. Inclusion probabilities.	(04)
III	**Summary Statistics:** 3.1 Classification: Raw data and its classification, ungrouped frequency distribution, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, open end classes, relative frequency distribution. 3.2 Measures of Central Tendency: Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, Trimmed arithmetic mean. Mode and Median: Definition, merits and demerits. Empirical relation between mean, median and mode. Partition values: Quartiles, Deciles and Percentiles. Geometric Mean (G.M.): Definition, merits and demerits. Harmonic Mean (H.M.): Definition, merits and demerits. Order relation between arithmetic mean, geometric mean, harmonic mean. Weighted Mean: weighted A.M., G.M. and H.M. Situations where one kind of average is preferable to others. 3.3 Measures of Dispersion: Concept of dispersion, characteristics of good measure of dispersion. Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits. Mean deviation: Definition, merits and demerits, minimality property (without proof) Mean squared deviation: Definition, minimality property of mean squared deviation Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups). Measures of dispersion for comparison: Coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.).	(12)

IV	**Moments, Skewness and Kurtosis:** 4.1 Moments: Raw moments (m'_r) for ungrouped and grouped data. Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale. Relations between central moments and raw moments upto 4^{th} order (with proof). 4.2 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution and its relation with central tendency. Bowley's coefficient of skewness: Bowley's coefficient of skewness lies between −1 to 1, interpretation using box and whisker plot. Karl Pearson's coefficient of skewness. Measures of Skewness based on moments (β_1, γ_1). 4.3 Concepts of kurtosis, Types of kurtosis: Leptokurtic, Mesokrtic and Platykurtic frequency distributions and its relation with dispersion. Measures of kurtosis based on moments (β_2,γ_2). Properties of β_1 and β_2 (i) $\beta_2 \geq 1$ (ii) $\beta_2 \geq \beta_1 + 1$	(06)
V	**Correlation and Regression:** 5.1 Bivariate data, Scatter diagram and interpretation. 5.2 Concept of correlation between two variables, positive correlation, negative correlation, no correlation. Covariance between two variables (m11) : Definition, computation, effect of change of origin and scale. Karl Pearson's coefficient of correlation I : Definition, Properties: (i) $-1 \leq r \leq 1$ (with proof), (ii) Effect of change of origin and scale (with proof). computation for ungrouped data and grouped frequency distributed data with interpretation. 5.3 Correlation Ratio 5.4 Spearman's rank correlation coefficient: Definition, derivation of formula, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.) 5.5 Kendall's Tau 5.6 Meaning of regression, difference between correlation and regression. Concept of error in regression, error modeled as a continuous random variable. Simple linear regression model: $Y= a + b X + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of a, b by the method of least squares. Interpretation of parameters. Statement of the estimator of σ^2. Concept of residual, plot of residual against X, concept of coefficient of determination.	(14)
VI	**Curve fitting:** 6.1 Fitting of second degree curve ($Y = a + b X + cX^2$), 6.2 Fitting of exponential curves of the type $Y = a\, b^X$ and $Y = aX^b$. In all these curves, parameters are estimated by the method of least squares.	(04)

VII	**Index Numbers:** 7.1 Introduction of index numbers**,** Definition and meaning, 7.2 Problems/considerations in the construction of index Numbers, 7.3 Simple and weighted price index numbers based on price relatives, Simple and weighted index numbers based aggregates, Laspeyre's, Paasche's and Fisher's Index numbers. 7.4 Time reversal Test, factor reversal test, circular test, 7.5 Consumer price index number: Considerations in its construction. Methods of construction of consumer price index number: (i) Family budget method (ii) Aggregate expenditure method. 7.6 Shifting of base, splicing, deflating, purchasing power. 7.7 Description of the BSE sensitivity and similar index numbers.	(09)
VIII	**Theory of Attributes:** 8.1 Attributes: Classification, notion of manifold classification, dichotomy, class frequency, order of a class, positive class frequency, negative class frequency, ultimate class frequency, relationship among different class frequencies (up to three attributes), and dot operator to find the relation between frequencies, fundamental set of class frequencies. 8.2 Consistency of data upto 3 attributes, Concepts of independence and association of two attributes. 8.3 Yule's coefficient of association (Q), $-1 \leq Q \leq 1$, Interpretation.	(09)
	References: 1. Agarwal, B. L. (2003). Programmed Statistics, 2nd Edition, New Age International Publishers, New Delhi. 2. Das (2009). Statistical Methods, Tata Mcgraw Hill Publishing 3. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. 1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta. 4. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi. 5. Krzanowski (2007). Statistical Principals and Techniques in Scientific and Social Research, Oxford University Press Inc., New York 6. Mukhopadhyay P. (2015). Applied Statistics, Publisher: Books & Allied (P) Ltd. 7. Mohanty (2016). Basic Statistics, Scientific Publisher 8. Rastogi (2015). Biostatistics, 3rd Edition, Publisher Medtec	

9. Robert S. Witte, John S. Witte (2017). Statistics, Publisher: Wiley
10. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers (1998). Probability and Statistics for Engineers and Scientists, Publisher, Prentice Hall.
11. Sarma, K. V. S. (2001). Statistics Made It Simple: Do it yourself on PC, Prentice Hall of India, New Delhi.
12. Lefebvre Mario (2006) Applied probability and Statistics, Publisher Springer. **Links:** https://mahades. mamarashtra.gov.in

www.mospi.gov.in
http://www.isical.ac.in
https://iipsindia.org

F. Y. B. Sc. Semester-I		
STS100	**Statistics Practical – 1** **(Major-Practical)**	**Credits : 2** **Hours : 60**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Present the data diagrammatically and graphically.	1
CO2	Articulate the data and its type and summarize information in the data using different summary measures. Explain simple regression models, fitting of second degree and exponential curves, computation of price, quantity indices and study of qualitative data.	2
CO3	Apply methods and procedures of summarizing information in real life situations in various fields. Apply appropriate statistical models to data generated in day to day life, Calculate various price and quantity indices and Yule's coefficient of association.	3
CO4	Analyze the bivariate quantitative data. Identify the situations for simple linear and multiple linear regression models.	4
CO5	Judge and make comparisons through the exploratory data analysis and summary measures. Compare fitted models on the basis of residual analysis and coefficient of determination.	5
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of regression analysis.	6

Sr. No.	**Title of the Experiment**
1.	Diagrammatic and graphical representation.
2.	Methods of Classification (Inclusive and Exclusive) and construction of frequency distributions.
3.	Drawing samples using various sampling methods.
4.	Measures of central tendency and measures of dispersion for ungrouped data.
5.	Measures of central tendency and measures of dispersion for grouped data.
6.	Computation of moments and its applications.
7.	Computation of coefficients of skewness and kurtosis and its interpretations.
8.	Computation of correlation coefficients and its interpretations.
9.	Fitting of simple linear regression model.
10.	Fitting of second degree curve and exponential curve.
11.	Methods construction of various index numbers and tests of adequacy of index numbers.
12.	Construction of consumer price index numbers, splicing , deflating and change of base year of index numbers
13.	Categorical data analysis.
14 and 15	Applications of statistical techniques to real life data.

F.Y.B.Sc. Semester-I		
STS-111	**Fundamentals of Descriptive Statistics – I (Minor - Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the concepts of statistical population and sample	1
CO2	Articulate the data and its type and summarize information in the data using different summary measures. Explain simple regression models, fitting of second degree and exponential curves, computation of price, quantity indices and study of qualitative data.	2
CO3	Apply methods and procedures of summarizing information in real life situations in various fields. Apply appropriate statistical models to data generated in day to day life, Calculate various price and quantity indices and Yule's coefficient of association.	3
CO4	Analyze the bivariate quantitative data. Identify the situations for simple linear and multiple linear regression models.	4
CO5	Judge and make comparisons through the exploratory data analysis and summary measures. Compare fitted models on the basis of residual analysis and coefficient of determination.	5
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of regression analysis.	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Population and Sample:** 2.1 Types of characteristics: Attributes: Nominal scale, ordinal scale, Likert scale, Variables: Interval scale, ratio scale discrete and continuous variables. 2.2 Types of data: Primary data, Secondary data, Cross-sectional data, Time series data, Directional data. 2.3 Notion of a statistical population and sample: Finite population, infinite population, homogeneous population and heterogeneous population. Sample and a random sample. 2.4 Methods of sampling (description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), Stratified Random Sampling, Systematic Sampling, Cluster sampling and Two-stage sampling.	(04)

II	**Summary Statistics:** 2.1 Classification: Raw data and its classification, ungrouped frequency distribution, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, open end classes, relative frequency distribution. 2.2 Measures of Central Tendency : Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, Trimmed arithmetic mean. Mode and Median: Definition, merits and demerits. Empirical relation between mean, median and mode. Partition values: Quartiles, Deciles and Percentiles. Geometric Mean (G.M.): Definition, merits and demerits. Harmonic Mean (H.M.): Definition, merits and demerits. Order relation between arithmetic mean, geometric mean, harmonic mean. Weighted Mean: weighted A.M., G.M. and H.M. Situations where one kind of average is preferable to others. 2.3 Measures of Dispersion : Concept of dispersion, characteristics of good measure of dispersion. Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits. Mean deviation: Definition, merits and demerits, minimality property (without proof) Mean squared deviation: Definition, minimality property of mean squared deviation Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups). Measures of dispersion for comparison: Coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.).	(10)

III	**Moments, Skewness and Kurtosis:** 3.1 Moments: Raw moments (m'_r) for ungrouped and grouped data. Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale. Relations between central moments and raw moments upto 4^{th} order (with proof). 3.2 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution and its relation with central tendency. Bowley's coefficient of skewness: Bowley's coefficient of skewness lies between -1 to 1, interpretation using box and whisker plot. Karl Pearson's coefficient of skewness. Measures of Skewness based on moments (β_1, γ_1). 3.3 Concepts of kurtosis, Types of kurtosis: Leptokurtic, Mesokrtic and Platykurtic frequency distributions and its relation with dispersion. Measures of kurtosis based on moments (β_2,γ_2).	(06)
IV	**Correlation and Regression:** 4.1 Bivariate data, Scatter diagram and interpretation. 4.2 Concept of correlation between two variables, positive correlation, negative correlation, no correlation. Covariance between two variables (m_{11}) : Definition, computation, effect of change of origin and scale. Karl Pearson's coefficient of correlation I : Definition, Properties: (i) $-1 \leq r \leq 1$ (without proof), (ii) Effect of change of origin and scale (without proof). computation for ungrouped data and grouped frequency distributed data with interpretation. 4.3 Correlation Ratio 4.4 Spearman's rank correlation coefficient: Definition, derivation of formula, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.) 4.5 Meaning of regression, difference between correlation and regression. Concept of error in regression, error modeled as a continuous random variable. Simple linear regression model: $Y= a + b X + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of a, b by the method of least squares. Interpretation of parameters. Statement of the estimator of σ^2. Concept of residual, plot of residual against X, concept of coefficient of determination. 4.6 Curve Fitting of second degree curve ($Y = a + b X + cX^2$), fitting of exponential curves of the type $Y = a\, b^X$ and fitting of curve of the type $Y = aX^b$. In all these curves, parameters are estimated by the method of least squares	(10)

References:

1. Agarwal, B. L. (2003). Programmed Statistics, 2nd Edition, New Age International Publishers, New Delhi.
2. Das (2009). Statistical Methods, Tata Mcgraw Hill Publishing
3. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2016). Fundamentals of Statistics, Vol. 1, 6th Revised Edition, The World Press Pvt. Ltd., Calcutta.
4. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Krzanowski (2007). Statistical Principals and Techniques in Scientific and Social Research, Oxford University Press Inc., New York
6. Mukhopadhyay P. (2015). Applied Statistics, Publisher: Books & Allied (*P*) Ltd.
7. Mohanty (2016). Basic Statistics, Scientific Publisher
8. Rastogi (2015). Biostatistics, 3rd Edition, Publisher Medtec
9. Robert S. Witte, John S. Witte (2017). Statistics, Publisher: Wiley
10. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers (1998). Probability and Statistics for Engineers and Scientists, Publisher, Prentice Hall.
11. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC, Prentce Hall of India, New Delhi.
12. Lefebvre Mario (2006) Applied probability and Statistics, Publisher Springer.

Links: https://mahades. mamarashtra.gov.in
www.mospi.gov.in
http://www.isical.ac.in
https://iipsindia.org

https://www.rubin-levin.com

F.Y.B.Sc. Semester-I		
STS-112	**Statistics Practical – 1 (Minor - Practical)**	**Credits : 2 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Present the data diagrammatically and graphically.	1
CO2	Articulate the data and its type and summarize information in the data using different summary measures. Explain simple regression models, fitting of second degree and exponential curves, computation of price, quantity indices and study of qualitative data.	2
CO3	Apply methods and procedures of summarizing information in real life situations in various fields. Apply appropriate statistical models to data generated in day to day life, Calculate various price and quantity indices and Yule's coefficient of association.	3
CO4	Analyze the bivariate quantitative data. Identify the situations for simple linear and multiple linear regression models.	4
CO5	Judge and make comparisons through the exploratory data analysis and summary measures. Compare fitted models on the basis of residual analysis and coefficient of determination.	5
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of regression analysis.	6

Sr. No	Title of the Experiment
1.	Diagrammatic and graphical representation.
2.	Methods of Classification (Inclusive and Exclusive) and construction of frequency distributions.
3.	Drawing samples using various sampling methods.
4.	Measures of central tendency for ungrouped data.
5.	Measures of central tendency for grouped data.
6.	Measures of dispersion for ungrouped data.
7.	Measures of dispersion for grouped data.
8.	Computation of coefficients of skewness and kurtosis and its interpretations.
9.	Computation of correlation coefficients and its interpretations.
10.	Fitting of simple linear regression model.
11.	Fitting of second degree curve and exponential curve.
12,13, 14,15	Applications of statistical techniques to real life data.

F. Y. B. Sc. Semester-I		
STS-120	**Fundamentals of Statistics – I (OE-1)**	**Credits: 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall statistical population and sample, need of Statistics and information about National Statistical Institutes.	1
CO2	Articulate the data, its types and summarize information in the data using different measures.	2
CO3	Apply methods and procedures of summarizing information in real life situations in different fields	3
CO4	Assess preliminary judgments and comparisons through exploratory data analysis and summary measures.	4
CO5	Compare different measures of summary statistics.	5
CO6	Create different frequency distributions for real life data	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Statistics:** 1.1 Meaning of Statistics as a Science, Importance of Statistics, 1.2 Scope of Statistics: In the field of Industry, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology Biological sciences, Medical sciences, Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and Statistics	(02)
II	**Population and Sample:** 2.1 Types of characteristics: Attributes: Nominal scale, Ordinal scale, Variables: Interval scale, Ratio scale, discrete and continuous variables, difference between linear scale and circular scale Types of data: (a) Primary data, Secondary data (b)Cross-sectional data, time series data. 2.2 Notion of a statistical population: finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample, Methods of sampling (description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), stratified random sampling, systematic sampling, cluster sampling and two-stage sampling.	(06)

III	**Summary Statistics: Measures of Central Tendency and Measures of Dispersion:** 3.1 Review / Revision of Presentation of Data, Classification: Raw data and its classification, ungrouped frequency distribution, Sturges' rule, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, Open end classes, and relative frequency distribution, 3.2 Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean, mode and median: Definition, formulae, merits and demerits. Empirical relation between mean, median and mode. Partition Values: Quartiles, Deciles and Percentiles, Box Plot. 3.3 Geometric Mean (G.M.): Definition, formula, merits and demerits. Harmonic Mean (H.M.): Definition. Formula, merits and demerits. Orderly relation between arithmetic mean, geometric mean, harmonic mean Weighted Mean: weighted A.M., G.M. and H.M. Situations where one kind of average is preferable to others, 3.4 Concept of dispersion, characteristics of good measure of dispersion. Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits, Mean deviation, Definition, merits and demerits, minimality property (without proof), Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups). Mean squared deviation: Definition, minimality property of mean squared deviation (without proof), Measures of dispersion for comparison: coefficient of \ range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)	(14)

IV	**Moments, Skewness and Kurtosis:** 4.1 Raw moments (m'_r) for ungrouped and grouped data, Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale, 4.2 Relations between central moments and raw moments, upto 4^{th} order (without proof), 4.3 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness: Bowley's coefficient of skewness lies between −1 to 1 (with proof), interpretation using Box plot, Karl Pearson's coefficient of skewness, 4.4 Measures of skewness based on moments (β_1,γ_1), Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions, Measures of kurtosis based on moments (β_2,γ_2).	(08)
	References: 1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi. 2. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta. 3. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi. 4. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi. 5. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi. 6. Sarma, K. V. S. (2001). Statistics Made It Simple: Do it yourself on PC. Prentice Hall of India, New Delhi. 7. Snedecor G. W. and Cochran W. G. (1989). Statistical Methods, Eighth Ed. East- West Press.	

F. Y. B. Sc. Semester –I		
STS-121	**Introduction to Probability (OE-2)**	**Credits: 2 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO 1	Recall principle of counting, Describe random and non-random experiments.	1
CO 2	Explain basic concepts of probability, Articulate sample space for a certain random experiment and identify events and their types.	2
CO 3	Illustrate different real life situations to find probability of different types of events, the theorems of probability, concept of univariate and bivariate discrete random variable, calculate mean, variance, correlation coefficient of univariate and bivariate discrete random variable	3
CO 4	Explain definition of independence of events, concept of conditional probability	4
CO 5	Justify random variable(s) of interest in given scenario and find the probability distribution.	5
CO 6	Formulate univariate and bivariate discrete probability distributions.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Permutations and Combinations:** 1.1 Definitions of permutation and combination 1.2 Relation between permutation and combination: (i) $\binom{n}{r} = \binom{n}{n-r}$ (ii) $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$	(05)

II	**Probability:** 2.1 Concept and definition of union, intersection of two sets, complement of a set Concept of random experiment, sample space 2.2 Definition of event, complementary event, elementary event, certain event, impossible event, problems on sample space, events for a given random experiment 2.3 Classical definition of probability and its limitations, Probability Model, Axioms of probability 2.4 Theorems of Probability (Explain through illustrations) (i) $P(A) + P(A) = 1$ (ii) $0 \leq P(A) \leq 1$ (iii) $P(\Phi)=0$ (iv) If A □ B then $P(A) \leq P(B)$ (v) $P(AUB) = P(A)+P(B)- P(A \cap B)$ (vi) $P(AUB) \leq P(A) + P(B)$ (vii) Statement for 3 events for (v) and (vi) 2.5 Definition of conditional probability Multiplication theorem on $P(A \cap B)$, Concept and definition of independence of two events Pairwise independence and complete independence in case of three events 2.6 Bayes' Theorem: Statement, Partition of the sample space, Applications of Bayes' theorem in real life.	(10)
III	**Uni-variate Discrete Probability Distributions:** 3.1 Definition of a discrete sample space and discrete r.v. 3.2 Definition of probability mass function (p.m.f.) of a discrete r.v. 3.3 Definition of expectation of a discrete r.v. and expectation of a linear combination of discrete r.v. X. 3.4 Definition of variance of discrete r.v. X. 3.5 Properties of expectation and variance	(07)
IV	**Bivariate discrete probability distributions:** 4.1 Definition of two-dimensional discrete random variable, its joint probability mass function 4.2 Distribution function and their properties 4.3 Computation of probabilities of events in bivariate probability distribution, concepts of marginal and conditional probability distributions. 4.4 Independence of two discrete random variables based on joint and marginal p. m. f, 4.5 Theorems on expectations of sum and product of two jointly distributed random variables 4.6 Definitions of conditional mean and conditional variance, 4.7 Definition of covariance, coefficient of correlation 4.8 Variance of linear combination of variables i.e. var(aX + bY).	(08)

	References: 1. Agarwal B. L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, New Delhi. 2. B.L.S. Prakasarao, (2008). A First Course in Probability and Statistics, World Scientific Publishing Company. 3. Ross S. (2002). A First Course in Probability, 6th edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc. 4. Walpole and Myres, (1986). Mathematical Statistics, 4th edition, Publisher: Longman Higher Education. 5. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi. 6. Lefebvre Mario (2006) Applied probability and Statistics, Publisher Springer 7. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.	

F. Y. B. Sc. Semester - I		
STS-140	**Basics of Statistics Using R - I (SEC-1)**	**Credits: 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to understand:		**Bloom's cognitive level**
CO1	Understand the R environment for downloading, installing, and using packages, debug, organize, and comment R code	1
CO2	Articulate Basic R programming with some basic notions for developing their own simple programs and visualizing graphics in R.	2
CO3	Explain how to extract and Read data into R, manipulate, and analyze it	3
CO4	Illustrate various methods of generating random sample from Population using R	4
CO5	Identify the methods and procedures of summarizing information by using summary statistics such as measures of central tendency, dispersion, skewness kurtosis using R	5
CO6	Apply correlation analysis to different realistic situations using R	6
	Note: Students are expected to write commands in script file wherever applicable.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Fundamentals of R:** 1.1 Overview of the R language, Input and output of data in R, Help command, In-built functions in R, installing packages and libraries, Data Types in R; Vectors, Matrices, Arrays, and Data Frames, Important operations of these Data Types, 1.2 Creating a vector using scan function, creating a data frame using edit command, Importing data from MS-Excel file Using read.table command, saving the R-output in a file using MS-Excel, concept of R-script file, Graphics using R: (a) High level plotting functions (b) Low level plotting functions (c) Interactive graphic functions The following statistical methods using „R" 1.3 **Diagrams** Simple bar diagram, Subdivided bar diagram, multiple bar diagram, Pie diagram, Stem and leaf diagram 1.4 **Graphs** Boxplot for one and more than one variables, rod or spike plot, histogram for raw data with prob=T option and for both equal and unequal class intervals, frequency polygon, ogive curves, empirical distribution function Saving the diagram and graph in MS-Word file	(10)

II	**Summary Statistics:** Population and Sample 2.1 Methods of sampling: generating random sample using Simple random sampling with and without replacement (SRSWR and SRSWOR) 2.2 Stratified Random Sampling, Systematic Sampling, Cluster sampling and Two-stage sampling. Measures of Central Tendency: 2.3 Computation of the following for ungrouped and grouped data: Arithmetic Mean (A.M.) Mode and Median, Partition values: Quartiles, Deciles and Percentiles. Geometric Mean (G.M.) Harmonic Mean (H.M.), Measures of Dispersion 2.4 Computation of the following for ungrouped and grouped data: Range, Semi-interquartile range (Quartile deviation): Mean deviation, Variance and standard deviation, Mean squared deviation, coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.).	**(11)**
III	**Moments, Skewness and Kurtosis:** Computation of following measures for ungrouped and grouped data: 3.1 Raw moments (m'_r), Central moments (m_r) 3.2 Computation of Bowley's coefficient of skewness, interpretation using box and whisker plot. Karl Pearson's coefficient of skewness. 3.3 Measures of Skewness based on moments (β_1, γ_1). kurtosis, Types of kurtosis: Leptokurtic, Mesokrtic and Platykurtic frequency distributions and its relation with dispersion. Measures of kurtosis based on moments (β_2,γ_2).	(05)
IV	**Correlation:** 4.1 Bivariate data, Scatter diagram and interpretation. 4.2 correlation between two variables, positive correlation, negative correlation, no correlation. 4.3 Covariance between two variables (m_{11}) 4.4 Karl Pearson's coefficient of correlation 4.5 Spearman's rank correlation coefficient (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)	(04)

	References: 1. Crawley, M. J. (2006). Statistics - An introduction using R. John Wiley, London 32 2. Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall / CRC Press, New York 3. Shahababa, B. (2011). Biostatistics with R, Springer, New York 4. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, New Delhi. Eighth Ed. East - West Press. Statistics, Vol. 1, 6^{th} revised edition, The World Press Pvt. Ltd., Calcutta.	

F.Y.B.Sc Semester-I		
STS-115	**Fundamental of Statistics (Minor - Theory)**	**Credits : 2 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe basic features of the data.	1
CO2	Help make informed judgments based on a pattern of data observed previously.	2
CO3	Find chance of an event based on prior knowledge of conditions that might be related to the event.	3
CO4	Provide brief summary about the sample using different graphs.	4
CO5	Enhance the computational techniques related to probability.	5
CO6	Develop analytical thinking by using the ability to see a problem or solution from different points of view.	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Data condensation and Graphical methods:** 1.1 Raw data, attributes and variables, discrete and continuous variables. 1.2 Presentation of data using frequency distribution and cumulative frequency distribution. (Construction of frequency distribution is not expected) 1.3 Graphical Presentation of frequency distribution –histogram, stem and leaf chart, less than and more than type ogive curves. 1.4 Numerical problems related to real life situations.	**6**
II	**Measures of central tendency and dispersion:** 2.1 Measures of Central tendency: Mean, Mode, Median. Examples where each one of these is most appropriate. 2.2 Partition values: Quartiles, Box-Plot. 2.3 Variance, Standard Deviation, Coefficient of Variation. (Section 2.1 to 2.3 should be covered for raw data, ungrouped frequency distribution and exclusive type grouped frequency distribution)	**10**
III	**Counting Principles, Sample spaces and Events:** 3.1 Counting Principles 3.2 Permutation 3.3 Combination. 3.4 Deterministic and non-deterministic models. 3.5 Random Experiment, Sample Spaces (finite and countably infinite) 3.6 Events: types of events, Operations on events.	**4**

IV	**Basic Theory of Probability:** 4.1 Probability - classical definition, probability models, axioms of probability, probability of an event. 4.2 Theorems of probability (with proof) i) $0 \leq P(A) \leq 1$ ii) $P(A) + P(A') = 1$ iii) $P(A) \leq P(B)$ when $A \subset B$ iv) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ 4.3 Numerical problems related to real life situations.	**10**
	References: 1. Statistical Methods, G.W. Snedecor, W.G. Cochran, John Wiley & sons, 1989. 2. Fundamentals of Applied Statistics (4th Edition), Gupta and Kapoor, S. Chand and Sons, New Delhi, 2014. 3. Modern Elementary Statistics, Freund J.E., Pearson Publication, 2005. 4. A First course in Probability 6^{th} Edition, Ross, Pearson Publication, 2006.	

F.Y.B.Sc Semester-I		
STS-116	**Statistics Practical - 1 (Minor - Practical)**	**Credits : 2 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Articulate the data, its types and summarize information in the data using different measures.	1
CO2	Create different frequency distributions for real life data	2
CO3	Articulate sample space for a certain random experiment and identify events and their types.	3
CO4	Illustrate different real life situations to find probability of different types of events, the theorems of probability.	4
CO5	Understand the R environment for downloading, installing, and using packages, debug, organize, and comment R code	5
CO6	Identify the methods and procedures of summarizing information by using summary statistics such as measures of central tendency, dispersion, skewness kurtosis using R	6

Sr. No.	Title of Experiment/ Practical
1	Diagrammatic Representation
2	Methods of Classification (Inclusive and Exclusive) and construction of frequency distributions
3	Introduction to R
4	Graphical methods using R
5	Measures of Central Tendency
6	Measures of Dispersion
7	Measure of Central Tendency and Dispersion using R
8	Counting Principles
9	Permutation and Combination
10	Sample spaces and events
11	Basic probability theory I
12	Basic probability theory II
13,14&15	Applications of statistical techniques to real life data.

F.Y.B.A Semester -I		
STS-119	**Introduction to Descriptive Statistics -I (Minor- Theory)**	**Credits : 02** **Hours : 30**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall statistical population and sample, need of Statistics and information about National Statistical Institutes.	1
CO2	Articulate the data, its types and summarize information in the data using different measures.	2
CO3	Apply methods and procedures of summarizing information in real life situations in different fields	3
CO4	Assess preliminary judgments and comparisons through exploratory data analysis and summary measures.	4
CO5	Compare different measures of summary statistics.	5
CO6	Create different frequency distributions for real life data	6

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Statistics:** 1.1 Meaning of Statistics as a Science, Importance of Statistics, 1.2 Scope of Statistics: In the field of Industry, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology Biological sciences, Medical sciences, Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and Statistics.	(02)
II	**Population and Sample:** 2.1 Types of characteristics: Attributes: Nominal scale, Ordinal scale, Variables: Interval scale, Ratio scale, discrete and continuous variables, difference between linear scale and circular scale, Types of data: (a) Primary data, Secondary data (b)Cross-sectional data, time series data.	(06)

	2.2 Notion of a statistical population: finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample, Methods of sampling (description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), stratified random sampling, systematic sampling, cluster sampling and two-stage sampling.	
III	**Summary Statistics: Measures of Central Tendency and Measures of Dispersion:** 3.1 Review / Revision of Presentation of Data, Classification: Raw data and its classification, ungrouped frequency distribution, grouped frequency distribution, cumulative frequency distribution, inclusive and exclusive methods of classification, Open end classes, and relative frequency distribution, 3.2 Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average. Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean, Mode and Median: Definition, formulae, merits and demerits. Empirical relation between mean, median and mode Partition Values: Quartiles, Deciles and Percentiles, Box Plot. Geometric Mean (G.M.): Definition, formula, merits and demerits. Harmonic Mean (H.M.): Definition. Formula, merits and demerits. Orderly relation between arithmetic mean, geometric mean, harmonic mean Weighted Mean: weighted A.M., G.M. and H.M. Situations where one kind of average is preferable to others	(14)
	3.3 Concept of dispersion, characteristics of good measure of dispersion. Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits, Mean deviation, Definition, merits and demerits, minimality property (without proof), Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups). Mean squared deviation: Definition, minimality property of mean squared deviation (without proof), Measures of dispersion for comparison: coefficient of \ range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)	

IV	**Moments, Skewness and Kurtosis:** 4.1 Raw moments (m'_r) for ungrouped and grouped data, Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale, Relations between central moments and raw moments, 4^{th} order (without proof), 4.2 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness: Bowley's coefficient of skewness lies between -1 to 1 (without proof), interpretation using Box plot, Karl Pearson's coefficient of skewness, Measures of skewness based on moments (β_1,γ_1), 4.3 Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions Measures of kurtosis based on moments (β_2,γ_2).	(08)
	References: 1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi. 2. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta. 3. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi. 4. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi. 5. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi. 6. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, New Delhi. 7. Snedecor G. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. East- West Press. **Links:** https://mahades. mamarashtra.gov.in www.mospi.gov.in http://www.isical.ac.in https://iipsindia.org https://www.rubin- levin.com	

F. Y. B. Sc. Semester - II		
STS-151	**Probability Theory and Distributions-I (Major - Theory)**	**Credits : 04 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe random and non-random experiments.	1
CO2	Articulate the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem.	2
CO3	Explain concept of discrete random variable and its probability distribution including expectation and moments.	3
CO4	Illustrate the concept of two dimensional discrete random variables, bivariate probability distributions.	4
CO5	Identify different discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial, Hyper-geometric and multinomial and their interrelations if any.	5
CO6	Apply standard discrete probability distribution to different realistic situations.	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Probability, conditional probability, independence:** 1.1 Experiments / Models, deterministic and non- deterministic models. random experiment, concept of statistical regularity. 1.2 Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite, (iii) Continuous sample space, (iv) Event, (v) Elementary event, (vi) Complement of an event, (vii) Certain event, (viii) Impossible event. Concept of occurrence of an event. 1.3 Algebra of events and its representation in set theory notation. Classical definition of probability and its limitations. Probability model, equiprobable and non-equiprobable sample space. 1.4 Axiomatic definition of probability, theorems of probability, computation of probability of an event conditional probability of an event. 1.5 Independence of two events. Pair-wise independence and mutual independence for three events. Multiplication theorem $P(A \cap B) = P(A) \cdot P(B\|A)$ and its generalization. 1.6 Bayes' Theorem Partition of the sample space. Proof of Bayes' theorem, Applications of Bayes' theorem in real life.	(11)

II	**Univariate Probability Distributions:** 2.1 Concept and definition of a discrete random variable. Probability mass function (p.m.f.) and distribution function (d.f.), FX (·), of discrete random variable, properties of distribution function. Mode and median of a univariate discrete probability distribution. 2.2 Definition of expectation (mean) of a random variable, properties of expectation, expectation of a function of a random variable, moment generating function (m.g.f.) and cumulant generating function (c.g.f.) and their properties. 2.3 Definitions of variance, properties of variance, standard deviation (s.d.) and coefficient of variation (c.v.) of univariate probability distribution 2.4 Definition of raw, central moments and factorial raw moments of univariate probability distributions and their interrelations. Coefficients of skewness and kurtosis based on moments.	(9)
III	**Bivariate discrete probability distribution:** 3.1 Definition of two-dimensional discrete random variable, its joint p.m.f. and its distribution function and their properties, concept of identically distributed random variables computation of probabilities of events in bivariate probability distribution. 3.2 Concepts of marginal and conditional probability distributions. Independence of two discrete random variables based on joint and marginal p.m.f, Definition of raw and central moments. 3.3 Theorems on expectations of sum and product of two jointly distributed random variables, Conditional expectation, Definitions of conditional mean and conditional variance, Definition of covariance, coefficient of correlation, variance of linear combination of variables i.e. var(aX + bY). Illustrations of some standard bivariate probability distributions.	(9)

IV	**Discrete Probability Distributions based on finite sample space:** 4.1 Degenerate distribution (one point distribution**)** p.m.f.: P(X=c) =1, mean and variance. 4.2 Uniform distribution on integers 1 to n: p.m.f. : $P(X=x) = \begin{cases} \frac{1}{n} & ,x = 1,2\ldots n \\ 0 & , \text{otherwise} \end{cases}$ mean, variance, real life situations, comments on mode and median. 4.3 Bernoulli distribution: p.m.f. $P(X=x) = \begin{cases} p^x(1-p)^{1-x} & ,x = 0, 1 \\ & 0 < p < 1 \\ 0 & otherwise \end{cases}$ mean, variance and moments. 4.4 Binomial distribution: p.m.f. $P(X=x) = \begin{cases} \binom{n}{x} p^x q^{n-x}, x = 0,1, \ldots, n \\ 0 < p < 1, q = 1-p \\ 0 \quad \text{otherwise} \end{cases}$ Notation: X ~ B(n, p). , situations where this distribution is applicable. mean, variance, recurrence relation for successive probabilities, computation of probabilities of different events, mode of the distribution, m.g.f., c.g.f., moments, skewness (comments when p = 0.5, p > 0.5, p < 0.5), additive property. 4.5 Hypergeometric Distribution: p.m.f $P(X = x) = \begin{cases} \frac{\binom{M}{x}\binom{N-M}{n-x}}{\binom{N}{n}} & ,x = 0,1, \ldots \min\{n, M\}, N > M \\ 0 \quad otherwise \end{cases}$ Notation : X ~ H (N, M, n), situations where this distribution is applicable, mean and variance, binomial approximation to hypergeometric distribution, computation of probability,	(13)

V	**Univariate discrete probability distributions based on countably infinite sample space**:	(13)

5.1 Poisson distribution: Notation X ~P(λ)

$$P(x) = \begin{cases} \frac{e^{-\lambda}\lambda^x}{x!}, x = 0,1,2 \ldots, \lambda > 0 \\ 0 \quad otherwise \end{cases}$$

Situations where this distribution is applicable. Mean variance and m.g.f. and c.g.f moment using c.g.f. skewness , kurtosis, recurrence relation, conditional distribution X | X + Y , additive property, Poisson distribution as a limiting form of binomial distribution.

5.2 Geometric distribution**:** Notation: X ~ G(p),

Geometric distribution on support (0, 1, 2…) , with p.m.f.

$$p(x) = \begin{cases} pq^x , x = 0, 1, 2\ldots , 0 < p < 1, q = 1 - p. \\ 0 \qquad \text{otherwise} \end{cases}$$

Geometric distribution on support (1, 2,…….) with p.m.f.

$$p(x) = \begin{cases} pq^{x-1} , x = 1, 2\ldots ,0 < p < 1, q = 1 - p. \\ 0 \qquad \text{otherwise} \end{cases}$$

distribution function, recurrence relation, situations where this distribution is applicable. mean, variance, m.g.f, c.g.f., moments, lack of memory property.

5.3 Negative Binomial Distribution: p.m.f.:

$$P(X = x) = \begin{cases} \binom{x+k-1}{x} p^k q^x & x = 0, 1, \ldots \\ & k > 0, 0 < p < 1, q = 1 - p \\ 0 & \text{otherwise} \end{cases}$$

Notation**:** X ~ NB (k, p).

Nature of p. m. f., negative binomial distribution as a waiting time distribution, Situations where this distribution is applicable, mean, variance, m.g.f, c.g.f., moments, skewness and kurtosis, recurrence relation between probabilities, Poisson approximation to negative binomial distribution, negative binomial distribution as a sum of k i.i.d. geometric random variables.

VI	**Multinomial distribution:** 6.1 Probability mass function (p. m. f.) $P(X_1 = x_1, X_2 \ldots X_k = x_k) = \frac{n!}{x_1!x_2!\ldots x_k!} p_1^{x_1} p_2^{x_2} \ldots p_k^{x_k}$ $, x_1 + x_2 + \ldots x_k = n, p_1 + p_2 + \ldots p_k = 1 ,$ $0 < p_i < 1, \quad x_i = 0, 1, 2 \ldots n , \quad i = 1, 2, \ldots k$ $= 0$ otherwise Notation: $(X_1, X_2 \ldots X_k) \sim MD(n, p_1, p_2 \ldots p_k) \underline{X} \sim MD(n, \underline{p})$ Where $\underline{X} = (X_1, X_2 \ldots X_k)$, $\underline{p} = (p_1, p_2 \ldots p_k)$ 6.2 Joint m.g.f. of $(X_1, X_2 \ldots X_k)$, use of m.g.f. to obtain mean, variance, covariance, total correlation coefficients, multiple and partial correlation coefficients for k = 3. Univariate marginal distribution of X_i, distribution of $X_i + X_j$, conditional distribution of X_i given $X_i + X_j = r$, variance – covariance matrix, rank of variance - covariance matrix and its interpretation, real life situations and applications.	(05)
	References: 1. Agarwal B. L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, New Delhi. 2. B. L. S. Prakasarao, (2008). A First Course in Probability and Statistics, World Scientific Publishing Company. 3. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York. 4. Hogg, R. V. and Craig R. G. (1989). Introduction to Mathematical Statistics, MacMillan Publishing Co., New York. 5. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw Hill Book Company. 6. Ross S. (2002). A First Course in Probability, 6th edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc. 7. Roussas, George G. (2016). First course in mathematical statistics. 2nd edition Publisher*:* Academic Press. 8. Walpole and Myres, (1986). Mathematical Statistics, 4th edition, Publisher: Longman Higher Education. 9. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi. 10. Lefebvre Mario (2006) Applied Probability and Statistics, Publisher Springer 11. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London. 12. Mukhopadhyay P (2006) Mathematical Statistics Books & Allied (P) Ltd.	

F. Y. B. Sc. Semester - II		
STS-150	**Statistics Practical - 2** **(Major- Practical)**	**Credits: 02** **Hours : 60**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify real life situations of various discrete distributions.	1
CO2	Fit different discrete distributions.	2
CO3	Compute probability and conditional probability.	3
CO4	Verify dependence and independence of events.	4
CO5	Model sampling from different discrete distributions	5
CO6	Construct univariate probability distributions	6

Title of Experiment / Practical	
1.	Computation of probability and conditional probability.
2.	Mutual and Pairwise independence of events.
3.	Applications of Bayes' theorem.
4.	Construction of univariate probability distributions.
5.	Model Sampling from Poisson, binomial and negative binomial distribution. Computation of Shannon's entropy
6.	Applications of Bernoulli and Binomial distributions.
7.	Fitting of binomial distribution.
8.	Applications of geometric and negative binomial distributions.
9.	Fitting of negative binomial distributions.
10.	Applications of Poisson and hypergeometric distributions.
11.	Bivariate probability distribution, computation of mutual information function.
12.	Fitting of Poisson distribution.
13.	Applications of multinomial distributions.
14 and 15.	Exploring fitting of discrete distributions to real life data.

F.Y.B.Sc Semester -II		
STS-161	**Elements of Probability Theory and Probability Distributions (Minor - Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe random and non-random experiments.	1
CO2	Articulate sample space for a certain random experiment and identify events and their types.	2
CO3	Illustrate different real life situations to find probability of different types of events, the theorems of probability.	3
CO4	Explain definition of independence of events to determine whether an assumption of independence is justifiable.	4
CO5	Justify random variable(s) of interest in a given scenario and find the probability distribution.	5
CO6	Formulate different discrete probability distributions based on finite and countably infinite sample space.	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Review of probability, conditional probability, independence:** 1.1 Experiments / Models, deterministic and non- deterministic models. random experiment, concept of statistical regularity. 1.2 Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite, (iii) Continuous sample space , (iv) Event, (v) Elementary event, (vi) Complement of an event, (vii) Certain event, (viii) Impossible event. Concept of occurrence of an event. 1.3 Algebra of events and its representation in set theory notation. 1.4 Classical definition of probability and its limitations. 1.5 Probability model, equiprobable and non-equiprobable sample space. 1.6 Axiomatic definition of probability, theorems of probability, computation of probability of an event 1.7 Conditional probability of an event. 1.8 Independence of two events. 1.9 Pair-wise independence and mutual independence for three events. 1.10 Multiplication theorem $P(A \cap B) = P(A) \cdot P(B\|A)$ and its generalization. 1.11 Partition of the sample space. 1.12 Statement and Proof of Bayes' theorem, Applications of Bayes' theorem in real life.	(08)

II	**Univariate Probability Distributions:** 2.1 Concept and definition of a discrete random variable. 2.2 Probability mass function (p.m.f.) and distribution function (d.f.), $F_X(\cdot)$, of discrete random variable, properties of distribution function. 2.3 Mode and median of a univariate discrete probability distribution. 2.4 Definition of expectation (mean) of a random variable, properties of expectation, expectation of a function of a random variable, moment generating function (m.g.f.) and cumulant generating function (c.g.f.) and their properties. Definitions of variance, properties of variance, standard deviation (s.d.) and coefficient of variation (c.v.) of univariate probability distribution Definition of raw, central moments and factorial raw moments of univariate probability distributions and their interrelations. Coefficients of skewness and kurtosis based on moments. Examples and Problems.	(10)
III	**Discrete Probability Distributions based on finite sample space:** 3.1 Uniform discrete distribution on integers 1 to n: p.m.f. P(X=x) = $\begin{cases} \frac{1}{n} & ,x = 1,2 \dots n \\ 0 & ,otherwise \end{cases}$ mean, variance , real life situations 3.2 Bernoulli distribution: p.m.f. P (X = x) = $\begin{cases} p^x(1-p)^{1-x} & ,x = 0,1 \\ & 0 < p < 1 \\ 0 & otherwise \end{cases}$ mean, variance, real life situations 3.3 Binomial distribution: p.m.f. P(X = x) = $\begin{cases} \binom{n}{x} p^x q^{n-x}, x = 0,1, \dots, n \\ 0 < p < 1, q = 1 - p \\ 0 \quad \text{otherwise} \end{cases}$ Notation: X ~ B(n, p). , situations where this distribution is applicable. mean, variance (statement only), recurrence relation for successive probabilities, computation of probabilities of different events, mode of the distribution, additive property.	[07]

	3.4 Hypergeometric Distribution: p.m.f $P(X = x) = \begin{cases} \frac{\binom{M}{x}\binom{N-M}{n-x}}{\binom{N}{n}}, x = 0,1,\dots n, n < M. \\ 0 \quad \text{Otherwise} \end{cases}$ Notation : X ~ H (N, M, n), situations where this distribution is applicable , mean and variance (statement only), computation of probabilities	
IV	**Univariate discrete probability distributions based on countably infinite sample space**. 4.1 Poisson distribution: Notation X ~P(λ) $P(x) \begin{cases} \frac{e^{-\lambda}\lambda^x}{x!} = , \quad x = 0, 1, 2 \dots \ ,\lambda > 0 \\ 0 \quad \text{otherwise} \end{cases}$ Situations where this distribution is applicable. Mean ,variance (statement only) , computation of probabilities 4.2 Geometric distribution**:** Notation: X ~ G(p), Geometric distribution on support (0, 1, 2…) , with p.m.f. $p(x) = \begin{cases} pq^x , x = 0, 1, 2\dots , 0 < p < 1, q = 1 - p. \\ 0 \quad \text{otherwise} \end{cases}$ Geometric distribution on support (1, 2,…….) with p.m.f. $p(x) = \begin{cases} pq^{x-1} , x = 1, 2\dots ,0 < p < 1, q = 1 - p. \\ 0 \quad \text{otherwise} \end{cases}$ Distribution function, situations where this distribution is applicable. mean, variance (statement only) , computation of probabilities	[05]

	5.3 Negative Binomial Distribution: p.m.f.: $P(X = x) = \begin{cases} \binom{x+k-1}{x} p^k q^x & x = 0, 1, \ldots \\ & k > 0, 0 < p < 1, q = 1 - p \\ 0 & \text{otherwise} \end{cases}$ Notation**:** X ~ NB (k, p). Nature of p. m. f., Situations where this distribution is applicable, mean, variance (statement only), computation of probabilities, Recurrence relation to compute successive probabilities	
	References: 1. Agarwal B. L. (2003). Programmed Statistics, 2nd edition, New Age International Publishers, New Delhi. 2. B.L.S. Prakasarao, (2008). A First Course in Probability and Statistics, World Scientific Publishing Company. 3. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York. 4. Hogg, R. V. and Craig R. G. (1989). Introduction to Mathematical Statistics, MacMillan Publishing Co., New York. 5. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw Hill Book Company. 6. Walpole and Myres, (1986). Mathematical Statistics, 4th edition, Publisher: Longman Higher Education. 7. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, 8th Edition, Sultan Chand and Sons Publishers, New Delhi. 8. Mukhopadhyay P (2006) Mathematical Statistics Books & Allied (*P*) Ltd.	

F. Y. B. Sc. Semester - II		
STS-162	**Statistics Practical – 2** **(Minor - Practical)**	**Credits: 02** **Hours : 60**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify real life situations of various discrete distributions.	1
CO2	Fit different discrete distributions.	2
CO3	Compute probability and conditional probability.	3
CO4	Verify dependence and independence of events.	4
CO5	Model sampling from different discrete distributions	5
CO6	Construct univariate probability distributions	6

Title of Experiment / Practical	
1.	Computation of probability - I
2.	Computation of probability – II
3.	Computation of conditional probability
4.	Mutual and Pairwise independence of events.
5.	Applications of Bayes' theorem.
6.	Construction of univariate probability distributions.
7.	Model Sampling from Poisson.
8.	Applications of Bernoulli and Binomial distributions.
9.	Fitting of binomial distribution.
10.	Applications of geometric and negative binomial distributions.
11.	Fitting of negative binomial distributions.
12.	Applications of Poisson and hypergeometric distributions.
13.	Fitting of Poisson distribution.
14 and 15.	Exploring fitting of discrete distributions to real life data.

F. Y. B. Sc. Semester - II		
STS-170	**Fundamentals of Statistics - II (OE-3)**	**Credits: 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe the concept of bivariate data theory of attributes.	1
CO2	Compute Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient and obtain lines and curves of regression.	2
CO3	Apply method of least squares for parameter estimation.	3
CO4	Differentiate between correlation and regression.	4
CO5	Consider and justify the use of correlation and regression.	5
CO6	Analyze categorical data.	6

Unit No	Title and Contents	No. of Lectures
I	**Correlation:** 1.1 Bivariate data, Scatter diagram and interpretation. 1.2 Concept of correlation between two variables, positive correlation, negative correlation, no correlation. 1.3 Covariance between two variables (m_{11}), Definition, computation, effect of change of origin and scale. 1.4 Karl Pearson's coefficient of correlation (r): Definition, computation for ungrouped data and interpretation. Properties: (i) $-1 \leq r \leq 1$ (without proof), (ii) Effect of change of origin and scale (without proof). 1.5 Spearman's rank correlation coefficient: Definition, derivation of formula, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)	**(10)**

II	**Linear Regression Model:** 2.1 Meaning of regression, difference between correlation and regression, 2.2 Concept of error in regression, error modeled as a continuous random variable. Simple linear regression model: $Y= a + b X + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) =0$, $V(\varepsilon) = \sigma^2$. Estimation of a, b by the method of least squares. Interpretation of parameters. Statement of the estimator of $\sigma^{2.}$ 2.3 Concept of residual, Residual plot concept of coefficient of determination.	(09)
III	**Fitting of curves to the bivariate data:** 3.1 Fitting of line ($Y = a + b X$), 3.2 Fitting of second degree curve ($Y = a + b X + c X^2$), 3.3 Fitting of exponential curves of the type $Y = a b^X$ and $Y = aX^b$. Estimation of parameters by method of least squares.	(03)
IV	**Theory of Attributes:** 4.1 Attributes: Concept of Likert scale, classification, notion of manifold classification, dichotomy, class frequency, order of a class, positive class- frequency, negative class frequency, ultimate class frequency, relationship among different class frequencies (up to three attributes), dot operator to find the relation between frequencies, fundamental set of class frequencies. 4.2 Consistency of data upto 2 attributes. 4.3 Concepts of independence and association of two attributes. 4.4 Yule's coefficient of association (Q), $-1 \leq Q \leq 1$ interpretation.	(08)
	References: 1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi. 2. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta. 3. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi. 4. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi. 5. Sarma, K. V. S. (2001). Statistics Made It Simple: Do it yourself on PC. Prentice Hall of India, New Delhi. 6. Snedecor G. W. and Cochran W. G. (1989). Statistical Methods, Eighth Ed. East- West Press.	

F. Y. B. Sc. Semester -II		
STS – 171	**Basic Applied Statistics (OE-4)**	**Credits: 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO 1	Define the index numbers, time series, vital statistics, national income	1
CO 2	Describe components of time series, personal income, disposable income, per capita income, gross domestic product (GDP), demographic ratios	2
CO 3	Calculate different index numbers, mortality and death rates and reproduction rates, Interpret index numbers and demographic ratios	3
CO 4	Analyze time series	4
CO 5	Estimate trend and seasonal indices of a time series	5
CO 6	Develop different index numbers for real life data	6

Unit. No.	Title of Unit and Contents	No. of lectures
I	**Index Numbers:** 1.1 Introduction of index numbers**,** Definition and meaning, 1.2 Problems/considerations in the construction of index Numbers, 1.3 Simple and weighted price index numbers based on price relatives, Simple and weighted index numbers based on aggregates, 1.4 Laspeyre's, Paasche's and Fisher's Index numbers. 1.5 Time reversal Test, factor reversal test, circular test, 1.6 Consumer price index number: Methods of construction of consumer price index number: (i) Family budget method (ii) Aggregate expenditure method. 1.7 Shifting of base, splicing, deflating, purchasing power. 1.8 Description of the BSE sensitivity and similar index numbers.	(08)

II	**Time Series Analysis:** 2.1 Meaning of Time Series, Various components of a time series (Explanation and illustrations of each component) 2.2 Additive and Multiplicative methods for analysis of time series 2.3 Methods of estimating trend: (i) Freehand or Graphical method (ii) Method of semi-averages (iii) Method of moving averages (iv) Method of least squares 2.4 Measurement of seasonal variations. (i) simple average method, (ii) ratio to moving averages method	(08)
III	**Elements of Demography :** 3.1 Introduction, need of vital statistics. 3.2 Methods of collecting vital statistics 3.3 Demographic Ratios (i) Mortality Rates: Crude Death Rate (CDR), Standardized Death Rate (STDR) (ii) Fertility and Reproduction Rates: Crude Birth Rate (CBR),General Fertility Rate(GFR), Age-specific Fertility Rate (ASFR).Total Fertility Rate(TFR), (iii) Gross Reproduction Rate (GRR),Net Reproduction Rate (NRR)	(09)
IV	**National Income :** 4.1 Definition of national income by (i) Marshall, (ii) Pigou, (iii) Fisher. 4.2 Different concept of national income (a) gross national product (GNP), (b) net national product (NNP). 4.3 Personal income, disposable income, per capita income, gross domestic product (GDP), national income at market price, national income at factor cost, national income at current prices, national income at constant prices. 4.4 Methods of estimation of national income and the difficulties in methods. (a) output method, (b) income method, (c) expenditure method. 4.5 Importance of national income.	(05)

	References: 1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi. 2. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi. 3. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi. 4. Sarma, K. V. S. (2001). Statistics Made It Simple: Do it yourself on PC. Prentice Hall of India, New Delhi. 7 5. M. L. Sheth: Macro Economics: Lakshmi-Narayan Agarwal education publishers Agra, ISBN Code **– 978-93-88297-80-6** 6. H. L. Ahuja (Twentieth edition (1 January 2016): Modern Economics: S. Chand Publishers, New Delhi.	

F.Y.B.Sc Semester -II		
STS165	**Introduction to Probability and Statistics (Minor- Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe basic features of the data.	**1**
CO2	Discuss shape and size of the data.	**2**
CO3	Compare different data sets and conclude the best fit.	**3**
CO4	Compute chance of an event based on prior knowledge of conditions that might be related to the event.	**4**
CO5	Evaluate the computational techniques related to advanced probability.	**5**
CO6	Build predictive models for the data.	**6**

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Moments:** 1.1 Raw and Central moments: definition, computations for ungrouped and grouped data (only up to first four moments) 1.2 Relation between raw and central moments upto fourth order (without proof) 1.3 Numerical problems related to real life situations	(03)
II	**Measures of Skewness and Kurtosis:** 2.1 Concept of symmetric frequency distribution, skewness, positive and negative skewness 2.2 Measures of Skewness-Pearson's measure, Bowley's measure ($\beta 1, \gamma 1$) 2.3 Kurtosis of a frequency distribution, measure of kurtosis ($\beta 2, \gamma 2$) based upon moments, type of kurtosis: leptokurtic, platykurtic and mesokurtic 2.4 Numerical problems related to real life situations.	(05)
III	**Correlation and Linear Regression:** 3.1 Bivariate data, Scatter diagram. 3.2 Correlation, Positive Correlation, Negative correlation, Zero Correlation. 3.3 Karl Pearson's coefficient of correlation (r), limits of r ($-1 \leq r \leq 1$), interpretation of r, Coefficient of determination (r^2) 3.4 Meaning of regression, difference between correlation and regression. 3.5 Concept and equation of regression line of Y on X. 3.6 Concept of residual plot and mean residual sum of squares. 3.7 Numerical Problems.	(06)

IV	**Non-Linear Regression :** 4.1 Second degree curve 4.2 Growth curve models of the type i) $Y = ae^{bX}$ ii) $Y = ab^{X}$ iii) $Y = aX_b$ 4.3 Logistic model $Y = k / (1+e^{a+bx})$ 4.4 Numerical problems related to real life situations.	(04)
V	**Advanced Theory of Probability:** 5.1 Concepts and definitions of conditional probability, multiplication theorem $P(A \cap B)=P(A).P(B\|A)$ 5.2 Bayes' theorem (without proof) 5.3 Concept of Posterior probability, problems on posterior probability. 5.4 Definition of sensitivity of a procedure, specificity of a procedure. Application of Bayes' theorem to design a procedure for false positive and false negative. 5.5 Concept and definition of independence of two events. 5.6 Numerical problems related to real life situations.	(12)
	References: 1. Statistical Methods, G.W. Snedecor, W.G. Cochran, John Wiley & sons, 1989. 2. Fundamentals of Applied Statistics (4th Edition), 3. Gupta and Kapoor, S. Chand and Sons, New Delhi, 2014. Modern Elementary Statistics, 4. Freund J.E., Pearson Publication, 2005. A First course in Probability 6th Edition, Ross, Pearson Publication, 2006.	

F. Y. B. Sc. Semester - II		
STS-166	**Statistics Practical - 2 (Minor - Practical)**	**Credits: 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Illustrate different real-life situations to find probability of different types of events using advanced theory of probability.	1
CO2	Discuss various applications of statistical measures using R software.	2
CO3	Execute the computational techniques using R software.	3
CO4	Analyse different concepts of statistics using R software.	4
CO5	Validate the fundamental knowledge and represent using R software.	5
CO6	Write a program using R to build different regression models for the given data and estimate the error.	6

Title of Experiment / Practical	
1.	Computation of moments
2.	Computation of moments using R
3.	Measures of skewness and kurtosis -I
4.	Measures of skewness and kurtosis -II
5.	Measures of skewness and kurtosis using R
6.	Correlation and Regression
7.	Correlation and Regression using R
8.	Fitting of Second degree and Exponential curves, verification using R
9.	Conditional probability
10.	Independence of events
11.	Applications of Multiplication and Bayes' theorem
12.	Sensitivity and Specificity
13, 14 and 15.	Applications of statistical techniques to real life data.

F. Y. B. A. Semester - II		
STS-169	**Introduction to Descriptive Statistics - II (Minor - Theory)**	**Credits:02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Describe the concept of bivariate data, index numbers.	1
CO2	Compute Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient and obtain lines and curves of regression.	2
CO3	Apply method of least squares in estimation of parameters.	3
CO4	Differentiate between correlation and regression.	4
CO5	Consider and justify the use of correlation and regression.	5
CO6	Construct price and quantity indices	6
Unit No	**Title and Contents**	**No. of Lectures**
I	**Correlation:** 1.1 Bivariate data, Scatter diagram and interpretation. 1.2 Concept of correlation between two variables, positive correlation, negative correlation, 1.3 Covariance between two variables (m_{11}), Definition, computation, effect of change of origin and scale. 1.4 Karl Pearson's coefficient of correlation (r): Definition, computation for ungrouped data and interpretation. Properties: (i) $-1 \leq r \leq 1$ (without proof), (ii) Effect of change of origin and scale (without proof). 1.5 Spearman's rank correlation coefficient: Definition, derivation of formula, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)	**(10)**
II	**Linear Regression Model:** 2.1 Meaning of regression, difference between correlation and regression, 2.2 Concept of error in regression, error modelled as a continuous random variable. Simple linear regression model: $Y= a + b X + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of a, b by the method of least squares. Interpretation of parameters. Statement of the estimator of $\sigma^{2.}$ 2.3 Concept of residual, (plot of residual against X,) residual plot concept of coefficient of determination.	(09)

III	**Fitting of curves to the bivariate data** : 3.1 Fitting of second degree curve ($Y = a + b X + c X^2$), 3.2 Fitting of exponential curves of the type $Y = a b^X$ and $Y = aX^b$. Estimation of parameters by method of least squares.	(03)
IV	**Index Numbers:** 4.1 Introduction of index numbers**,** definition and meaning, 4.2 Problems/considerations in the construction of index numbers, 4.3 Simple and weighted price index numbers based on price relatives, simple and weighted index numbers based on aggregates, Laspeyre's, Paasche's and Fisher's Index numbers. 4.4 Time reversal Test, factor reversal test, circular test, 4.5 Consumer price index number: Considerations in its construction. Methods of construction of consumer price index number: (i) Family budget method (ii) Aggregate expenditure method. 4.6 Shifting of base, splicing, deflating, purchasing power. 4.7 Description of the BSE sensitivity and similar index numbers.	(08)

References:

1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
2. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.
3. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
4. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.
5. Sarma, K. V. S. (2001). Statistics Made It Simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
6. Snedecor G. W. and Cochran W. G. (1989). Statistical Methods, Eighth Ed. East- West Press.