Structure and Detailed Syllabus

for

Undergraduate Course

in

Statistics

Under Curriculum and Credit Framework for Undergraduate Programmes (CCFUP) - NEP 2020

With effect from Academic Session 2023-24

Kazi Nazrul University

Asansol 713 340

West Bengal

☐ www.knu.ac.in ☐

Scheme for the Curriculum under CCFUP (As per NEP 2020)

✧ Major Course (MJC)

BSCSTSMJ101 – **Descriptive Statistics and Probability - I**

BSCSTSMJ201 – **Bivariate Data Analysis and Probability - II**

BSCSTSMJ301 – **Sampling Distributions**

BSCSTSMJ302 – **Linear Algebra**

BSCSTSMJ401 – **Statistical Inference - I**

BSCSTSMJ402 – **Sampling Techniques and Indian Official Statistics**

BSCSTSMJ501 – **Statistical Computing with R**

BSCSTSMJ502 – **SQC and Reliability Analysis**

BSCSTSMJ503 – **Statistical Inference – II**

BSCSTSMJ601 – **Time Series Analysis**

BSCSTSMJ602 – **Multivariate Analysis and Non Parametric Inference**

BSCSTSMJ603 – **Predictive Analysis**

BSCSTSMJ604 – **Linear Model and Design of Experiments**

BSCSTSMJ701 – **Distribution Theory**

BSCSTSMJ702 - **Econometrics**

BSCSTSMJ703 – **Stochastic Process and Queuing Theory**

BSCSTSMJ704 – **Linear Programming and Game Theory**

BSCSTSMJ801 – **Applied Multivariate Analysis**

BSCSTSMJ802 – **Bayesian Inference**

BSCSTSMJ803 – **Survival Analysis**

BSCSTSMJ804 – **Data Analysis Using Python**

✧ **Minor Course (MNC)**

BSCSTSMN101 – **Descriptive Statistics and Probability - I**

BSCSTSMN201 – **Bivariate Data Analysis and Probability - II**

BSCSTSMN301 – **Introduction to Statistical Inference**

BSCSTSMN401 – **Introduction to Applied Statistics**

BSCSTSMN501 – **Sampling Techniques and Design of Experiments**

BSCSTSMN701 – **Statistical Computing Using R**

BSCSTSMN801 – **Economic Statistics**

✧ **Ability Enhancement Compulsory Elective/ Course (AECE/ AECC)**

AEC-1 - **English/ MIL Communication**

AEC-2 - **English Communication**

✧ **Skill Enhancement Course (SEC)**

BSCSTSSE101 – **Index Number and Demography**

BSCSTSSE201 – **Numerical Analysis**

BSCGEOSE401 – **Real Analysis**

✧ **Value Added Course (VAC)**

VAC201 - **Environment Studies**

VAC401 - **Health and Wellness**

VAC402 - **Social Values and Ethics**

VAC403 - **Digital and Technological Solutions**

VAC404 - **Understanding India**

✧ **Summer Internship/ Apprenticeship**

BSCSTSSI601 - **Summer Internship**

✧ **Research Project/ Dissertation**

BSCSTSRP801 - **Research Project/ Dissertation**

✧ Credits and Marks Distribution Scheme for Course Structure under CCFUP: UG Statistics

Discipline Code: BSCSTS

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Continuous Assessment Marks Practical Exam	Continuous Assessment Marks Theoretical Exam	End Semester Marks Practical Exam	End Semester Marks Theoretical Exam	Total Marks
I Marks: 350 Credits: 20	Major MJC-1	BSCSTSMJ101: Descriptive Statistics and Probability - I	5	3 - 0 - 4	30	15	20	35	100
	Minor MNC-1	Choose from the Pool of Minor Courses offered in 1st Semester by the other Disciplines	5	3 - 0 - 4	30	15	20	35	100
	MD Multidisciplinary Course-1	Choose from the Pool of Multidisciplinary Courses offered in 1st Semester	3	3 - 0 - 0	----	15	----	35	50
	AEC-1 Ability Enhancement Elective Course	AECE: English/ MIL Communication (See Pool)	4	4 - 0 - 0	----	15	----	35	50
	SEC Skill Enhancement Course-1	BSCSTSSE101: Index Number and Demography	3	2 - 1 - 0	----	15	---	35	50
II Marks: 350 Credits: 20	Major MJC-2	BSCSTSMJ201: Bivariate Data Analysis and Probability - II	5	3 - 0 - 4	30	15	20	35	100
	Minor MNC-2	Minor Course opted for in the 1st Semester should be continued in the 2nd Semester with the Syllabus Content of 2nd Semester	5	3 - 0 - 4	30	15	20	35	100
	MD Multidisciplinary Course-2	Choose from the Pool of Multidisciplinary Courses offered in 2nd Semester	3	3 - 0 - 0	----	15	----	35	50
	VAC Value Added Course-1	VAC-201: Environment Studies	4	4 - 0 - 0	----	15	----	35	50
	SEC Skill Enhancement Course -2	BSCSTSSE201: Numerical Analysis	3	2 - 1 - 0	---	15	----	35	50

Students exiting the programmes after securing **40 credits** will be awarded **UG Certificate** in the relevant Discipline/ Subject, provided they secure **4 credits** in work-based vocational courses offered during the **Summer Term** or **Internship**/ **Apprenticeship** in addition to **6 credits** from **skill-based courses** earned during the first and second semesters.

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Marks Distribution				Total Marks
					Continuous Assessment Marks		End Semester Marks		
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
III **Marks: 400** **Credits: 22**	**Major MJC-3**	**BSCSTSMJ301: Sampling Distributions**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-4	**BSCSTSMJ302: Linear Algebra**	5	3 - 0 - 4	30	15	20	35	100
	Minor MNC-3	**Choose from the Pool of Minor Courses offered in 3rd Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
	MD Multidisciplinary Course-3	**Choose from the Pool of Multidisciplinary Courses offered in 3rd Semester**	3	2 - 1 - 0	----	15	----	35	50
	AEC-2 Ability Enhancement Compulsory Course	**AECC: English Communication**	4	4 - 0 - 0	----	15	----	35	50
IV **Marks: 400** **Credits: 22**	**Major MJC-5**	**BSCSTSMJ401: Statistical Inference - I**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-6	**BSCSTSMJ402: Sampling Techniques and Indian Official Statistics**	5	3 - 0 - 4	30	15	20	35	100
	Minor MNC-4	**Choose from the Pool of Minor Courses offered in 4th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
	SEC Skill Enhancement Course-3	**BSCSTSSE401: Real Analysis**	3	2 - 1 - 0	----	15	----	35	50

	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Marks Distribution				Total Marks
					Continuous Assessment Marks		End Semester Marks		
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
	VAC **Value Added Course-2** **(Any One)**	**VAC-401: Health and Wellness**	4	4 - 0 - 0	----	15	----	35	50
		VAC-402: Social Values and Ethics		4 - 0 - 0	----	15	----	35	
		VAC-403: Digital and Technological Solutions		4 - 0 - 0	----	15	----	35	
		VAC-404: Understanding India		4 - 0 - 0	----	15	----	35	
Students exiting the programmes after securing **80 credits** will be awarded **UG Diploma** in the relevant Discipline/ Subject, provided they secure additional **4 credits** in **skill-based vocational courses** offered during first year or second year summer term.								
V **Marks: 400** **Credits: 22**	**Major MJC-7**	**BSCSTSMJ501: Statistical Computing with R**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-8	**BSCSTSMJ502: SQC and Reliability Analysis**	5	3 - 0 – 4	30	15	20	35	100
	Major MJC-9	**BSCSTSMJ503: Statistical Inference - II**	5	3 - 0 – 4	30	15	20	35	100
	Minor **MNC-5**	**Choose from the Pool of Minor Courses offered in 5th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
VI **Marks: 450** **Credits: 22**	**Major MJC-10**	**BSCSTSMJ601: Time Series Analysis**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-11	**BSCSTSMJ601: Multivariate Analysis and Non Parametric Inference**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-12	**BSCSTSMJ603: Predictive Analysis**	5	3 - 0 - 4	30	15	20	35	100
	Major **MJC-13**	**BSCSTSMJ604: Linear model and Design of Experiments**	5	3 - 0 - 4	30	15	20	35	100
	SI **Summer Internship-1**	**BSCSTSSI601: Summer Internship**	2	0 - 0 - 4	30	----	20	----	50

Total Credit and Marks			Total Credit	126			Total Marks	2350

Students who want to undertake **3-year** UG programme will be awarded **UG Degree** in the relevant Discipline / Subject upon securing **126 credits**.

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Marks Distribution				Total Marks
					Continuous Assessment Marks		End Semester Marks		
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
VII **Marks: 500** **Credits: 25**	**Major MJC-14**	**BSCSTSMJ701: Distribution Theory**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-15	**BSCSTSMJ702: Econometrics**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-16	**BSCSTSMJ703: Stochastic Process and Queuing Theory**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-17	**BSCSTSMJ704: Linear Programming and Game Theory**	5	3 - 0 – 4	30	15	20	35	100
	Minor MNC-6	**Choose from the Pool of Minor Courses offered in 7th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
VIII **Marks: 500** **Credits: 22**	**Major MJC-18**	**BSCSTSMJ801: Stochastic Process and Queuing Theory**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-19	**BSCSTSMJ802: Bayesian Inference**	4	3 - 0 - 4	30	15	20	35	100
	Major MJC-20	**BSCSTSMJ803: Survival Analysis**	4	3 - 0 - 4	30	15	20	35	100
	Major MJC-21	**BSCSTSMJ804: Data Analysis Using Python**	4	3 - 0 - 4	30	15	20	35	100
	Minor MNC-7	**Choose from the Pool of Minor Courses offered in 8th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
Total Credit and Marks		**Total Credit**	173				**Total Marks**		3350

Students will be awarded **UG Degree** (**Honours**) in the relevant Discipline / Subject provided they secure **173 credits**.

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Continuous Assessment Marks		End Semester Marks		Total Marks
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
VII Marks: 500 Credits: 25	**Major MJC-14**	**BSCSTSMJ701: Distribution Theory**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-15	**BSCSTSMJ702: Econometrics**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-16	**BSCSTSMJ703: Stochastic Process and Queuing Theory**	5	3 - 0 - 4	30	15	20	35	100
	Major MJC-17	**BSCSTSMJ704: Linear Programming and Game Theory**	5	3 - 0 - 4	30	15	20	35	100
	Minor MNC-6	**Choose from the Pool of Minor Courses offered in 7th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
VIII Marks: 500 Credits: 22	**Major MJC-18**	**BSCSTSMJ801: Data Classification Techniques**	5	3 - 0 - 4	30	15	20	35	100
	RP **Research Project-1**	**BSCSTSRP801: Research Project/ Dissertation**	12	0 - 0 - 24	180	----	120	----	300
	Minor MNC-7	**Choose from the Pool of Minor Courses offered in 8th Semester by the other Disciplines**	5	3 - 0 – 4	30	15	20	35	100
Total Credit and Marks		**Total Credit**	**173**				**Total Marks**		**3350**

4-year UG Degree (Honours with Research)

Students will be awarded **UG Degree** (**Honours**) in the relevant Discipline / Subject provided they secure **173 credits**.

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Continuous Assessment Marks		End Semester Marks		Total Marks
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
I Marks: 50 Credits: 3	**MD** Multidisciplinary Course -1	**Physical Science** (Department of Physics/ Chemistry)	3	3 - 0 - 0	----	15	----	35	50
		E-Commerce (Department of Commerce/ BBA)	3	3 - 0 - 0	----	15	----	35	50
		Human Rights (Department of Political Science)	3	3 - 0 - 0	----	15	----	35	50
		Disaster Management (Department of Geography/ Geology)	3	3 - 0 - 0	----	15	----	35	50
		Film Appreciation (Department of English)	3	3 - 0 - 0	----	15	----	35	50
II Marks: 50 Credits: 3	**MD** Multidisciplinary Course -2	**Business Environment** (Department of Commerce)	3	3 - 0 - 0	----	15	----	35	50
		Adhunik Bangla Sahitya (Department of Bengali)	3	3 - 0 - 0	----	15	----	35	50
		Adhunik Hindi Sahitya (Department of Hindi)	3	3 - 0 - 0	----	15	----	35	50
		Application of Bio-Science (Department of Zoology/ Botany/ Microbiology)	3	3 - 0 - 0	----	15	----	35	50
		Educational Philosophy (Department of Education)	3	3 - 0 - 0	----	15	----	35	50
		Sports and Fitness (Department of Physical Education)	3	3 - 0 - 0	----	15	----	35	50
III Marks: 50 Credits: 3	**MD** Multidisciplinary Course -3	**Mathematical Science** (Department of Mathematics)	3	3 - 0 - 0	----	15	----	35	50
		Cultural History of Bengal (Department of History)	3	3 - 0 - 0	----	15	----	35	50
		Business Management (Department of BBA)	3	3 - 0 - 0	----	15	----	35	50

Semester wise Pool of **Multidisciplinary Courses** offered for **Major** Disciplines

Semester	Course Type and Details	Course Code and Name	Credits	Credit Pattern (L-T-P)	Marks Distribution				Total Marks
					Continuous Assessment Marks		End Semester Marks		
					Practical Exam	Theoretical Exam	Practical Exam	Theoretical Exam	
	MD **Multidisciplinary Course -3**	**Nutrition and Public Health** (Department of Nutrition)	3	3 - 0 - 0	----	15	----	35	50
		Stress Management (Department of Psychology/ Philosophy/ Sociology)	3	3 - 0 - 0	----	15	----	35	50
Pool of **Communication Courses** offered as **Ability Enhancement Compulsory Courses**									
I **Marks: 50** **Credits: 4**	**AEC-1** **Ability Enhancement Elective Course**	**AECEE101: English Communication**	4	4 - 0 - 0	----	15	----	35	50
		AECEB101: Bengali Communication	4	4 - 0 - 0	----	15	----	35	50
		AECEH101: Hindi Communication	4	4 - 0 - 0	----	15	----	35	50
		AECEU101: Urdu Communication	4	4 - 0 - 0	----	15	----	35	50
Semester wise Pool of **Minor Courses** offered by this Discipline for other Disciplines									
I	**Minor MNC-1**	**BSCSTSMN101: Descriptive Statistics and Probability – II**	5	3- 0- 4	30	15	20	35	100
II	**Minor MNC-2**	**BSCSTSMN201: Bivariate Data Analysis and Probability – II**	5	3- 0- 4	30	15	20	35	100
III	**Minor MNC-3**	**BSCSTSMN301: Introduction to Statistical Inference**	5	3- 0- 4	30	15	20	35	100
IV	**Minor MNC-4**	**BSCSTSMN401: Introduction to Applied Statistics**	5	3- 0- 4	30	15	20	35	100
V	**Minor MNC-5**	**BSCSTSMN501: Sampling Techniques and Design of Experiments**	5	3- 0- 4	30	15	20	35	100
VII	**Minor MNC-6**	**BSCSTSMN701: Statistical computing Using R**	5	3- 0- 4	30	15	20	35	100
VIII	**Minor MNC-7**	**BSCSTSMN801: Economic Statistics**	5	3- 0- 4	30	15	20	35	100

Semester–I (Major)

Course Name: Descriptive Statistics and Probability- I

Course Code: BSCSTSMJ101

Course Type: **MAJOR** (Theoretical + Practical)	Course Details: MJC- 1		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

- **Descriptive Statistics:**

Introduction: Nature of Statistics, Uses of Statistics, Statistics in relation to other disciplines, Abuses of Statistics, Statistics in India, and A historical note.

Types of Data: Concepts of population and sample, quantitative and qualitative data, cross-sectional and time- series data, discrete and continuous data, different types of scales. Primary data, Secondary data.

Collection of data: Concepts of population and sample, complete enumeration and sample surveys, different methods of collection of data including the questionnaire and interviewer methods.

Presentation of data: Scrutiny of data, frequency and non-frequency data, Textual and tabular presentation of data with one or more factors of classification, diagrammatic representation frequency distributions and cumulative frequency distributions and their graphical presentations, histograms, frequency polygons, frequency curves and ogives, Stem and Leaf.

Univariate data: different measures of location, mean- AM, GM and HM, median, mode, different measures of dispersion, range, MD, SD, QD, relative dispersion, moments, factorial moments, skewness and kurtosis. Sheppard's correction and Charliers' check, outlier Detection. Box-plot.

- **Probability -I:**

Random Experiment: Trials, events, outcomes, mutually exclusive events, equally likely and exhaustive, Sample point, Sample space, Different types of events.

Definition of probability: Classical and relative-frequency approach to probability, limitations of Classical definition, Geometric definition of Probability, Kolmogorov's Axiomatic definition. Examples based on classical approach, repeated trials and geometric definition of probability.

Some theorems on Probability: Probability of union and intersection of events, Poincare's theorem, Boole's Inequality, Theorem of total probability. Conditional probability and Independence of events, theorem of compound probability, Bayes' Theorem and its applications.

Random Variables : Definition of discrete and continuous random variables, cumulative distribution function (c.d.f.) and its properties, probability mass function (p.m.f.) and probability density function (p.d.f), Expectation and Moments, Dispersion, Skewness, Kurtosis, Quartiles.

Probability Inequalities: Markov's and Chebyshev's inequalities, Uniqueness and Inversion Theorems (without proof), Weak Law of Large numbers (without proof).

List of Practical:

1. Data visualization using the statistical software R. Bar diagram, histogram, ogive, pie chart etc.

2. Computation of measures of central tendency and dispersion using the statistical software

   R. Use of an appropriatemeasure and interpretation of results.

3. Computation of the measures of skewness and kurtosis using the statistical software R.
4. Outlier detection using Box plot in R.
5. Q-Q plot, stem and leaf plot using the statistical software R.
6. Graphical interpretation of WLLN using R.

Suggested Readings:

1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I , World Press, Kolkata.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

3. Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

4. Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.

5. Chung, K. L.(1974) A Course in Probability Theory .Second Edition. Cambridge University Press.

6. Feller, William. An Introduction to Probability Theory and its Applications .Vol-I. Wiley.

7. Hoel P.G., Port S.C., Stone C.J. Introduction to Probability Theory

Suggested OnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx

- https://swayam.gov.in/explorer?searchText=statistics

- https://nptel.ac.in/course.html

- https://www.edx.org/search?q=statistics

- https://www.coursera.org/search?query=statistics&

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Semester–I (Minor)

Course Name: Descriptive Statistics and Probability- I

Course Code: BSCSTSMN101

Course Type: **MINOR** (Theoretical + Practical)	Course Details: MNC- 1		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

- **Descriptive Statistics:**

Introduction: Nature of Statistics, Uses of Statistics, Statistics in relation to other disciplines, Abuses of Statistics, Statistics in India, and A historical note.

Types of Data: Concepts of population and sample, quantitative and qualitative data, cross-sectional and time- series data, discrete and continuous data, different types of scales. Primary data, Secondary data.

Collection of data: Concepts of population and sample, complete enumeration and sample surveys, different methods of collection of data including the questionnaire and interviewer methods.

Presentation of data: Scrutiny of data, frequency and non-frequency data, Textual and tabular presentation of data with one or more factors of classification, diagrammatic representation frequency distributions and cumulative frequency distributions and their graphical presentations, histograms, frequency polygons, frequency curves and ogives, Stem and Leaf.

Univariate data: different measures of location, mean- AM, GM and HM, median, mode, different measures of dispersion, range, MD, SD, QD, relative dispersion, moments, factorial moments, skewness and kurtosis. Sheppard's correction and Charliers' check, outlier Detection. Box-plot.

- **Probability -I:**

Random Experiment: Trials, events, outcomes, mutually exclusive events, equally likely and exhaustive, Sample point, Sample space, Different types of events.

Definition of probability: Classical and relative-frequency approach to probability, limitations of Classical definition, Geometric definition of Probability, Kolmogorov's Axiomatic definition. Examples based on classical approach, repeated trials and geometric definition of probability.

Some theorems on Probability: Probability of union and intersection of events, Poincare's theorem, Boole's Inequality, Theorem of total probability. Conditional probability and Independence of events, theorem of compound probability, Bayes' Theorem and its applications.

Random Variables : Definition of discrete and continuous random variables, cumulative distribution function (c.d.f.) and its properties, probability mass function (p.m.f.) and probability density function (p.d.f), Expectation and Moments, Dispersion, Skewness, Kurtosis, Quartiles.

Probability Inequalities: Markov's and Chebyshev's inequalities, Uniqueness and Inversion Theorems (without proof), Weak Law of Large numbers (without proof).

List of Practical:

1. Data visualization using the statistical software R. Bar diagram, histogram, ogive, pie chart etc.

2. Computation of measures of central tendency and dispersion using the statistical software

   R. Use of an appropriatemeasure and interpretation of results.

3. Computation of the measures of skewness and kurtosis using the statistical software R.
4. Outlier detection using Box plot in R.
5. Q-Q plot, stem and leaf plot using the statistical software R.
6. Graphical interpretation of WLLN using R.

Suggested Readings:

1. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2013). Fundamental of Statistics, Vol I , World Press, Kolkata.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

3. Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
4. Mood, A.M. Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.
5. Chung, K. L.(1974) A Course in Probability Theory .Second Edition. Cambridge University Press.
6. Feller, William. An Introduction to Probability Theory and its Applications .Vol-I. Wiley.
7. Hoel P.G., Port S.C., Stone C.J. Introduction to Probability Theory

Suggested OnlineLinks/Readings:
   a. http://heecontent.upsdc.gov.in/SearchContent.aspx

   b. https://swayam.gov.in/explorer?searchText=statistics

   c. https://nptel.ac.in/course.html

   d. https://www.edx.org/search?q=statistics

   e. https://www.coursera.org/search?query=statistics&

Semester – I (SEC)

Course Name: Index Number and Demography

Course Code: BSCSTSSE101

Course Type: **SEC** **(Theoretical)**	Course Details: SEC- 1		L-T-P: 2-1-0	
Credit: 3	**Full Marks: 50**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		-	15	-	35

Index numbers:

Definition of index numbers, price and quantity index numbers; criteria of good index number, their construction, Laspeyres', Paasche's and Fisher's index numbers. Value index. Tests of index numbers. Fixed-base and chain-base index numbers. Consumer price index number, Wholesale price index number and index of industrial production. Uses of price index numbers and its limitations.

Demography:

Sources of demographic data, census, registration, ad hoc surveys, hospital records, demographic profiles of the Indian census. Measurement of Mortality and Life Table: Crude death rate, Standardized death rates, Age-specific death rates, Infant Mortality rate, Death rate by cause, Complete life table and its main features, Uses of life table. Measurement of Fertility: Crude birth rate, general fertility rate, age specific birth rate, total fertility rate, gross reproduction rate, and net reproduction rate. Rates and ratios.

Suggested Readings:

1. Allen, R.G.D. Allen (1975).Index Numbers in Theory and Practice. Macmillan.
2. Benjamin, B. (1959). Health and Vital Statistics. Allen and Unwin.
3. Mudgett, B.D.(1951). Index Numbers. John Wiley.
4. Mukhopadhyay, P. (1994). Applied Statistics. New Central Book Agency Pvt. Ltd. Calcutta.
5. Srinivasan, K. (1998). Demographic Techniques and Applications. Sage Publications.
6. Srivastava O.S. (1983). A TextBook of Demography. Vikas Publishing House.

Semester – II (Major)

Course Name: Bivariate Data Analysis and Probability- II.

Course Code: BSCSTSMJ201

Course Type: **MAJOR** **(Theoretical + Practical)**	Course Details: MJC- 2		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

- **Bivariate Data Analysis:**

Correlation and Regression: Meaning of correlation, scatter diagram, Karl Pearson's correlation coefficient and its properties, probable error of Correlation Coefficient. Correlation Ratio, Intra–class Correlation, Multiple and Partial Correlation– Yule's.

Rank correlation – Spearman's and Kendall's measures (tied and untied case).

Regression: Concept of Linear regression and properties of regression coefficient, plane of regression, standard error of Estimate and residual variance, R^2, Principles of least squares, Fitting of polynomial and exponential curves.

Association between two attributes: Contingency table, Marginal and Conditional independence. Odds ratio, Properties of odds ratio, Relative Risk, Relationship between odds ratio and relative risk.

- **Probability II:**

Probability distributions of a few standard discrete random variables: Uniform, Binomial, Poisson, Geometric, Hyper-geometric and Negative Binomial distribution.

Probability distributions of a few standard continuous random variables: Rectangular, Normal, Exponential, Gamma, Beta-I, Beta-II, Cauchy and log-Normal distribution. Fitting of univariate standard probability distributions with the data. Central Limit Theorem (iid case only).

Bivariate probability distributions: Properties of pmf, pdf and cdf of bivariate random variables. Marginal and conditional distributions, Sum and Product rules of expectations, Conditional expectation. Bivariate Normal (BVN) distribution and its properties. Marginal and conditional pdf.

List of practical:

1. Analysis of bivariate data with the application of correlation and linear regression in R.
2. Computation of rank correlation (both ties and non ties) in R.
3. Fitting of polynomial and exponential curves by least square method using the statistical software R.
4. Computing odd ratio and relative risk using R.
5. Fitting of univariate (binomial, poisson, geometric, hypergeometric, negative binomial, normal) distributions and computation of expected frequencies, mean variance, m.g.f. by using R programming.
6. Problems based on area property of normal distribution using normal table.
7. Q-Q plot to check the normality of the data using R.
8. Theory of Attributes: Making contingency table and computation of measure of association using the statistical software R. Calculation of odds ratio and relative risk.

Suggested Readings:

1. S. C. Gupta and V. K.Kapoor. Fundamentals of Mathematical Statistics.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

3. B. L.Aggarwal. Basic Statistics.

4. Ross, S, Prentice Hall. A First Course in Probability.

5. Feller, W, John Wiley. An Introduction to Probability Theory and its Applications.

Suggested OnlineLinks/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx

- https://swayam.gov.in/explorer?searchText=statistics

- https://nptel.ac.in/course.html

- https://www.edx.org/search?q=statistics

- https://www.coursera.org/search?query=statistics&

<mark>**Semester – II (Minor)**</mark>

Course Name: Bivariate Data Analysis and Probability- II.

Course Code: BSCSTSMJ201

Course Type: **MINOR** (**Theoretical + Practical**)	Course Details: MNC- 2		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

- **Bivariate Data Analysis:**

Correlation and Regression: Meaning of correlation, scatter diagram, Karl Pearson's correlation coefficient and its properties, probable error of Correlation Coefficient. Correlation Ratio, Intra–class Correlation, Multiple and Partial Correlation– Yule's.

Rank correlation – Spearman's and Kendall's measures (tied and untied case).

Regression: Concept of Linear regression and properties of regression coefficient, plane of regression, standard error of Estimate and residual variance, R^2, Principles of least squares, Fitting of polynomial and exponential curves.

Association between two attributes: Contingency table, Marginal and Conditional independence. Odds ratio, Properties of odds ratio, Relative Risk, Relationship between odds ratio and relative risk.

- **Probability II:**

Probability distributions of a few standard discrete random variables: Uniform, Binomial, Poisson, Geometric, Hyper-geometric and Negative Binomial distribution.

Probability distributions of a few standard continuous random variables: Rectangular, Normal, Exponential, Gamma, Beta-I, Beta-II, Cauchy and log-Normal distribution. Fitting of univariate standard probability distributions with the data. Central Limit Theorem (iid case only).

Bivariate probability distributions: Properties of pmf, pdf and cdf of bivariate random variables. Marginal and conditional distributions, Sum and Product rules of expectations, Conditional expectation. Bivariate Normal (BVN) distribution and its properties. Marginal and conditional pdf.

List of practical:

1. Analysis of bivariate data with the application of correlation and linear regression in R.

2. Computation of rank correlation (both ties and non ties) in R.

3. Fitting of polynomial and exponential curves by least square method using the statistical software R.

4. Computing odd ratio and relative risk using R.

5. Fitting of univariate (binomial, poisson, geometric, hypergeometric, negative binomial, normal) distributions and computation of expected frequencies, mean variance, m.g.f. by using R programming.

6. Problems based on area property of normal distribution using normal table.

7. Q-Q plot to check the normality of the data using R.

8. Theory of Attributes: Making contingency table and computation of measure of association using the statistical software R. Calculation of odds ratio and relative risk.

Suggested Readings:

1. S. C. Gupta and V. K.Kapoor. Fundamentals of Mathematical Statistics.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World Press, Kolkata.

3. B. L.Aggarwal. Basic Statistics.

4. Ross, S, Prentice Hall. A First Course in Probability.

5. Feller, W, John Wiley. An Introduction to Probability Theory and its Applications.

Suggested OnlineLinks/Readings:

a. http://heecontent.upsdc.gov.in/SearchContent.aspx

b. https://swayam.gov.in/explorer?searchText=statistics

c. https://nptel.ac.in/course.html

d. https://www.edx.org/search?q=statistics

e. https://www.coursera.org/search?query=statistics&

<p style="text-align:center"><mark>**Semester – II (SEC)**</mark></p>

<p style="text-align:center">Course Name: Numerical Analysis</p>
<p style="text-align:center">Course Code: BSCSTSSE201</p>

Course Type: **SEC** (Theoretical)	Course Details: SEC- 2		L-T-P: 2-1-0	
Credit: 3	**Full Marks: 50**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		-	15	-	35

Numerical Analysis: Factorial with positive and negative index. Operators: Shift operator, forward difference, backward difference, central difference, average, differential and interrelations between them. Finite differences of order n, divided differences of order n and interpolation.

Interpolation: Newton's forward, backward and divided difference interpolation formulae with error term. Lagrange's interpolation formula. Central difference formulae: Gauss and Stirling's formulae. Inverse interpolation: Lagrange's inverse interpolation formula, Method of successive approximation and method of reversion of series. Summation of finite series.

Finding Root of an Equation: Bisection, Regula Falsi and Newton Raphson Methods. Numerical differentiation.

Numerical integration: Newton-Cote's integration formula, Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule and Weddle's rule with error term. Euler-Maclaurin's summation formula. Stirling's approximation to factorial n. Solution of difference equations of first order with variable coefficients and linear difference equations with constant coefficients.

Suggested Readings:

1. S. C. Gupta and V. K.Kapoor. Fundamentals of Mathematical Statistics.

2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2011). Fundamental of Statistics, Vol II, World

3. Bradie, B. (2006). A friendly introduction to Numerical Analysis, Pearson Education, India.

4. Gerald, C. F. and Wheatly, P. O. (2005). Applied Numerical Analysis, Pearson Education, India.

5. Hilderbrand, F.B. (1987). Introduction to Numerical Analysis, Second Edition, Dover Publications.

6. Jain, M.K., Iyengar, S.R. K. and Jain, R.K. (2007). Numerical Methods for Scientific and Engineering Computation, Second Edition, Wiley Eastern Ltd.

7. Saxena, H.C. (2005). Finite Differences and Numerical Analysis, 15th Revised Edn. (Reprint). S. Chand & Co.

Semester- II

Course Name: Basic Statistics

Course Code: MDC203

Course Type: Multidisciplinary (Theoretical)	Course Details: MD- 2		L-T-P: 3-0-0	
Credit: 3	Full Marks: 50	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	15	-	35

Introduction- Origin and development of Statistics, Definition and Scope of Statistics.

Statistical data: Qualitative & Quantitative. Collection of data- primary and secondary data.

Scales of measurement: Nominal, Ordinal, Interval and Ratio. Attribute and Variable (Discrete and continuous).

Frequency distribution of the data. Diagrammatic and Graphical representation of Data: Pie chart, Bar diagram, Histogram, Ogive.

Measures of Central tendency and Dispersion- Measure of central tendency- Mean (AM, GM, HM), Median and Mode. Measures of dispersion- Range, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Root Mean Square Deviation, Coefficient of Variation.

Correlation and Regression- Scatter diagram, Correlation and its properties, Regression equation using Method of least square (linear, bi-variate case only). Spearman rank correlation (non-tie case only).

Probability and Random variable- Classical definition of Probability and its limitations. Geometric and frequency definition of probability. Use of Venn diagram in calculation of probability. Conditional probability and Bayes' Theorem. Definition of random variable. Probability distribution (pmf, pdf, cdf) of discrete and continuous random variable. Expectation of random variable.

Index number- Definition of index number, purpose of index number, Paasche's index number, Laspeyres' index number, Fisher's index number. Time reversal test and factor reversal test, cost of living index number, wholesale price index number.

Time series Data analysis- What is time series data? Different components of time series data and their significance. Finding trend using moving average method, fitting of linear trend equation,

Suggested Readings:

1) A.M. Goon, M.K. Gupta, B. Dasgupta: *Fundamentals of Statistics* (Vol. I)
2) A.M. Goon, M.K. Gupta, B. Dasgupta: *Fundamentals of Statistics* (Vol. II)
3) N.G. Das : Statistical Methods (Vol I and II)
4) S. Ross : A First Course in Probability.

Semester–III (Major)

Course Name: Sampling Distributions

Course Code: BSCSTSMJ301

Course Type: **MAJOR** (Theoretical + Practical)	**Course Details: MJC- 3**		**L-T-P: 3-0-4**	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	**15**	**20**	**35**

Unit I

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean, sample variance and sample proportion. Order Statistics: Introduction, distribution of the rth order statistic, smallest and largest order statistics. Joint distribution of rth and s^{th} order statistics, distribution of sample median and sample range.

Unit II

Concept of degrees of freedom, Exact sampling distribution: Definition and derivation of pdf of χ^2 with n degrees of freedom (d.f.) using mgf, nature of pdf curve for different degrees of freedom, mean, variance, mgf, mode, additive property and limiting form of χ^2 distribution.

Unit III

Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its pdf, nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution.

Unit IV

Snedecor's F Distribution: Derivation of pdf, nature of pdf nature of pdf curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1, n_2)$ and various other properties. Relationship between t, F and χ^2 distributions.

List of Practical:

Problems on

1. sampling distributions of sample mean and sample variance of normal population.

2. generating random samples from a chi square ($\chi2$) distribution using other standard distributions (like binomial, normal etc.)

3. generating random samples from t and F distributions using other standard distributions (like binomial, normal etc.)

Suggested Readings:

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

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

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

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

5. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, 2nd Ed., (Reprint) John Wiley and Sons.

6. Chougule, S, P.(2022) .Statistical Inference: Testing of Hypothesis. Bluerose Publishers Pvt. Ltd.; First edition

Online links/Readings:

- http://heecontent.upsdc.gov.in/SearchContent.aspx
- https://swayam.gov.in/explorer?searchText=statistics
- https://nptel.ac.in/course.html
- https://www.edx.org/search?q=statistics
- https://www.coursera.org/search?query=statistics&

Semester – III (Major)

Course Name: Linear Algebra

Course Code: BSCSTSMJ302

Course Type: **MAJOR** (Theoretical + Practical)	Course Details: MJC- 4		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

Unit 1

Definition of vectors, operation of vectors (angle, distance etc.). Vector Spaces over the field of real numbers, subspaces, linear span, linear dependence and independence, dimension and basis and related theorems. Orthogonal vectors, Gram-Schmidt Orthogonalization. Algebra of matrices. Linear transformation. Matrices with special structures: symmetric and skew symmetric, diagonal, scalar, identity, triangular and related theorems. Idempotent and orthogonal matrices. Trace of a matrix. Elementary operations on matrices. Partitioned matrices.

Unit 2

Rank and inverse of a matrix and their properties. Null space of a matrix. Theorems on rank of sum and product of two matrices. Singular and non-singular matrices. Inverse of a partitioned matrix. Reduction of matrices to echelon form and Hermite canonical form.

Unit 3

System of linear equations $Ax = b$ conditions for consistency, uniqueness of solution, infinite solutions. Solution of the system $Ax = b$. Applications. Determinants of matrices- Definition, Properties and evaluation of determinants of order 3 or above. Cramer's rule for solution of the system $Ax = b$. Adjoint and inverse of a square matrix.

Unit 4

Properties of Characteristic polynomial of a matrix, characteristic roots and characteristic vectors. Quadratic forms, their classification and canonical reduction.

List of Practical:

Problems on

1. operations on vectors, subspaces, linear independence of vectors, basis and Gram-Schmidt orthogonalization process.
2. finding the rank and inverse of a matrix by elementary row operations, transformation of matrices, transforming matrix.
3. evaluation of determinants of matrices.
4. solution of linear system of equations Ax=b by sweep-out method and method of pivotal condensation.
5. finding characteristic roots and vectors of matrices, quadratic forms.

Suggested Readings:

1. Artin, M. (1994): Algebra. Prentice Hall of India.
2. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International
3. Chakraborty, Arnab (2014): Linear Algebra, first edition. Sarat Book House.
4. Datta, K.B (2002): Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd.
5. Gun, A.M. (1988): Vectors and Matrices, World Press
6. Gupta, S.C. (2008).: An Introduction to Matrices (Reprint). Sultan Chand & Sons.
7. Hadley, G (2002) : Linear Algebra. Narosa Publishing House (Reprint).
8. Rao, A.R. and Bhimasankaram, P. (1996): Linear Algebra
9. Rao, C.R. (2009). Linear Statistical Inference and its Applications, Second Edition, Wiley.
10. Schaum's Outline Series (2006): Linear Algebra, Tata McGraw-Hill Edition, 3rdEdition
11. Searle, S.R (1982).: Matrix Algebra Useful for Statistics. John Wiley &Sons

Semester–III   (Minor)

Course Name: Introduction to Statistical Inference

Course Code: BSCSTSMN301

Course Type: **MINOR** (Theoretical + Practical)	Course Details: MNC-3		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

Unit I

Parametric model, parameter, random sample and its likelihood, brief idea of statistics and their sampling distributions. Point estimation: Method of moments, Maximum likelihood estimation. Properties of good estimators: unbiased estimator, Consistency and efficiency of estimators.

Unit II

Testing of hypothesis : Definitions of hypothesis, null hypothesis (H0), and alternative hypothesis (H1), Type I and Type II errors, Significance level (α) and power of the test, Test for population proportion, One sample Z- test, Two-sample z-test for comparing means, One-sample t-test, Independent two-sample t-test.

Unit III

Definition and purpose of interval estimation, Point estimation vs. interval estimation, Confidence intervals: Basic concepts and interpretation, Confidence interval for a population mean (z-distribution and t-distribution). Application and interpretation in real-world scenarios.

Unit IV

Non Parametric Inference: Introduction to non-parametric tests, Chi-square goodness-of-fit test. Chi-square test for independence (2x2 contingency table), Mann-Whitney U test, Wilcoxon signed-rank test, Kruskal-Wallis test.

List of Practical: (Use R for computation)

Problems on

1. Maximum Likelihood Estimation for Population Mean and Proportion.
2. Testing of significance and confidence intervals for single proportion.
3. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
4. Testing of goodness of fit using χ^2 distributions.
5. Testing and confidence intervals of equality of two population variances.
6. Man-Whitney U test.
7. Sign test, Wilcoxon signed-rank test.

Suggested Readings:

1. Bickel, P.J. and Doksum, K.A. (2000). Mathematical Statistics, Second Edition, Prentice Hall.

2. Casella, G. and Berger, R.L. (2001). Statistical Inference, Second Edition, Cengage Learning.

3. Gupta, M.K., Gun, A.M., and Dasgupta, B. (2013). An Outline of Statistical Theory, Vol. 2. The World Press Publishers Pvt. Ltd., Calcutta.

4. Hogg, R.V., McKean J.W. and Craig, A.T. (2006). Introduction to Mathematical Statistics, Paperback Edition, Pearson.

5. Kale, B.K. (2005). A First Course on Parametric Inference. Alpha Science International Ltd.

6. Mood, A.M., Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edition., (Indian Edition), Tata McGraw-Hill Pub. Co. Ltd.

7. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference. PHI Learning Pvt. Ltd., New Delhi.

8. Rao, C.R. (2009). Linear Statistical Inference and its Applications, Second Edition, Wiley.

9. Rohatgi, V. K. and Saleh A.K.M.E. (2008). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Suggested OnlineLinks/Readings:

a. http://heecontent.upsdc.gov.in/SearchContent.aspx

b. https://swayam.gov.in/explorer?searchText=statistics

c. https://nptel.ac.in/course.html

d. https://www.edx.org/search?q=statistics

e. https://www.coursera.org/search?query=statistics&

Semester – IV (Major)

Course Name: Statistical Inference- I

Course Code: BSCSTSMJ401

Course Type: **MAJOR** (Theoretical + Practical)	Course Details: MJC- 5		L-T-P: 3-0-4	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

Unit I

Concepts of parameter, parametric space, statistic, estimator, estimate. Point estimation: Properties of good estimators, mean square and minimum mean square error estimator, unbiasedness, BLUE and minimum variance unbiased estimator, Cramer- Rao lower bound, Fisher amount of information.

Unit II

Consistency of estimators and sufficient conditions for consistency, relative efficiency of an estimator, unbiased estimator, sufficiency, factorization theorem, concept of complete sufficient statistics, Rao- Blackwell and Lehmann Scheffe theorems (without proof).

Unit III

Minimum variance unbiased estimators for the parameters of binomial, Poisson, gamma and normal families. Cramer- Rao inequality and MVB estimators. Methods of estimation: Moments, maximum likelihood, minimum chi-square, least squares with examples.

Unit IV

Point estimators of measures of location, dispersion and other useful parameters. Concepts of confidence interval and confidence coefficient, confidence intervals for the parameters of univariate normal, two independent normal distributions and exponential distributions.

List of Practicals:

Problems on

1. Checking the unbiasedness using suitable empirical examples to prove that the sample mean is an unbiased estimator of population mean.

2. Checking the unbiasedness of sample variance and sample mean square as an estimator of population variance.

3. Calculating by the method of maximum likelihood for Binomial, Poisson and Normal parameters and obtaining variances of these estimates.

4. Calculation of asymptotic distribution of maximum likelihood estimators.

5. Calculations of Minimum chi-square, Moment estimators for standard distributions.

6. Calculation of Interval estimates, for mean and variance of normal distribution.

Suggested Readings:

1. Bickel, P.J. and Doksum, K.A. (2000). Mathematical Statistics, Second Edition, Prentice Hall.

2. Casella, G. and Berger, R.L. (2001). Statistical Inference, Second Edition, Cengage Learning.

3. Gupta, M.K., Gun, A.M., and Dasgupta, B. (2013). An Outline of Statistical Theory, Vol. 2. The World Press Publishers Pvt. Ltd., Calcutta.

4. Hogg, R.V., McKean J.W. and Craig, A.T. (2006). Introduction to Mathematical Statistics, Paperback Edition, Pearson.

5. Kale, B.K. (2005). A First Course on Parametric Inference. Alpha Science International Ltd.

6. Mood, A.M., Graybill, F.A. and Boes, D.C. (2011). Introduction to the Theory of Statistics, 3rd Edition., (Indian Edition), Tata McGraw-Hill Pub. Co. Ltd.

7. Rajagopalan, M. and Dhanavanthan, P. (2012). Statistical Inference. PHI Learning Pvt. Ltd., New Delhi.

8. Rao, C.R. (2009). Linear Statistical Inference and its Applications, Second Edition, Wiley.

9. Rohatgi, V. K. and Saleh A.K.M.E. (2008). An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Suggested OnlineLinks/Readings:

a. http://heecontent.upsdc.gov.in/SearchContent.aspx

b. https://swayam.gov.in/explorer?searchText=statistics

c. https://nptel.ac.in/course.html

d. https://www.edx.org/search?q=statistics

e. https://www.coursera.org/search?query=statistics&

<p style="text-align:center"><mark>Semester – IV (Major)</mark></p>

Course Name: Sampling Techniques and Indian Official Statistics.

Course Code: BSCSTSMJ402

Course Type: **MAJOR** (Theoretical + Practical)	Course Details: MJC- 6		L-T-P: 3-0-4	
Credit: 5	Full Marks: 100	CA Marks		ESE Marks	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

Unit I

Basic concepts: population and sample, census and sample survey, sampling frame, sampling distribution, standard error, sampling design, sampling and non-sampling errors, sample surveys, principles of sample survey, principal steps in sample survey, limitations of sampling, Sample survey versus complete enumeration survey.

Unit II

Simple Random Sampling (with and without replacement): Notations and terminology, various probabilities of selection. Random numbers tables and its uses. Methods of selecting simple random samples, lottery method, method based on random numbers. Estimates of population total, mean and their variances and standard errors, determination of sample size, simple random sampling of attributes.

Unit III

Stratified random sampling: principles of stratification, notations, estimation of population mean and variances, cost function, allocation techniques, proportional and optimum allocations. Comparison of stratified sampling with simple random sampling.

Unit IV

Probability proportional to size (PPS) sampling- Definition and terminology, cumulative total method and Lahiri's methods of selecting PPS sampling with and without replacement. Systematic sampling: linear systematic sampling, estimates of population total, mean, and their variances and standard errors. Interpenetrating sub samples. Systematic sampling with linear trend. Circular systematic sampling, concepts and examples. Comparison of systematic sampling with simple random sampling.

Unit V

Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and statistics.

Official Statistics: (a) Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility (b) Compilation, Collection, Processing, Analysis and Dissemination, Agencies Involved, Methods

National Statistical Organization: Vision and Mission, NSSO, CSO and State Bureau of Economics and statistics; roles and responsibilities; Important activities, Publications, etc.

National Statistical Commission: Need, Constitution, its role, functions, etc.; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts

List of Practicals:

Problems on

1. Simple Random Sampling – Lottery, random number method and other related problems, Sample size calculation.

2. Stratified Random Sampling – Problems related to Different types of allocation.

3. Stratified Random Sampling – Problems related to Optimum allocation and other related problems.

 4. Sample size calculations.

5. Systematic Sampling – Problems related to Linear and Circular systematic sampling.

6. Probability Proportional to Size Sampling: Cumulative total method & Lahiri's method.

Suggested Readings:

1. Ardilly, P. and Yves T. (2006). Sampling Methods: Exercise and Solutions. Springer.

2. Cochran, W.G. (2007). Sampling Techniques. (Third Edition). John Wiley & Sons, New Delhi

3. Des Raj. (1976). Sampling Theory. Tata McGraw Hill, New York. (Reprint 1979)

4. Mukhopadyay, P. (2007). Survey Sampling. Narosa Publisher, New Delhi.

5. Sampath, S. (2005). Sampling Theory and Methods, 2nd Edition, Alpha Science International Ltd.

 6. Singh, D. and Choudhary, F.S. (1977). Theory and Analysis of Sample Survey Designs. Wiley Eastern Ltd, New Delhi. (Reprint 1986)

7. Sukhatme, P.V. and Sukhatme, B.V. (1970). Sampling Theory Surveys with Applications (Second Edition). Iowa State University Press.

8. Thompson, S.K. (2012). Sampling. John Wiley & Sons.

<mark>**Semester – IV (SEC)**</mark>

Course Name: Real Analysis.

Course Code: BSCSTSSE401

Course Type: **SEC** **(Theoretical)**	Course Details: SEC- 3		L-T-P: 2-1-0	
Credit: 3	**Full Marks: 50**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		-	**15**	**-**	**35**

Unit I

Introduction to Real Analysis: Bounded and unbounded sets, neighbourhood of a point, Supremum and infimum, review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $sinx$, $cosx$, $log(1 + x)$, Uncountable sets and Uncountability of $\mathbb{R}$.

Unit II

Sequences and Series of real numbers: Sequences of real numbers, their convergence, and limits. Cauchy sequences and their convergence. Monotonic sequences and their limits. Limits of standard sequences. Infinite series and its convergence, and divergence. Convergence of series with non-negative terms. Tests for convergence and divergence of a series. Comparison test, limit comparison test, D'Alembert's ratio test, Cauchy's n[th] root test, Cauchy's condensation test and integral test. Absolute convergence of series. Leibnitz's test for the convergence of alternating series. Conditional convergence. Convergence of power series and radius of convergence.

Suggested Readings:

1. Bartle, R.G. and Sherbert, I D. R. Introduction to Real Analysis, 3rd Ed., John Wiley and Sons.

2. Berberian, S.K. (1994). A First Course in Real Analysis, Springer Verlag, New York.

3. Shirali, S. andH. L. Vasudeva (2013). An Introduction to Mathematical Analysis, Alpha Science International Ltd.

4. Thomson, Brian S., Andrew. M. Bruckner and Judith B. Bruckner (2001). Elementary Real Analysis, Prentice Hall.

<mark>**Semester -IV(Minor)**</mark>

Course Name: Introduction to Applied Statistics

Course Code: BSCSTSMN401

Course Type: **MINOR** (Theoretical + Practical)	**Course Details: MNC- 4**		**L-T-P: 3-0-4**	
Credit: 5	**Full Marks: 100**	**CA Marks**		**ESE Marks**	
		Practical	**Theoretical**	**Practical**	**Theoretical**
		30	15	20	35

Unit I (Time Series Data Analysis):

Definition and examples of time series data, Components of time series: trend, seasonality, cyclic, and irregular components, Time series plots and visualization.

Measurement of Trend: Method of Moving Average, Fitting of Mathematical Curve. Measurement of Seasonal fluctuation: Ratio to trend, Ratio to Moving Average.

Concept of stationarity in time series. Differencing and transformations to achieve stationarity. Autocorrelation Function (ACF).

Case studies and real-world data analysis.

Unit II (Vital Statistics):

Definition and scope of vital statistics, Rates and ratios, importance of vital statistics in public health and demography, Vital registration systems: Births, deaths, marriages, and divorces. International sources: WHO, UN, World Bank etc.

Death Statistics: Measures of mortality: Crude Death Rate (CDR), Age-Specific Death Rates (ASDR), Standardized death rates (STDR), Infant Mortality Rate (IMR)

Birth Statistics: Measures of fertility and birth rates: Crude Birth Rate (CBR), Total Fertility Rate (TFR), Gross Reproduction Rate (GRR), Net Reproduction Rate (NRR), Crude Rate of Natural Increase (CRNI). Infant mortality rate (IMR) and under-5 mortality rate.

Life Tables: Construction and interpretation of life tables, Measures of mortality derived from life tables.

Unit III (Official Statistics):
Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and statistics.

Official Statistics: (a) Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility (b) Compilation, Collection, Processing, Analysis and Dissemination, Agencies Involved, Methods

National Statistical Organization: Vision and Mission, NSSO, CSO and State Bureau of Economics and statistics; roles and responsibilities; Important activities, Publications, etc.

National Statistical Commission: Need, Constitution, its role, functions, etc.; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts.

List of Practical: (Use R for computation)

Problems on

1. Plot time series data using R.

2. Measurement of Trend: Method of Moving Average, Fitting of Mathematical Curve

3. Measurement of Seasonal fluctuation: Ratio to trend, Ratio to Moving Average.

4. Plotting ACF and their interpretation.

5. Calculation of Birth and Death rates.

6. Problems on lifetables.

Suggested Readings:

1. Box, G.E.P., Jenkins, G.M., Reinsel, G.C. and Ljung, G.M. (2015). Time Series Analysis: Forecasting and Control. 5th Edition. John Wiley & sons, Inc.

2. Brockwell, P.J. and Davis, R.A. (2003). Introduction to Time Series Analysis. Springer.

3. Chatfield, C. (2001). Time Series Forecasting., Chapman & Hall.

4. Fuller, W.A. (1996). Introduction to Time Series. 2nd Edition. Wiley.

5. Kendall, M.G. and Ord, J.K. (1990). Time Series. 3rd edition. Edward Arnold.

6. Montgomery, D.C., Jennings, C.L. and Kulahci, M. (2012). Introduction to Time Series Analysis and Forecasting, John Wiley.

7. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). Fundametal of Statistics,Vol. II, 4th Ed., World Press, Kolkata.

Suggested OnlineLinks/Readings:

a. http://heecontent.upsdc.gov.in/SearchContent.aspx

b. https://swayam.gov.in/explorer?searchText=statistics

c. https://nptel.ac.in/course.html

d. https://www.edx.org/search?q=statistics

e. https://www.coursera.org/search?query=statistics&