MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI – 12.

B.Sc., Statistics

under CBCS with effect from the academic year 2021-2022 and onwards

Learning Outcome based Curriculum

Vision of the University

To provide quality education to reach the un-reached

Mission of the University

- To conduct research, teaching and outreach progrmmes to improve conditions of human living.
- To create an academic environment that honours women and men of all races, caste, creed, cultures, and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity.
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development.
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled.

Preamble

The **B.Sc., Statistics** degree programme of Manonmaniam Sundaranar University through its affiliated Colleges aims to provide a strong foundation for higher studies in Statistics to teach essential statistical methods for enabling the students for dealing with real world situations comprising uncertainty. It augments the ability of students to link statistical concepts and methods in other fields and to develop computer programs for carrying out essential statistical computations. It exposes towards the basic opensource software and foster interests among students to work as Statistics and Data Analytics professionals. It prepares skilled human resource for the needs of Statistics personnel in Central and State Government organizations and private sector institutions.

MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI – 12.

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Eligibility for Admission:

Candidates who have passed the higher secondary examination conducted by Government of Tamil Nadu with Statistics / Mathematics / Business Statistics / Business Mathematics / Computer Science as one of the courses or other equivalent examinations are eligible for admission to the first year of the B.Sc., (Statistics) degree program.

Duration of the Program:

The duration of the program is three academic years comprising of six semesters with two semesters in each academic year. Examinations will be conducted at the end of each semester for the respective courses.

Medium of Instructions and Examinations:

The medium of instructions and examinations for the courses of Part I and Part II shall be in the languages concerned. For the courses of Part III and Part IV, the medium of instructions and examinations shall be in English.

Examination

The regulations for examination, passing minimum in each course and classification of successful candidates and award of ranks are at par with the regulations for other undergraduate science programs of the University.

SCHEME OF EXAMINATION

Sem. (1)	Pt. I/II/ III/ IV/ V (2)	Course No. (3)	Course Category (4)	Course Title (5)	Contact Hrs./week (6)	**L** Hrs. / week (7)	**T** Hrs. / week (8)	**P** Hrs. / week (9)	**C** Credits (10)
I	I	1	Language	Tamil / Other Languages	6	6	0	0	4
	II	2	Language	Communicative English - I	6	6	0	0	4
	III	3	Core-I	Descriptive Statistics	6	4	2	0	4
	III	4	Add on Major (Mandatory)	Professional English for Physical Sciences - I	4	4	0	0	4
	III	5	Allied - I	Mathematics for Statistics - I	6	4	2	0	3
	IV	6	Common	Environmental Studies	2	2	0	0	2
	Subtotal				**30**	**26**	**4**	**0**	**21**
II	I	7	Language	Tamil / Other Languages	6	6	0	0	4
	II	8	Language	Communicative English - II	6	6	0	0	4
	III	9	Core-II	Time Series and Official Statistics	5	4	1	0	4
	III	10	Major Practical-I	Statistics Practical – I	4	0	0	4	4

	III	11	Add on Major (Mandatory)	Professional English for Physical Sciences - II	4	4	0	0	4
	III	12	Allied - II	Programming with C	3	3	0	0	3
	IV	13	Common	Value Based Education : சமூக ஒழுக்கங்களும் பண்பாட்டு விழுமியங்களும் / Social Harmony	2	2	0	0	2
	Subtotal				**30**	**25**	**1**	**4**	**25**
III	I	14	Language	Tamil / Other Languages	6	6	0	0	4
	II	15	Language	English	6	6	0	0	4
	III	16	Core-III	Probability Theory	6	4	2	0	4
	III	17	Allied-III	Mathematics for Statistics - II	4	3	1	0	3
	III	18	Skill Based Core	Mathematical Computations using *R / Python*	4	3	0	1	4
	III	19	Non-Major Elective	Elements of Statistics - I	2	2	0	0	2
	IV	20	Common	Yoga	2	1	0	1	2
	Subtotal				**30**	**25**	**3**	**2**	**23**
IV	I	21	Language	Tamil / Other Languages	6	6	0	0	4
	II	22	Language	English	6	6	0	0	4
	III	23	Core-IV	Statistical Distributions	4	4	0	0	4
	III	24	Major Practical - II	Statistics Practical – II	3	0	0	3	4
	III	25	Allied- IV	Real Analysis and Matrix Theory	3	3	0	0	3
	III	26	Skill Based Core	Numerical Methods	4	3	1	0	4
	III	27	Non-Major Elective	Elements of Statistics – II	2	2	0	0	2
	IV	28	Common	Computers for Digital Era	2	2	0	0	2
	V	29	Extension Activity	NCC / NSS / YRC / YWF	0	0	0	0	1
	Subtotal				**30**	**26**	**1**	**3**	**28**
	III	30	Core - V	Statistical Inference - I	6	4	2	0	4
V	III	31	Core-VI	Sampling Techniques	6	4	2	0	4
	III	32	Core-VII	Econometrics	6	4	2	0	4
	III	33	Major Elective-I	Demographic Methods / Biostatistics	6	4	2	0	4
	III	34	Major Practical – III	Statistics Practical-III	4	0	0	4	4
	IV	35	Skill Based - Common	Personality Development / Effective Communication / Youth Leadership	2	2	0	0	2
	Subtotal				**30**	**18**	**08**	**4**	**22**
	III	36	Core - VIII	Statistical Inference - II	6	4	2	0	4
VI	III	37	Core - IX	Design of Experiments	6	4	2	0	4
	III	38	Core-X	Statistical Quality Control & Operations Research	6	4	2	0	4
	III	39	Major Elective-II	Stochastic Processes / Regression Analysis	4	4	0	0	4
	III	40	Major Practical - IV	Statistics Practical-IV	4	0	0	4	4
	III	41	Major Practical -V / Mini Project	Statistics Practical-V / Mini Project	4	0	0	4	4
	Subtotal				**30**	**16**	**6**	**8**	**24**

Note 1:

Statistics Practical – I : *Based on the courses Descriptive Statistics, Time Series and Official Statistics*

Statistics Practical – II : *Based on the courses Probability Theory, Statistical Distributions*

Statistics Practical – III : *Based on the courses Statistical Inference – I, Sampling Techniques, Econometrics*

Statistics Practical – IV : *Based on the courses Statistical Inference – II, Design of Experiments*

Statistics Practical – V : *Based on the course Statistical Quality Control &Operations Research*

Note 2:

Elective – I: *Demographic Methods /Biostatistics*

Elective – II: *Stochastic Processes /Regression Analysis*

Programme Outcomes (POs)

On completion of the B.Sc., Statistics degree programme, the students will be able to

PO1: Pursue higher studies in Statistics

PO2: Apply knowledge on statistical methods to the real-world problems

PO3: Select and apply appropriate statistical methods for analyzing given database and to make meaningful interpretations

PO4: Draw relevant inferences in decision-making problems involving uncertainty

PO5: Plan and conduct sample surveys

PO6: Develop computer programs and to use statistical software for carrying out statistical computations and data analysis

PO7: Succeed in national and state level competitive examinations; to work as Statistics personnel in Central and State Government organizations and private sector institutions

Programme Specific Outcomes (PSOs)

On completion of the B.Sc., Statistics degree programme, the students will be able to

PSO1: Plan sample surveys and analyze the outcomes

PSO2: Handle data sets and describe their inherent properties employing knowledge acquired on statistics software

PSO3: Select and apply appropriate statistical methods for analyzing data

PSO4: Understand, Interpret and explain the relationships among the characteristics in the data

PSO5: Learn the procedures for making optimal inferences in decision making situations

PSO6: Solve mathematical problems applying statistical theory

PSO7: Develop computer programs for statistical computations

SYLLABUS

SEMESTER – I

1.1 Tamil / Other Languages

1.2 Communicative English-I

1.3 DESCRIPTIVE STATISTICS (Core-I)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		DESCRIPTIVE STATISTICS	4	2	0	4
Prerequisites		Basic knowledge of Statistics	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Understand the origin, significance and scope of Statistics.
- Know the significance of presenting data in the form of tables and diagrams.
- Learn computational aspects of basic statistical measures.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand the scope and necessity of Statistics.	K1, K2
CO2	Able to obtain, tabulate and present the data in tables, diagrams and graphs.	K1-K3 and K5
CO3	Apply the formula and compute descriptive measures of statistics.	K2, K3
CO4	Analyze the importance of the data and interpret the calculated results	K2, K4
CO5	Able to choose appropriate curves and to fit them for given data	K1-K3
CO6	Develop computer programs for carrying out computations related to this course	K1 –K6
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit - I

Origin, scope, limitations and misuses of Statistics – Collection – Classification - Tabulation of data. Population and Sample - Types of Data – Nominal, ordinal, Interval and ratio. Diagrammatic and graphic representation of data.: line diagram, frequency polygon, frequency curve, histogram and Ogive curves.

Unit - II

Measures of central tendency: mean, median, mode, geometric mean and harmonic mean. Partition values: Quartiles, Deciles and Percentiles. Measures of Dispersion: Mean deviation, Quartile deviation and Standard deviation – Coefficient of variation. Skewness and Kurtosis.

Unit - III

Linear correlation - scatter diagram, Pearson's coefficient of correlation, computation of co-efficient of correlation from a bivariate frequency distribution, Rank correlation, Coefficient of concurrent deviation- Simple linear regression equations - properties of regression coefficients

Unit - IV

Curve fitting: principle of least squares, fitting of the curves of the form $y = a+bx$, $y = a+bx+cx^2$ and Exponential and Growth curves.

Unit - V

Test of Significance: Testing of hypothesis, two types of errors, level of significance, critical region, Students' t – test, Paired t-test and Chi-square test-ANOVA.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

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BOOKS FOR STUDY:

1. Gupta, S.C. and V.K. Kapoor (2020) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
2.Goon, A.M., M.K. Gupta and B. Das Gupta (2017) Fundamentals of Statistics- Vol. I. World Press Ltd, Kolkata.
3. Agarwal, B. L. (2013). Basic Statistics, New Age International Private Limited, New Delhi, India

BOOKS FOR REFERENCE:

1. Anderson, T.W. and Sclove, S.L. (1978) Introduction to Statistical Analysis of data, Houghton Mifflin, Boston.
2. Bhat, B.R., Srivenkataramna, T. and Madhava Rao, K.S. (1996) statistics A Beginner's Text, Vol. I, New Age International, New Delhi.

3. Croxton, F.E. and Cowden, D.J. (1969) Applied General Statistics, Prentice Hall, New Delhi.
4. Spiegel, M.R. and Stephens, L. (2010) Statistics, Schaum's Outline Series, Mc Graw Hill, New York.
5. Holcomb, Z. C. (2017). Fundamentals of Descriptive Statistics, Routledge, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1**.** https://nptel.ac.in/courses/111/104/111104120/
2. https://www.iiserpune.ac.in/~bhasbapat/phy221_files/curvefitting.pdf
3. https://www.toppr.com/guides/maths/statistics/bar-graphs-and- histogram/
4. https://nptel.ac.in/courses/111/104/111104098/

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*Low*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

1.4 Professional English for Physical Sciences-I

1.5 MATHEMATICS FOR STATISTICS-I (Allied-I)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		MATHEMATICS FOR STATISTICS-I	4	2	0	3
Prerequisites		Basic knowledge of Real number system and Calculus	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to

- Understand the concept of Tangent and polar coordinates
- Know the method of finding the envelop and Curvature
- Learn computational aspects of multiple and infinite integral
- Acquire the knowledge on Homogeneous, Non-homogeneous and Linear equations.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand the scope and necessity of Tangent and polar coordinates	K1, K2
CO2	Obtain the values of different types of curvature	K1-K3 and K5
CO3	Apply the formula and compute the different types of integrals	K2, K3
CO4	Evaluate integrals using Beta and Gamma functions.	K2, K4
CO5	Construct Homogeneous, Non-homogeneous and Linear equations.	K1-K3
CO6	Develop computer programs for carrying out computations related to this course	K1 –K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Unit - I

Tangent and Normal-Direction of the tangent-Angle of intersection of curves-subtangent and subnormal - Differential coefficient of the length of an arc of $y=f(x)$ - Polar coordinates - Angle between the radius vector and the tangent-Polar subtangent and polar subnormal - Length of arc in polar coordinates.

Unit - II

Method of finding the envelop - Curvature - Circle, radius and centre of curvature - Cartesian formulae - Evolute and Involute - Radius of curvature when the curve is given in polar coordinates.

Unit - III

Multiple integrals - Evaluation of double integrals - Double integral in polar coordinates - Triple integrals - Applications of multiple integrals.

Unit - IV

Infinite integrals - Integrand becoming infinite at certain points in the interval of integration - Beta and Gamma functions - Properties of Beta functions - Relation between Beta and Gamma functions - Evaluation of integrals using Gamma functions.

Unit - V

Differential equations: Standard types of first order and first degree equations. Variables separable, Homogeneous, Non-homogeneous equations and Linear equation. Equations of first order but of higher degree.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Narayanan, S. and Manicavachagom Pillay, T.K. (2015) Calculus Vol. I, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.
2. Narayanan, S. and Manicavachagom Pillay, T.K. (2014) Calculus Vol. II, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.
3. Narayanan, S. and Manicavachagom Pillay, T.K. (2015) Calculus Vol. III, S.Viswanathan (Printers publishers) Pvt. Ltd., Chennai.

BOOKS FOR REFERENCE:

1. P.Duraipandian and S.Udayabaskaran,(1997) Allied Mathematics, Vol. I & II. Muhil Publishers, Chennai
2. S.P.Rajagopalan and R.Sattanathan,(2005) Allied Mathematics .Vol. I & II. Vikas Publications, New Delhi.
3. P.Kandasamy, K.Thilagavathy (2003) Allied Mathematics Vol-I, II S.Chand & company Ltd., New Delhi-55.

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*Low*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

1.6 Environmental Studies - (Common - Part-IV)

SEMESTER – II

2.1 Tamil / Other Languages

2.2 Communicative English –II

2.3 TIME SERIES and OFFICIAL STATISTICS (Core-II)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		TIME SERIES and OFFICIAL STATISTICS	4	1	0	4
Prerequisites		Basic knowledge of probability theory and Descriptive Statistics	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to

- Learn the Components of Time Series
- Enable to determine the components of given time series
- Acquire knowledge on applications of time series models in emerging fields
- Impart knowledge on Index numbers and their applications
- Provide knowledge on the fundamental methods of Psychological Statistics
- Gain knowledge on Official Statistics and Statistical System in India

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the Components of Time Series and to determine trend values	K1, K2
CO2	Determine the values of Seasonal and Cyclical Components of Time Series and to interpret the results	K1-K5
CO3	Compute Index numbers and evaluate their properties	K2-K5
CO4	Understand the norms and scaling procedures and to measure reliability	K2, K4
CO5	Acquire knowledge on Official Statistics and Statistical System in India	K1-K6
CO6	Develop computer programs for carrying out computations related to this course	K1-K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit-I

Time Series – components of time series – additive and multiplicative models - Resolving components of a time series-measuring trend: Graphic, semi-averages, moving average and least squares methods.

Unit -II

Seasonal variation- measuring seasonal variation: method of simple averages, ratio-to- trend method, ratio-to-moving average method and link relative method- Cyclical and Random fluctuations- variate difference method.

Unit -III

Index numbers and their definitions - construction and uses of fixed and chain based index numbers - simple and weighted index numbers - Laspeyre's, Paasche's, Fisher's, and Marshall - Edgeworth index numbers – optimum tests for index numbers - Cost of living index numbers.

Unit -IV

Percentile curve and percentile ranks-their uses – combination and comparison of examination scores - Norms and scaling procedures-T and C scaling of tests - Reliability of measurements - method of measuring reliability – Internal consistency and reliability – item validity – special correlation methods.

Unit -V

Present official statistics system in India – Ministry of statistics – NSSO, CSO and their functions - Registration of vital events – National Income Statistics – Agricultural Statistics – Industrial Statistics in India – Trade Statistics in India – Labour Statistics in India – Financial Statistics in India.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A.M., M. K. Gupta and B. Das Gupta (2005) Fundamentals of Statistics- Vol. II (Fourth Edition). The World Press Pvt. Ltd, Kolkata.
2. Gupta, S.C. and V.K. Kapoor (2007) Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
3. Guilford, J. P. (1986) Fundamental Statistics in Psychology and Education, McGraw-Hill Book Company, New Delhi.
4. Srivastava, S. C. and S. Srivastava (2003) Fundamentals of Statistics, Anmol Publications Pvt. Ltd., New Delhi.

BOOKS FOR REFERENCE:

1. Anderson, T. W. (2011). The Statistical Analysis of Time Series. John Wiley & Sons.
2. Box, G. E. P. and Jenkins, G.M. and Reinsel,G.C.(2013). Time Series Analysis – Forecasting and Control (Fourth Edition). Holden- Day, San Francisco.
3. Brockwell, P. J. and Davis, R. A. (2002). Introduction to Time Series and Forecasting. Taylor& Francis.
4. Chatfield, C. (1978). The Analysis of Time Series - Theory and Practice (Third Edition). Chapman and Hall, London.
5. Guide to Official Statistics (CSO) 1999.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/ahl.php?csrno=34, P-10. Stochastic Processes and Time Series Analysis.
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ== P-10. Statistical processes and time series analysis.

Mapping of Course Outcomes to Programme Outcomes

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PO6***	***PO7***
CO1	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*
CO2	*High*	*High*	*High*	*Medium*	*High*	*Medium*	*Medium*
CO3	*High*	*Medium*	*High*	*Low*	*High*	*Medium*	*High*
CO4	*Medium*	*High*	*High*	*Medium*	*High*	*Medium*	*Medium*
CO5	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*
CO6	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Medium*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

2.4 STATISTICS PRACTICAL – I

Based on the course “Descriptive Statistics”, “Time Series and Official Statistics”

2.5 Professional English for Physical Sciences-II

2.6 PROGRAMMING with C (Allied-II)

Course Code	TITLE OF THE COURSE	L	T	P	C
Elective	PROGRAMMING with C	3	0	0	3
Prerequisites	Knowledge of writing Program; object-oriented language; Coding and Statistical Computation	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to:

- Provide programming skills in C.
- Describe the procedure and object-oriented paradigm including streams, classes, functions, data and objects
- Understand the operations and functions of C.
- Import and export the data outputs in C
- Enable the students to write programmes for Mathematical and Statistical computations

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand variables, symbolic constants and data types for writing programmes	K1-K6
CO2	Gain knowledge on Control statements	K1-K6
CO3	Acquire knowledge on arrays and strings	K2-K6
CO4	Understand Function declaration and Structural declaration	K1-K6
CO5	Understand the concept of Pointers and File Management	K1-K6
CO6	Develop computer programs for carrying out Mathematical and Statistical computations	K2-K6
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit - I

Introduction to Constants and Variables – Defining symbolic constant - Character set – Keywords and Identifiers – Declaration of Variables – Assigning values to variables – Declaring variable as a constant – Data Types.

Unit - II

Decision Making and Branching: Introduction – Decision making with IF statement – Simple IF statement – The ELSE IF Ladder – GOTO Statement - Decision Making and Looping : WHILE statement – Do Statement – FOR statement – Jumps in LOOPS.

Unit - III

Arrays: One-dimensional Arrays –Two-dimensional Arrays – Multi-dimensional Arrays – Dynamic Arrays - Handling of Character Strings: Declaring and Initializing String Variable – Arithmetic operations on Character – String handling functions.

Unit - IV

User Defined functions: Introduction – Need for User-defined function – Function calls – Function Declaration - Structures and Unions: Defining Structure – Declaring Structure variables – Structures within Structures – Union.

Unit - V

Pointers: Understanding Pointers – Declaring Pointer Variable – Accessing a variable through its Pointer – Pointer Expression - File Management in C: Defining and Opening a File – Closing a File - Input/Output operations on Files – Random access to Files.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Balagurusamy, E. (2010) Programming in ANSI C (5th Edition), Tata McGraw-Hill Education, New Delhi.
2. Ashok, M. Kamthane (2006) Programming with ANSI and Turbo C, Dorling Kindersley (India) Pvt. Ltd., New Delhi.

BOOKS FOR REFERENCE :

1. Herbert Schildt, (2003) "C: The complete Reference", 4th Edition, Mc Graw Hill.
2. B.L. Juneja,(2012) "Programming in C", 1st Edition, Cengage Learning.

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO2	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO3	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO4	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO5	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO6	*High*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

2.7 Value Based Education - (Common - Part-IV)

SEMESTER – III

3.1 Tamil / Other Languages

3.2 English

3.3 PROBABILITY THEORY (Core-III)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Probability Theory**	4	2	0	4
Prerequisites		Basic knowledge of Set theory, Real analysis and Calculus	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Inculcate knowledge on basic concepts of probability theory
- explore the concepts of random variable, distribution function, expectation and inequalities
- enhance the ability of proving fundamental theorems related to convergence of sequences of random variables and distribution functions
- inculcate the students with the practice of solving problems related to characteristic function and convergence properties of sequences of random variables and distribution functions

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand the basic concepts of probability theory	K1, K2
CO2	Understand and obtain the CDF, Expectations, Moments and Inequalities.	K1-K3 and K5
CO3	Describe the concepts of convergence and their implications.	K2, K3
CO4	Understand and analyze the importance of Independence and Law of large numbers	K2,K4
CO5	Describe the Central Limit Theorem and its applications	K1-K3
CO6	Develop computer programs for carrying out computations related to this course	K1 –K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Probability: sample space – Events - algebraic operations on events- definition of probability - independent events – conditional probability - addition and multiplication theorems of probability – Bayes Theorem.

Unit - II

Random variables: Discrete and continuous random variables – distribution function - properties – probability mass function and probability density function – discrete and continuous probability distributions.

Unit - III

Multiple random variables: Joint, marginal and conditional distribution functions - independence of random variables – transformation of random variables and their distribution functions.

Unit - IV

Mathematical expectation: Expectation – properties – Cauchy - Schwartz inequality, conditional expectation and conditional variance. Moment generating function, characteristic function, probability generating function and their properties. Chebyshev's inequality.

Unit - V

Limit Theorems: convergence in probability, weak law of large numbers – Bernoulli's theorem, Khintchine's theorem (statements only) - Central limit theorem.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A.M., M. K. Gupta and B. Das Gupta (2017) Fundamentals of Statistics- Vol. I., World Press, Ltd, Kolkata.
2. Gupta, S.C. and V.K. Kapoor (2020) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.

BOOKS FOR REFERENCE:

1. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
2. Lipschutz, S. (2008) Probability Theory (Second Edition), Schaum's Outline Series, McGraw Hill, New York.
3. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (2017). Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Education, New Delhi.
4. Bhuyan K.C. (2010), Probability Distribution Theory and Statistical Inference, New Central Book Agency (P) Ltd., New Delhi.

5. Spiegel, M.R. and Ray, M. (1980) Theory and Problems of Probability and Statistics, Schaum's Outline Series, McGraw Hill, New York.
6. Bhat B.R.(2014) Modern Probability Theory , New Age International Publishers, New Delhi.
7. Rohatgi, V. K. and A. K. Md. E. Saleh (2009). An Introduction to Probability Theory and Mathematical Statistics (Second Edition). John Wiley & Sons, New York

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ==P-01.Probability I
2. https://nptel.ac.in/courses/111101004
3. https://nptel.ac.in/courses/111104079

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*Low*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

3.4 MATHEMATICS FOR STATISTICS-II (Allied-III)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		MATHEMATICS FOR STATISTICS-II	3	1	0	3
Prerequisites		Basic knowledge of theory of equations and Calculus	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Inculcate and understand the mathematical concepts in calculus.
- Improve problem-solving and analytical skills in differentiation and integration.
- Explore and analyze the concepts of functions using derivatives and integrals.
- Familiarize with the properties of differentiation and integration.
- Apply the appropriate techniques in calculus to solve statistical problems.
- Enhance the ability of solving problems related to maxima and minima.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand solving Algebraic and differential equations of different kind applying suitable methods	K1, K2
CO2	Acquire knowledge on differentiation and integration and solve related problems.	K3
CO3	Develop competency in applying the ideas of derivatives, partial derivatives and integration	K4
CO4	Evaluate integrals and application problems on differentiation.	K5
CO5	Obtain the maxima and minima for algebraic functions and solutions for integration with appropriate techniques.	K6
CO6	Develop computer programs for carrying out computations related to this course	K1 –K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Theory of Equations: Nature of roots, Formulation of equation whose roots sre given. Relation between coefficients and roots - Transformation of equations - Reciprocal equations - Horner's method of solving equatios.

Unit - II

Successive differentiation – Trignometrical tranformations - Leibnitz's Formulas, nth derivative of standard functions - simple problems. Partial differentiation – Successive partial differentiation – Implicit functions – homogeneous functions – Euler's theorem.

Unit - III

Maxima and Minima for one variable – Applicationas – Concavity, Convexity and points of inflexion - Maxima and Minima for two variables – working rule.

Unit – IV

Linear differential equations of second order with constant coefficients - $(aD^2+bD+c)y = X$, various forms of $X : e^{\alpha x}$, $cos\alpha x$ $sin\alpha x$, x^m. Methods of solving homogenious linear differential equations of second order. Laplace transform and its inverse – solving ordinary differential equation with constant coeficients using Laplce transform.

Unit - V

Integration- Reverse process of differentiation – Methods of integration - Integrals of functions containing linear functions of x - Integrals of functions involving $a^2 \pm x^2$ - Integration of rational algebraic functions - $1/(ax^2+bx+c)$, $(px+q)/(ax^2+bx+c)$. Integration of irrational functions - $1/(ax^2+bx+c)^{1/2}$, $(px+q)/(ax^2+bx+c)^{1/2}$, $(px+q)\sqrt{(ax^2+bx+c)}$ - Integration by parts.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1.Narayanan,S., Hanumantha Rao and T.K. Manicavachagom Pillay (2008) Ancillary Mathematics, Volume I, S. Viswanathan Pvt. Ltd, Chennai.

2.Narayanan, S. and T.K. Manicavachagom Pillay (2015) Calculus Vol. I, II and III, S. Viswanathan Pvt. Ltd, Chennai.

BOOKS FOR REFERENCE:

1. P.Kandasamy, K.Thilagavathy (2003) Allied Mathematics Vol-I, II S.Chand & company Ltd., New Delhi-55.
2. P.Duraipandian and S.Udayabaskaran,(1997) Allied Mathematics, Vol. I & II. Muhil Publishers, Chennai
3. S.P.Rajagopalan and R.Sattanathan,(2005) Allied Mathematics .Vol. I & II. Vikas Publications, New Delhi.

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

1. https://www.youtube.com/watch?v=-OITIc9HeUQ
2. **https://mathinsight.org/integration_applications**
3. **https://ocw.mit.edu/ans7870/resources/Strang/Edited/Calculus/Calculus.pdf**
4.https://www.sac.edu/FacultyStaff/HomePages/MajidKashi/PDF/MATH_150/Bus_Calculus.pdf

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*Low*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

3.5 MATHEMATICAL COMPUTATIONS USING *R* / *PYTHON* (Skill based Core)

Course Code	**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Elective	**MATHEMATICAL COMPUTATIONS USING *R* / *PYTHON***	**3**	**0**	**1**	**4**
Prerequisites	Programming in C; Programming in C ++	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to:

- Understand R/Python environment, Packages and data types.
- Provide programming skills in R/ Python.
- Understand the operations and functions of R/ Python
- Perform statistical analysis using built-in functions
- Write customized program for mathematical and statistical computations

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the basics of R Language and Python	**K2**
CO2	Apply the logical skills for performing statistical analysis	**K3, K4**
CO3	Use appropriate plots, charts and diagrams for presentation of data	**K3**
CO4	Perform statistical computations in Python/R	**K3**
CO5	Determine and evaluate the relationship among variables in Python/R	**K1-K5**
CO6	Develop computer programs in R and Python	**K2-K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

UNIT–I

Introduction - History of R programming - R commands – Random numbers generation – Data Types – Objects – Basic data and Computations – Data input – Data frames – Graphics – Tables.

UNIT–II

Fundamentals of Python - Running Python Programs - Writing Python Code; Working with Data – Data Types and Variables - Using Numeric Variables - Using String Variables; Input and Output - Making Decisions - Lists and Loops; Numeric and Date Functions - Working with Strings – Functions - Python Classes - Class Instances

UNIT–III

Descriptive Statistics - Diagrammatic representation of data - measures of central Tendency - measures of dispersion - measures of skewness and kurtosis.

UNIT–IV

Probability and probability distributions - problems on finding basic probabilities - some special discrete distributions – Binomial distribution – Poisson Distribution – Continuous distributions – Normal distribution – Uniform distribution.

UNIT–V

Correlation - inference procedure for correlation coefficient - bivariate correlation - multiple correlations - Linear regression and its inference procedure.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Normal Maltoff (2009) The art of R programming, William Pollock Publishers, San Fransisco.
2. Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa Publishing House Pvt. Ltd., New Delhi.
3. Lee, K. D. (2015). Python Programming Fundamentals. United Kingdom: Springer London.
4. John Braun, W. and Duncan James Murdoch (2007) First Course in Statistical Programming with R, Cambridge University Press, Uk.

BOOKS FOR REFERENCE

1. Ugarte, M. D., A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R, CRC Press, Taylo & Francis Group, London.
2. Peter Dalgaard (2008) Introductory Statistics with R, Springer India Private Limited, New Delhi.
3. Michael J. Crawley (2007) The R Book, John Wiley and Sons, New York.
4. Lambert, K. (2014). Fundamentals of Python: Data Structures. United States: Cengage Learning PTR.
5. Python Programming Fundamentals: A Beginner's Handbook. (n.d.). (n.p.): Educreation Publishing.
6. Jones, P. (2016). Python: The Fundamentals of Python Programming. United States: CreateSpace Independent Publishing Platform.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ== P-15. Basic R programming
2. https://www.tutorialspoint.com/python/index.htm
3. https://docs.python.org/3/tutorial/
4. https://www.geeksforgeeks.org/linear-regression-python-implementation/

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*Medium*	*High*
CO2	*High*	*Medium*	*Medium*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO4	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*	*High*
CO5	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO 6	PSO7
CO1	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

3.6 ELEMENTS OF STATISTICS – I (Non-Major Elective)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**ELEMENTS OF STATISTICS – I**	**2**	**0**	**0**	**2**
Prerequisites		Knowledge of data basic Statistical tool	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Understand the origin, significance and scope of Statistics.
- Know the significance of presenting data in the form of tables and diagrams.
- Learn computational aspects of basic statistical measures.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand the scope and necessity of Statistics.	**K1, K2**
CO2	Able to obtain, tabulate and present the data in tables, diagrams and graphs.	**K1-K3 and K5**
CO3	Apply the formula and compute descriptive measures of statistics.	**K2, K3**
CO4	Identify the linear relationship among the variables	**K2, K4**
CO5	Determine the measures of Skewness and kurtosis numerically	**K1-K3**
CO6	Develop computer programs for carrying out computations related to this course	**K1 –K6**

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

UNIT I

Nature and scope of Statistics - characteristics and limitation of Statistics - statistical investigation - preparation of questionnaire - Population and Sample - collection of data - primary and secondary data.

UNIT II

Processing and presentation of data - Classification of data - tabulation of data - Formation of frequency tables - Diagrammatic presentation of statistical data - bar diagrams - pie diagrams and pictograms - simple problems - Graphical presentation of statistical data - Histogram, frequency curves - simple problems.

UNIT III

Measures of Central tendency: Arithmetic Mean, Median, Mode. Measures of Dispersion: Range, Inter-Quartile Range, Standard Deviation and Coefficient of Variation.

UNIT IV

Simple Correlation- Scatter diagram - Properties of coefficient of correlation- Kendall's coefficient of correlation -Partial and Multiple correlation coefficients. Regression -regression coefficients and their properties-regression equations- Simple problems.

UNIT V

Concept of Skewness and Kurtosis - Karl Pearson's and Bowley's coefficients of Skewness- moments- coefficients of Skewness and Kurtosis - simple problems.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2017): Fundamentals of Statistics, Volume-I, World Press Ltd, Calcutta.
2. Gupta, S.C. and V.K. Kapoor. (2020): Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.

BOOKS FOR REFERENCE:

1. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
2. Spiegel, M.R., Schiller, J. and Srinivasan, R.A. (2012): Probability and Statistics, Schaum's Outline Series (Fourth Edition). McGraw- Hill Publishing Company, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1**.** https://nptel.ac.in/courses/111/104/111104120**.**
2. https://www.iiserpune.ac.in/~bhasbapat/phy221_files/curvefitting.pdf**.**
3. https://www.toppr.com/guides/maths/statistics/bar-graphs-and- histogram**.**
4. https://nptel.ac.in/courses/111/104/111104098.

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*Low*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

3.7 YOGA - (Common - Part-IV)

SEMESTER – IV

4.1 Tamil / Other Languages

4.2 English

4.3 STATISTICAL DISTRIBUTIONS (Core-IV)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		STATISTICAL DISTRIBUTIONS	4	0	0	4
Prerequisites		Knowledge of Probability Theory and Real Analysis	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- facilitate for acquiring knowledge on theoretical aspects of probability distributions
- understand relationships among statistical distributions
- inculcate the ability for carrying out statistical analysis of probability distributions.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Compute marginal and conditional distributions from joint distributions	K1 – K3
CO2	Obtain the distributions of functions of random variables	K1, K6
CO3	Describe the properties of univariate discrete distributions	K3, K5
CO4	Analyze the properties of univariate continuous distributions and bivariate normal distribution	K4
CO5	Derive the sampling distributions related to Normal distribution and to study their properties	K1, K6
CO6	Develop computer programs for carrying out computations related to this course	K1 – K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Distributions of functions of one-dimensional and two-dimensional random variables – Distribution function method, Transformations and Moment generating function method.

Unit - II

Discrete distributions: Bernoulli, Binomial, Poisson, Geometric and Negative binomial distributions - Multinomial distribution. Moments – probability generating function, moment generating function, characteristic function and properties.

Unit - III

Continuous distributions: Uniform, Normal, Cauchy and Lognormal distributions - concepts, moments, moment generating function, characteristic function and properties.

Unit - IV

Exponential, Gamma, Beta (first and second kinds) concepts, moments, moment generating function, characteristic function and properties.

Unit - V

Sampling distributions: *Chi*-square, *t* and *F* distributions- concepts, moments, moment generating function, characteristic function and properties.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A. M., M.K. Gupta, and B. Dasgupta (2002) Fundamentals of Statistics, Vol. I, (Third Edition), World Press Ltd, Kolkata.
2. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (2017). Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Education, New Delhi.

BOOKS FOR REFERENCE:

1. Bhuyan K.C. (2010), Probability Distribution Theory and Statistical Inference, New Central Book Agency (P) Ltd., New Delhi.
2. Gupta, S. C., and V. K. Kapoor (2020) Fundamentals of Mathematical Statistics, (Twelfth Edition). Sultan Chand & Sons, New Delhi.
3. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
4. Rohatgi, V. K. and A. K. Md. E. Saleh (2009). An Introduction to Probability Theory and Mathematical Statistics (Second Edition). John Wiley & Sons, New York.

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

1. https://swayam.gov.in/nd2_cec20_ma01/preview
2. https://nptel.ac.in/courses/111/104/111104032/

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO5	*High*	*High*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*Medium*
CO2	*Medium*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*High*	*Medium*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

4.4 STATISTICS PRACTICAL - II (Core)

Based on the course Probability Theory, Statistical Distributions

4.5 REAL ANALYSIS AND MATRIX THEORY (Allied-IV)

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core		**REAL ANALYSIS AND MATRIX THEORY**	**3**	**0**	**0**	**3**
Prerequisites		Basics of Real Analysis and Matrix Theory	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Enhance the analytical ability of proving the theorems and solving the problems in real analysis and matrix theory
- Impart the matrix methods and related mathematical techniques

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Investigate real valued functions and their limits	**K1, K2, K3**
CO2	Able to study the convergence of sequences of real numbers and real valued functions	**K2, K4**
CO3	Able to study the convergence of series of real numbers and real valued functions	**K1, K5**
CO4	Analyze and study the properties of matrices using Ranks	**K3, K4**
CO5	Analyze the properties of matrices from their eigenvalues and eigenvectors	**K3, K5**
CO6	Develop computer programs for carrying out computations related to this course	**K1 –K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit - I

Functions – Real Valued functions – Equivalence countability – Real numbers – Least upper bound Sequence of real numbers – definition of sequence and subsequence – Limit of a sequence - Convergent sequences – divergent sequences.

Unit - II

Bounded sequences – Monotone sequences – operations on convergent sequences – operations on divergent sequences – Limit superior and limit inferior – Cauchy sequences

Unit - III

Convergent and divergent series of real numbers – series with non–negative terms – Alternating series – conditional convergence and absolute convergence – Rearrangements of series – Test for absolute convergence – series whose terms form a non-increasing sequence

Unit – IV

Matrix Algebra: Introduction – Operations on Matrices – Determinant of a Matrix – Adjoint and Inverse of a Matrix – Singular and Non-singular Matrices. Transpose of a matrix - Symmetric and Skew-symmetric Matrices – Conjugate of a Matrix – Hermitian and Skew – Hermitian matrices**.**

Unit – V

Rank of a matrix: Elementary transformations, Elementary matrices, Row and Column ranks – rank of a matrix. Invariance of rank through elementary transformations, Reduction to Normal form, Rank of sum and product of matrices, Equivalent matrices Characteristic Roots and Vectors.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. D. Somasundaram and B.Choudhary (2007). A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
2. Vasishtha,A.R.(2014) Matrices, Krishna Prakashan, Meerut.
3. Shanthi Narayan. and Mittal,P.K. (2000) A Text Book of Matrices, S.Chand& Co, New Delhi.

BOOKS FOR REFERENCE:

1. Gold berg, R.R (1970): Methods of Real Analysis, Oxford and IBH.
2. Apostol, T.M. (1985): Mathematical Analysis, Narosa Publications.
3. Narayanan and T. K. Manickavachagam Pillai – Ancillary Mathematics, Vol. II, S. Viswanathan Pvt. Ltd, Chennai.
4. Bartle , R. G & Shebert, D. R. (1982): Introduction to Real Analysis, Wiley Eastern & Son.
5. Gentle,J.E. (2007) Matrix Algebra Theory, Computations, and Applications in Statistics, Springer, New York.
6. Richard Bronson. (2011) Matrix Operations, Schaum'sOuline Series, McGraw Hill, New York.
7. Searle, S. R. (2006) Matrix Algebra useful for Statistics, Wiley Interscience, New York.

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/111106053
2. https://nptel.ac.in/courses/111105069
3. https://www.math.pku.edu.cn/teachers/anjp/textbook.pdf
4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A== P03. Real analysis and measure theory

Mapping of Course Outcomes to Programme Outcomes

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PO6***	***PO7***
CO1	*High*	*Medium*	*High*	*High*	*Low*	*High*	*High*
CO2	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO3	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Low*	*High*	*High*
CO5	*High*	*High*	*High*	*Medium*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*Low*	*High*	*Medium*
Correlation Levels:	*Low*	*Medium*	*High*				

Mapping of Course Outcomes to Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
CO3	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO5	*Medium*	*High*	*High*	*High*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Levels: *Low* *Medium* *High*							

4.6 NUMERICAL METHODS (Skill Based Core)

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core		**NUMERICAL METHODS**	**3**	**1**	**0**	**4**
Prerequisites		Basics of Differentiation and integration	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Convert a system of linear equations into matrix form and acquire knowledge to solve them using Gauss elimination and Gauss-Seidel methods.
- Obtain approximate solutions to the functions using iterative methods.
- Utilize various interpolation techniques of discrete data in real life situations.
- Evaluate numerical calculations of problems in differentiation and integration.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Understand various concepts in numerical methods.	**K1, K2**
CO2	Apply different techniques for finding solutions to intractable mathematical problems.	**K3**
CO3	Solve algebraic and transcendental equations applying different techniques.	**K4**
CO4	Interpolate the values for given data applying different forward and backward operators.	**K5**
CO5	Carry out numerical differentiation and Integration of functions from given data.	**K6**
CO6	Develop computer programs for carrying out computations related to this course	**K1 –K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit - I

Solving algebraic equations: Bisection method, False position method, Newton - Raphson method. Simple problems and applications.

Unit - II

Gauss Elimination method, Gauss – Jordan, Gauss –Jocobi and Gauss- Seidel methods. Solving system of linear equations using Cramer's rule and inverse of matrix. Simple problems and applications.

Unit - III

Operators and differences: Operators – E, Δ, δ and ∇ - their relationship and their role in difference tables.

Interpolation: Solving problems for equidistant cases using Newton's forward and backward difference formulae. Lagrange's formula and Newton's divided difference formula for unequal intervals. Simple problems and applications.

Unit - IV

Numerical differentiation – Newton's forward and backward formulae – maxima and minima using numerical methods.

Unit - V

Numerical Integration: Quadrature rule- trapezoidal rule - Simpson's one - third rule and three-eighth rule – Gregory Formula, Newton – Cote's formula.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Sastry, S. S. (2012). Introductory Methods of Numerical Analysis (Fifth Edition). Prentice Hall of India, New Delhi.
2. Jain, M. K., S. R. K. Iyengar and R.K. Jain (2019). Numerical Methods for Scientific and Engineering Computation (Seventh Edition). New Age International (P) Ltd., New Delhi.

BOOKS FOR REFERENCE:

1. Atkinson, K. (2003). Elementary Numerical Analysis (Third Edition). John Wiley & Sons, New York.
2. Gerald, C. F. and P. O. Wheatley (2004) Applied Numerical Analysis (Seventh Edition). Pearson, New York.

   James B. Scarborough, (2010). Numerical Mathematical Analysis (Sixth Edition). Oxford & IBH Publishing Co., New Delhi.

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

1.https://books.google.co.in/books?id=anwHfrXY8_wC&printsec=frontcover#v=onepage&q&f=false.

2.https://numericalmethodstutorials.readthedocs.io/en/latest.

3.Elementary Numerical Analysis: An Algorithmic Approach by Samuel Daniel Conte (e-book).

Mapping of Course Outcomes to Programme Outcomes

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PO6***	***PO7***
CO1	*High*	*Medium*	*High*	*High*	*Low*	*High*	*High*
CO2	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO3	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Low*	*High*	*High*
CO5	*High*	*High*	*High*	*Medium*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*Low*	*High*	*Medium*
Correlation Levels:	*Low*	*Medium*	*High*				

Mapping of Course Outcomes to Programme Specific Outcomes (PSOs)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*Low*	*High*	*High*
CO3	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO5	*Medium*	*High*	*High*	*High*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Levels:	*Low*	*Medium*	*High*				

4.7 ELEMENTS OF STATISTICS – II (Non-Major Elective)

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core		**ELEMENTS OF STATISTICS – II**	**3**	**0**	**0**	**3**
Prerequisites		Knowledge of data and basic statistical methods.	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

- Understand the basic concepts of statistics.
- Develop the ability to deal with numerical and quantitative issues in relevant field.
- Enable the use of statistical, graphical and algebraic techniques wherever relevant.
- Analyze relationship between factors and quantify the same,

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Levels
CO1	Identify the method of collecting primary and secondary data.	**K1 ,K2**
CO2	Understand the basic concepts and results of probability theory in real-life situations	**K3**
CO3	Introduce the concepts of hypothesis testing.	**K4**
CO4	Differentiate between large and small samples and apply apt testing procedures.	**K5**
CO5	Apply various non-parametric tests and its applications.	**K3,K4**
CO6	Develop computer programs for carrying out computations related to this course	**K1 –K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

UNIT I

Definition of Statistics and its applications in various disciplines - Collection of Data - classification, Tabulation and Graphical representation of data - construction of univariate and Bivariate frequency distribution

UNIT II

Random experiment - sample space - events - mathematical and empirical definitions of Probability - conditional probability – Bayes' theorem - Random variable - Distribution function – moment generating functions and their properties-simple problems.

UNIT III

Tests of significance - hypotheses - two types of errors - power function - critical region - level of significance - small sample tests based on t and F distributions. Chi-square test for goodness of fit.

UNIT IV

Small sample and Large sample tests: Test of significance of population mean when population variance is (i) known and (ii) unknown – Test of significance equality of means of two normal populations when population variances (i) known and (ii) unknown.

UNIT V

Analysis of Variance: One-way classification – Two-way classification - Kruskal-Wallis test, Friedman's test.

BOOKS FOR STUDY:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2017): Fundamentals of Statistics, Volume-I, World Press Ltd, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2019): Fundamentals of Statistics, Volume-II (Fourth Edition), The World Press Pvt., Ltd, Kolkata.
3. Gupta, S.C. and V.K. Kapoor. (2020): Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.

BOOKS FOR REFERENCE:

1. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
2. Spiegel, M.R., Schiller, J. and Srinivasan, R.A. (2012): Probability and Statistics, Schaum's Outline Series (Fourth Edition). McGraw- Hill Publishing Company, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://online.stat.psu.edu/statprogram
2. https://www.cliffsnotes.com/study-guides/statistics

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*Medium*	*Medium*	*High*	*Medium*	*Medium*	*High*
CO2	*High*	*Medium*	*High*	*High*	*Low*	*Medium*	*High*
CO3	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO4	*High*	*Medium*	*Medium*	*Medium*	*High*	*Medium*	*High*
CO5	*Medium*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO 7
CO1	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO2	*Medium*	*Medium*	*High*	*Low*	*High*	*Medium*	*High*
CO3	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO4	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*High*	*High*	*Low*	*Medium*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

4.8 Computers for Digital Era - (Common - Part-IV)

4.9 NCC, NSS, YRC, YWF - (Extension Activity - Common - Part-V)

SEMESTER – V

5.1 STATISTICAL INFERENCE - I (Core V)

Course Code	NSTC 21	TITLE OF THE COURSE	L	T	P	C
Core		STATISTICAL INFERENCE - I	4	2	0	4
Prerequisites		Knowledge of Real Analysis, Probability Theory and Distribution Theory	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Facilitate for investigating the properties of point estimators
- Impart the application of various methods of finding point estimators
- Inculcate construction of confidence intervals.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Evaluate the properties of point estimators	K1 & K2
CO2	Compute minimum variance bound and to determine minimum variance unbiased estimator	K1 - K3
CO3	Find point estimators employing the frequentist and Bayesian approaches	K1 - K3
CO4	Determine the asymptotic behavior of point estimators	K3 & K4
CO5	Construct confidence intervals for various parametric functions	K1, K3 & K6
CO6	Develop computer programs for carrying out computations related to this course	K1 – K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Statistical Inference: meaning and purpose, parameter and statistic. Sampling distribution and standard error. Estimator and estimate. Point Estimation: consistency, unbiasedness, efficiency and sufficient statistic - Neyman's factorization theorem (without proof) - simple problems.

Unit - II

Unbiased Estimation: Minimum variance unbiased estimator - Cramer-Rao Inequality and Rao-Blackwell theorem - applications and simple problems.

Unit - III

Methods of estimation: Method of moments and Method of maximum liklihood. Properties of estimators obtained by these methods. Method of least squares for regression models. Asymptotic properties of maximum liklihood estimators (without proof).

Unit - IV

Interval estimation: Interval estimator, confidence coefficient, confidence limits, pivotal quantity. Interval estimation for proportions, mean(s), variance(s) based on *Chi* - square, Student's *t, F* and normal distributions – simple problems.

Unit - V

Bayes estimation: concepts of prior, posterier and conjugate prior. Loss function: 0-1 loss function and quadratic error loss function. Bayes estimator. Simple problems involving quadratic error loss function.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A. M., M.K. Gupta, and B. Dasgupta (2002) Fundamentals of Statistics, Vol. I, (Third Edition), World press Ltd, Kolkata.
2. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (2017). Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Education, New Delhi.

BOOKS FOR REFERENCE:

1. Bhuyan K.C. (2010), Probability Distribution Theory and Statistical Inference, New Central Book Agency (P) Ltd., New Delhi.
2. Gupta, S. C., and V. K. Kapoor (2020) Fundamentals of Mathematical Statistics, (Twelfth Edition). Sultan Chand & Sons, New Delhi.
3. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
    1. Rohatgi, V. K. and A. K. Md. E. Saleh (2009). An Introduction to Probability Theory and Mathematical Statistics (Second Edition). John Wiley & Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ=P-04. Statistical Inference (38).
2. https://nptel.ac.in/courses/111105043/Statistical Inference-IIT Kharagpur.
3. https://nptel.ac.in/courses/111105124/Statistical Inference-IIT Kharagpur

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*Medium*	*Medium*	*High*	*Medium*	*Medium*	*High*
CO2	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO4	*High*	*Medium*	*Medium*	*Medium*	*High*	*Medium*	*High*
CO5	*High*	*High*	*High*	*Medium*	*High*	*Medium*	*High*
CO6	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO 7
CO1	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO2	*Medium*	*Medium*	*High*	*Low*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO4	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*High*	*High*	*Low*	*Medium*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

5.2 SAMPLING TECHNIQUES (Core-VI)

Course Code	**MSTC13**	**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core		**SAMPLING TECHNIQUES**	**4**	**2**	**0**	**4**
Prerequisites		Basic notions of sampling methods, Probability computation, Descriptive Statistics	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Introduce sampling techniques, which are used for drawing random samples from finite population.
- Develop skill to compute estimators their sampling errors and to provide knowledge for conducting field surveys.
- Study the properties of estimators related to various sampling methods.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the principles of sampling as a means of making inferences about a population	**K1 – K3**
CO2	Understand the difference between randomization theory and model-based analysis	**K1, K6**
CO3	Understand the concepts of bias and sampling variability and strategies for reducing these,	**K3, K5**
CO4	Conduct sample surveys and analyze the data	**K4**
CO5	Address the practical issues arising in sampling studies.	**K1, K6**
CO6	Develop computer programs for carrying out computations related to this course	**K1 – K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit-I

Population, Census method - Need for sampling - Basic concepts of sample surveys - sampling unit - sampling frame - Principal steps involved in sample surveys - Preparation of schedules and questionnaires.

Unit-II

Sampling errors - Bias and standard errors - Mean squared error - Determination of sample size with reference to sampling errors. Non-sampling errors, Sources and types of non-sampling errors - non-response and response errors.

Unit-III

Simple random sampling with and without replacement (Lottery method and random number table) - estimation of population parameters - mean, variance and proportion - Simple random sampling for attributes; confidence limits - Determination of sample size.

Unit-IV

Stratified random sampling-principles of stratification - Estimation of population mean and its variance - Allocation techniques (equal allocation, proportional allocation, Neyman allocation and optimum allocation) - Estimation of gain due to stratification.

Unit-V

Systematic sampling - Estimation of population mean and its variance - Comparison of simple random, stratified random and systematic sampling.

UNIT VI

Contemporary Issues: Expert lectures, online seminars – webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. William G. Cochran (1990) Sampling Techniques (Third Edition), John Wiley Sons, New York.
2. Sampath, S. (2006) Sampling Theory and Methods (Second Edition), Narosa Publishing House, New Delhi.
3. Gupta, S.C., and Kapoor, V.K., (2007). Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.

BOOKS FOR REFERENCE:

1. Daroga Singh and Choudary, F.S.(1986) Theory and Analysis of Sample Survey Designs, New age International publishers, New Delhi.
2. Des Raj and Promod Chandhok (1998) Sample Survey Theory, Narosa Publishing House Pvt. Ltd, New Delhi.
3. Murthy, M.N. (1977) Sampling Theory and Statistical Methods, Statistical Publishing Society, Kolkata.

Related Online MOOCs Contents [SWAYAM, NPTEL, Websites etc.]

4. MTH 432A: Introduction to Sampling Theory http://home.iitk.ac.in/~shalab/course432.htm)
5. https://nptel.ac.in/courses/111/104/111104073/
6. https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf
7. https://www.mooc-list.com/tags/sampling-methods

Mapping of Course Outcomes to Programme Outcomes

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PO6***	***PO7***
CO1	*High*	*Medium*	*High*	*Low*	*High*	*High*	*High*
CO2	*High*	*Medium*	*High*	*Low*	*High*	*High*	*High*
CO3	*High*	*High*	*Low*	*Medium*	*High*	*High*	*High*
CO4	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*High*	*High*	*Medium*
Correlation Levels: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO1	*Medium*	*Medium*	*High*	*High*	*High*	*High*	*High*
CO2	*Medium*	*High*	*Low*	*High*	*Low*	*High*	*High*
CO3	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO5	*High*	*High*	*Medium*	*Low*	*High*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Levels: *Low* *Medium* *High*							

5.3 ECONOMETRICS (Core VII)

Course Code	NSTC 33	TITLE OF THE COURSE	L	T	P	C
Core		ECONOMETRICS	4	2	0	4
Prerequisites		Knowledge of Micro Economics, Statistical Models, Estimation Theory, Hypotheses testing	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Provide knowledge on basic principles of econometric models.
- Construct and validate models for given economic data.
- Inculcate the applications of econometrics in various fields.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the basic concepts of Econometrics, methodology and limitations of using Econometric theory	K1 & K2
CO2	Acquire knowledge on Least square estimators.	K2 & K3
CO3	Evaluate the model adequacy conducting Residual analysis	K3 & K5
CO4	Detect presence of autocorrelation through analytical methods	K3 & K4
CO5	Detect presence of multicollinearity and to overcome such issues	K3 & K5
CO6	Develop computer programs for carrying out computations related to this course	K1 – K6

K1: *Remember* **K2:** *Understand* **K3:** *Apply* **K4:** *Analyze* **K5:** *Evaluate* **K6:** *Create*

Course Outline:

Unit - I

Model with one explanatory variable: Definition, scope and objectives of Econometrics. Linear model with one independent variable - Least squares estimators of regression coefficients, properties of least squares estimators - analysis of variance to regression model.

Unit - II

Model with more variables: Linear model with more than one explanatory variables – assumptions – estimation of model parameter - Least squares estimators and their properties. Hypothesis testing – test the overall significance of the regression – Testing the individual regression coefficients.

Unit - III .

Adequacy of Model: Model adequacy checking – residual analysis – residuals – standardized residuals – residual plot – normal probability plot – plot of residuals against estimated response. A formal test for lack of fit of the model.

Unit - IV

Autocorrelation: Meaning of serial independence – sources of autocorrelation – first order autoregressive scheme – consequences of autocorrelation – Durbin – Watson test – analysing the model in the presence of autocorrelation.

Unit - V

Multicollinearity : meaning and sources – consequences of multicollinearity. Test for detecting multicollinearity – Examining the correlation matrix – Variance Inflation factor.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Montgomery, D.C, Peck, E.C and Vining, G.G (2003) Introduction to Linear Regression Analysis (Third Edition). Wiley India, New Delhi.
2. Koutsoyiannis, A. (2006) Theory of Econometrics. (Second Edition) Palgrave, New York.

BOOKS FOR REFERENCE:

1. Singh, S. P., Parashar, K. and Singh, H. P. (1980) Econometrics. Sultan Chand & Co., New Delhi.
2. Klein, L. R. (1975) A Text Book of Econometrics (Second Edition). Prentice Hall of India, New Delhi.
3. Johnston, J. and DiNardo, J. (1997). Econometric Methods, McGraw-Hill.
4. Gujarati, D.N. and Sangeetha (2007). Basic Econometrics (Third Edition). McGraw Hill Publisher, New York.
5. Wooldridge, J. (2012). Introduction Econometrics: A Modern Approach. Cengage Learning.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/home/viewsubject?catid=+u3y6udbivoj97lfescmhq==P-14. Econometrics and financial time series

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*Medium*	*High*	*Medium*	*High*	*High*
CO2	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*Medium*	*High*	*Medium*	*High*	*High*
CO4	*High*	*Medium*	*Medium*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*High*	*High*	*Medium*	*High*	*Medium*	*High*
CO6	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO2	*Medium*	*Medium*	*High*	*Medium*	*Medium*	*Medium*	*High*
CO3	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO4	*Medium*	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*
CO5	*High*	*Medium*	*High*	*High*	*Low*	*Medium*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*Low*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

5.4 MAJOR ELECTIVE- I

1. DEMOGRAPHIC METHODS

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core		**DEMOGRAPHIC METHODS**	**4**	**2**	**0**	**4**
Prerequisites		Basic ideas on demography, vital statistics, population migration and data sources.	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Introduce the basic techniques of demographic analysis.
- Impart knowledge on sources of demographic data, perform basic demographic analysis and facilitate using various techniques **to** ensure their comparability across populations.
- Focus on measures of mortality, Fertility, Migration levels patterns and population projection techniques.
- Inculcate the practice of preparing lifetable and drawn informations.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	**Course Outcome**	**Cognitive Level**
CO1	Understand the concepts of demography, demographic data on its sources and learn the basics in Birth, Death and other vital statistics.	**K1, K2**
CO2	Evaluate fertility measures for a human population and to interpret them.	**K3**
CO3	Determine mortality measures for a human population and to interpret them.	**K2, K4**
CO4	Construct Lifetables; and understand the concept of Migration and its measures.	**K3, K4**
CO5	Understand the population growth, population projection and applications of Logistic curve.	**K1-K3**
CO6	Develop computer programs for carrying out computations related to this course	**K1-K6**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

Unit - I

Demography Data: Demography – definition-sources of demographic data - population census -demographic surveys - Registration method: vital registration - population register and other administrative records, registration of population in India.

Unit - II

Fertility: Fertility measurements – crude birth rates - general, specific and total fertility rates -gross and net reproduction rates and their interpretation.

Unit - III

Mortality: Mortality measurements: crude death rate - specific death rate - standardized death rate - infant mortality rate – maternal mortality rate – case fertility rate - comparative mortality index.

Unit – IV

Life Table and Migration: Description and construction of various columns of a life table and their relationships - uses of life table – migration-factors effecting migration - gross and net migration rates.

Unit - V

Population Growth: Population projection – population estimates and projection – arithmetic, geometric and exponential growth rates - logistic curve and its suitability for graduating population data - Basic ideas of stationary and stable population.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Gupta, S.C, and V. K. Kapoor (2007) Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
2. V.C.Sinha E.Zacharia (2012) Elements of Demography, Allied Publishers, New Delhi.
3. Agarwala, S.N. (1991) Indian Population Problems, Tata Mc Graw Hill Publishing House, New Delhi.

BOOKS FOR REFERENCE:

1. Mishra, D.E. (1982) An introduction to the Study of Population, South India Publishers, Madras.
2. Hansraj, D.R. (1981) Fundamentals of Demography, Surjeet publications, New Delhi
3. Asha A. Bhende and Tara Karitkar (1994) Principles of Population Studies, Himalaya Publishing House Pvt Ltd., Mumbai.
4. Suddhendu Biswas and G. L. Sriwatav (2006), Stochastic Processes in Demography and Applications, New Central Book Agency, London.Bogue, D. J. (2007). Principles of Demography, Wiley, New York.

5. Gibbs, J.P. (2012). Urban Research Methods.Literary Licensing, LLC.77
6. Keyfitz, N. and Caswell, H. (2006). Applied Mathematical Demography. Springer lag, New York.
7. Kumar, R. (1986). Technical Demography. John Wiley & Sons, Canada.
8. Spiegelman, M. (1969). Introduction to Demographic Analysis.Harvard University Press.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/102101056

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO 6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*Medium*	*Medium*	*High*	*High*	*High*	*High*	*Medium*
CO4	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*Medium*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

2. BIO-STATISTICS

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Supportive		**Bio-Statistics**	**4**	**2**	**0**	**4**
Prerequisites		Basic knowledge of Probability theory, Distribution theory and Sampling theory	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Understand data collection methods and techniques in the field of Health Sciences.
- Instill the applications of various statistical tools used in Biostatistics.
- Enable to understand the properties of biomedical data.

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the concepts of Study Designs and its importance in biomedical study.	**K1, K2**
CO2	Classify, tabulate and present biomedical data.	**K1-K3 and K5**
CO3	Determine and interpret descriptive properties of biomedical data.	**K2, K3, K5**
CO4	Investigate and determine simple regression models.	**K2,K4**
CO5	Apply appropriate statistical tests for decision making.	**K1-K3**
CO6	Develop computer programs for carrying out computations related to this course	**K1-K4**
K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*		

Course Outline:

UNIT I

Study Designs and Statistical Measures Introduction to Study Designs- Different Types of Observational, Studies –Experimental Studies. Epidemiology – Odds-Odds Ratio- Confidence Interval for Odds Ratio- Control Event Rate – Experimental Event Rate- Relative Risk.

UNIT II

Collection of data – primary data, designing questionnaire and schedule – Secondary data – Methods of collection of data – classification of data – Tabulation and presentation of data

UNIT III

Measures of Central Tendency – Mean, Median, Mode, Geometric Mean – Merits and Demerits. Measures of dispersion – Range, Standard deviation, Mean deviation, Quartile deviation, Merits and demerits, coefficient of variations

UNIT IV

Correlation – Types and methods of correlation, Rank – Correlation, Regression, Simple regression equation, fitting, Prediction

UNIT V

Sampling Methods – population. Sample – Simple Random sample – concept of sampling distributions – standard error – Test of significance – Hypothesis – Simple hypothesis – Tests based on large samples and small samples – Chi-square test.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. P.S.S. Sundar Rao, J. Richard (2012). An introduction to Biostatistics and Research methodology. Fifth Edition, Prentice Hall of India Learning Private Ltd, New Delhi.
2. Gurumani N (2005). An introduction to Biostatistics. 2nd Revised Edition, MJP Publishers, Chennai.

BOOKS FOR REFERENCE:

1. Daniel WW, (1987). Biostatistics, John Wiley and Sons, New York.
2. Dr. Pranab Kumar Banarjee. An Introduction to Biostatistics (A text book of Biometry). Reviced and 4th enlarged Edition 2011,S. Chand and Company Ltd, Ram Nagar, New Delhi.
5. A. Indrayan, L. Sathyanarayana(2006).Biostatistics for Medical,Nursing and Pharmacy students. Prentice Hall of India Private Ltd, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://swayam.gov.in/nd1_noc20_bt28/preview.
2. https://swayam.gov.in/nd2_cec20_ma05/preview.
3. www.healthknowledge.org.uk.

Mapping of Course Outcomes to Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*Low*	*Medium*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO 6**	**PSO7**
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

5.5 Statistics Practical – III (Core)

Based on the course Statistical Inference – I, Sampling Techniques, Econometrics

5.6 Personality Devolvement / Effective Communication / Youth Leadership (Skill Based Common)

SEMESTER – VI

6.1 STATISTICAL INFERENCE - II (Core VIII)

Course Code	NSTC 31	TITLE OF THE COURSE	L	T	P	C
Core		STATISTICAL INFERENCE - II	4	2	0	4
Prerequisites		Knowledge of Probability Theory, Distribution Theory and Estimation Theory	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- formulate statistical hypotheses testing problem for given decision making situations.
- facilitate developing decision-making procedures for testing various parametric hypotheses
- impart applications of nonparametric methods for decision-making

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Formulate hypotheses testing problems	K1
CO2	Evaluate and to select appropriate parametric tests	K5
CO3	Develop most powerful test for testing simple hypotheses.	K1 – K4
CO4	Construct a nontrivial test for any hypotheses testing problem	K3 & K6
CO5	Apply nonparametric methods for drawing inferences	K3
CO6	Develop computer programs for carrying out computations related to this course	K1 – K6

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Statistical hypotheses- simple and composite hypotheses - null and alternative hypotheses-critical region- two kinds of errors. Randomized and non-randomized tests -most powerful test- Neyman-Pearson lemma. Simple problems.

Unit - II

Likelihood ratio test- construction of tests for mean, equality of two means (independent samples), variance and equality of variances of normal populations.

Unit - III

Tests of significance: sampling distribution, standard error. Large sample tests concerning mean(s), variance(s), proportion(s) and correlation coefficient – simple problems.

Unit - IV

Tests of significance: Exact tests based on *t*, *F* and *chi*-square distributions concerning mean(s), variance(s), correlation coefficient(s) - Partial and multiple correlation coefficients. *Chi* – square test - contingency table-test for goodness of fit, test for independence of attributes, test for association – simple problems.

Unit - V

Non-parametric tests – advantages and disadvantages of nonparametric tests- test for randomness, Kolmogorov -Smirnov test, sign test, median test, Mann-Whitney U test, and Wilcoxon's signed - rank test – simple problems and applications.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Goon, A. M., M.K. Gupta, and B. Dasgupta (2002) Fundamentals of Statistics, Vol. I, (Third Edition), World press Ltd, Kolkata.
2. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (2017). Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Education, New Delhi.

BOOKS FOR REFERENCE:

1. Bhuyan K.C. (2010), Probability Distribution Theory and Statistical Inference, New Central Book Agency (P) Ltd., New Delhi.
2. Gupta, S. C., and V. K. Kapoor (2020) Fundamentals of Mathematical Statistics, (Twelfth Edition). Sultan Chand & Sons, New Delhi.
3. Robert, V. Hogg, Joseph W. McKean and Allen T. Craig (2013) Introduction to Mathematical Statistics (Seventh Edition), Pearson Education, New York.
4. Rohatgi, V. K. and A. K. Md. E. Saleh (2009). An Introduction to Probability Theory and Mathematical Statistics (Second Edition). John Wiley & Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ== P-05. Statistical inference II.
2. https://nptel.ac.in/courses/111105043/Statistical Inference-IIT Kharagpur.
3. https://nptel.ac.in/courses/111105124/Statistical Inference-IIT Kharagpur

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*Low*	*Medium*	*High*	*Medium*	*Medium*	*Medium*
CO2	*High*	*Medium*	*Medium*	*High*	*Medium*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*Low*	*High*	*High*
CO4	*High*	*High*	*Medium*	*Medium*	*Low*	*High*	*High*
CO5	*High*	*High*	*High*	*Medium*	*Low*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*Medium*	*Medium*
CO2	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO4	*Medium*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*Low*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

6.2 DESIGN OF EXPERIMENTS (Core IX)

Course Code	**--**	**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Core	**--**	**DESIGN OF EXPERIMENTS**	**4**	**2**	**0**	**4**
Prerequisites		Basic knowledge of Linear Algebra, Linear regression models, Estimation and Testing of Hypotheses	**Syllabus Version**		**2021-22**	

Course Objectives:

The main objectives of this course are to:

- Understand the need and the objectives of experimental designs.
- Inculcate the need for principles of experimental designs.
- plan and conduct designed experiments efficiently and effectively,
- analyze and interpret experimental results,
- Motivate towards construction of experimental designs.

Course Outcomes (COs):
At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Understand the basic principles and methods of experimental designs.	**K2**
CO2	Perform suitable post -ANOVA tests	**K1,K2**
CO3	Analyze the outcome of basic designs.	**K1,K2,K5**
CO4	Analyze the outcomes of factorial experiments.	**K4,K6**
CO5	Apply the concept of reduction in block sizes and analyze the results	**K3,K4**
CO6	Develop computer programs for carrying out computations related to this course	**K1-K6**
K1: Remember **K2 :** Understand **K3:** Apply **K4:**Analysis **K5:** Evaluate **K6 :** Create		

Course Outline:

Unit - I

Fundamental principles of experiments – randomization, replication and local control. Size of experimental units. Analysis of variance- one-way and two-way classifications.

Unit - II

Post ANOVA Tests: Fisher Critical Difference Test,Multiple range test; Newman-Keul's test-Duncan's multiple range test-Tukey's test. Concept of Analysis of Covariance.

Unit - III

Analysis of Variance and Basic Designs: Concept of Cochran's Theorem. Completely randomized design(CRD)- Randomized Complete Block Design(RCBD) - Latin square design(LSD) and their analysis - Missing plot techniques in RCBD.

Unit - IV

Factorial experiments: 2^2, 2^3 and 2^n factorial experiments. Definitions and their analyses.

Unit - V

Principles of confounding –partial and complete confounding in 2^3– Introduction to Incomplete Block Design – Concept, definitions and examples of Balanced Incomplete Block Design (BIBD) – parametric relationship of BIBD.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only

BOOKS FOR STUDY:

1. Das, M.N. and Giri,N.C. (1988) Design and Analysis of Experiments(2nd Edition). New Age International, New Delhi.
2. Gupta, S. C. and V. K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & Sons, New Delhi.
3. Agarwal, B.L., (2010). Theory and Analysis of Experimental Designs., CBS Publishers & Distributors Pvt. Ltd., New Delhi.

BOOKS FOR REFERENCE:

1. Douglas,C. Montgomery(2012) Design and Analysis of Experiemnts. John Wiley & sons, New York.
2. Dean, A and Voss (2006) Design and Analysis of Experiments. Springer India Private Limited, New Delhi.
3. Rangasamy, R (2010) A Textbook of Agricultural Statistics, New Age International Pvt Ltd.

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Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. Https://epgp.inflibnet.ac.in/home/viewsubject?catid=+u3y6udbivoj97lfescmhq== p-03. Design of experiments and sample surveys.
2. https://nptel.ac.in/courses/102106051

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

6.3 STATISTICAL QUALITY CONTROL and OPERATIONS RESEARCH (Core X)

Course Code		TITLE OF THE COURSE	L	T	P	C
Core		**Statistical Quality Control and Operations Research**	4	2	0	4
Prerequisites		Basic knowledge of probability theory, Distribution theory and Sampling theory	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Inculcate the concepts of process control and product control
- Impart skill for construction of variable and attribute control charts
- Instill the practice of conducting sampling inspection for given conditions
- enable formulation of optimization problems for given decision-making situations
- enhance the ability of solving optimization problem
- develop skills for finding optimal solutions through analytical and computational methods

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Construct variable and attribute control charts for detecting shifts in production process.	**K1, K3**
CO2	Understand the applications of acceptance sampling procedures in industries	**K4, K5**
CO3	Evaluate the performance of sampling plans using OC, ASN, ATI, AOQ functions	**K2, K3 and K5**
CO4	Formulate optimization problems for given requirements	**K2, K3 and K6**
CO5	Determine optimal solutions for given optimization problems	**K2, K4, K5 and K6**
CO6	Develop computer programs for carrying out computations related to this course	**K2, K4, K5 and K6**

K1: *Remember* **K2**: *Understand* **K3**: *Apply* **K4**: *Analyze* **K5**: *Evaluate* **K6**: *Create*

Course Outline:

Unit - I

Control charts for variables: Quality control and need for statistical quality control techniques in industries - causes of variation - process control and product control. Process control: specifications and tolerance limits-3σ limits, construction of Shewhart control charts - variable control charts - $\overline{X}$, R and σ charts- simple problems.

Unit - II

Control charts for attributes: control chart for fraction defectives (p chart), control chart for number of defectives (d chart) and control chart for number of defects per unit (c chart)-simple problems.

Unit - III

Acceptance sampling by attributes: Single sampling plan - OC, AOQ, ATI and ASN curves - Dodge and Romig sampling plans –Double sampling plan and its advantages over single sampling plan, Operating procedure. Acceptance sampling by variables.

Unit - IV

Concepts of Operations Research – Linear Programming Problem(LPP) - mathematical formulation of normal form - graphical solution. Simplex method – Big M method –dual formulation.

Unit - V

Transportation problem-mathematical formulation- North-West corner rule and Vogel's rule-MODI method - Assignment problem - Hungarian method. Game theory: Maximin and Minimax criterion.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOKS FOR STUDY:

1. Montgomery, D.C. (1991) Statistical Quality Control (2nd Edition) John Wiley and Sons, New York.
2. Eugene L. Grant, and Richard S. Leavenworth (1988) Statistical Quality Control (Sixth Edition), McGrawhill Book co, New York.
3. Gupta, S. C. and V.K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & sons, New Delhi.
4. Kanti Swarup, Gupta, P.K. and Man Mohan (2008) Operations Research (3rd Edition). Sultan Chand & Co, New Delhi.

BOOKS FOR REFERENCE:

1. Mahajan (1997) Statistical Quality Control, Dhanpat Rai & sons, New Delhi.
2. Juran, J.M.(1988) Quality Control Handbook, McGraw Hill, New York.

3. Goon, A. M., M.K. Gupta and B. Dasgupta (1987) Fundamentals of Statistics, Vol. II. World Press, Kolkata.
4. Goel,B.S.and Mittal,S.K. (2000) Operations Research, PragatiPrakashan, Meerut.
5. Gupta, R.K.(1985) Operations Research, Krishna Prakashan, Mandir, Meerut.
6. Hillier, F.S and Lieberman, G. J. (1998) Operations Research, CBS Publishers and Distributors, New Delhi.
7. Taha, H.A. (2007) Operations Research – An Introduction (8th Edition) Prentice Hall of India, New Delhi.
8. Taha, H.A. (1996) Operations Research, 6/e, Prentice Hall,New Delhi

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/110101150
2. https://nptel.ac.in/courses/112107259
3. https://nptel.ac.in/courses/116102019
4. https://nptel.ac.in/courses/110106062
5. https://nptel.ac.in/courses/111107128
6. https://nptel.ac.in/courses/110106059
7. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZLCHeZEhCZ8yCri36nSF3A== P-14. Operations Research (35).

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*Low*	*High*	*High*	*High*	*High*
CO2	*High*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*Low*	*Medium*	*Medium*	*High*	*High*
CO4	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*High*
CO5	*High*	*Medium*	*Medium*	*High*	*Low*	*High*	*High*
CO6	*Medium*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*High*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO4	*High*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*High*	*Low*	*Medium*
Correlation Level: *Low* *Medium* *High*							

6.4 MAJOR ELECTIVE – II

1. STOCHASTIC PROCESSES

Course Code	TITLE OF THE COURSE	L	T	P	C
Core	STOCHASTIC PROCESSES	4	0	0	4
Prerequisites	Knowledge of Probability Theory and Distribution Theory	Syllabus Version		2021-22	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives:

The main objectives of this course are to

- Understand concept of stochastic process with illustrations
- Provide knowledge on classification and properties of stochastic processes
- Facilitate to learn theoretical concepts pertaining to handling various stochastic models.
- Impart the application of various stochastic models for forecasting and prediction

Course Outcomes (COs):

At the end of this course of study, the student will be able to

CO No.	Course Outcome	Cognitive Level
CO1	Classify of given stochastic process and to study its stationary properties.	K1, K2 & K4
CO2	Determine transition probability matrix for given Markov chain.	K1 - K3
CO3	Study the properties of states of Markov Chain and classify them.	K1 - K3
CO4	Perform computations related to Poisson Process, Birth and Death process and their differential and difference equations.	K3 & K4
CO5	Understand the concept of Queueing models, their Classifications and applications	K1, K3 & K6
CO6	Develop computer programs for carrying out computations related to this course	K1 – K6

K1: *Remember* **K2:** *Understand* **K3:** *Apply* **K4:** *Analyze* **K5:** *Evaluate* **K6:** *Create*

Course Outline:

Unit - I

Elements of Stochastic Processes: Basic terminologies. Classification of stochastic processes according to state space and domain-Elementary ideas on the Poisson process and Wiener process-Martingales-Markov processes- Stationary processes.

Unit - II

Markov Chain: definition-transition probability- discrete time Markov chain and transition probability matrix. Spatially homogeneous Markov Chain-one -dimensional random walk.

Unit - III

Classification of states of Markov Chain. Reducible and irreducible Markov Chains- periodicity. Recurrent and transient states with examples. Concepts, results and problems concerning limiting probabilities (without Proof)- Simple problems.

Unit - IV

Classical examples of continuous time Markov Chain- infinitesimal generator - Poisson processes. General pure birth process and Yule's process. Birth and death processes - their differential and difference equations and solutions.

Unit - V

Queueing models and Classifications – Queueing system - Definition of transient and Steady-states - Kendall's notations and classification of queuing models - Distributions in queuing systems.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

BOOK FOR STUDY:

1. Medhi, J. (1994) Stochastic Processes (Second Edition). Wiley Eastern Limited, New Delhi.
2. Samuel Karlin and Taylor (1975) A First Course in Stochatic Processes. Academic Press, NewYork.

BOOKS FOR REFERENCE:

1. Bhat, U. N. (1972) Elements of Applied Stochastic Processes. John Wiley & Sons, New York.
2. Basu, A.K. (2005) Introduction to Stochastic Process, Narosa Publishing House Pvt. Ltd., New Delhi.
3. Ross, S.M (1983): Stochastic Processes, John Wiley and Sons, New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

4. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=34 Paper: P-10. Stochastic Processes and Time Series Analysis - ISI, Kolkata
5. https://nptel.ac.in/courses/111/103/111103022/ Stochastic Processes – IIT Guwahati
6. https://nptel.ac.in/courses/111/102/111102098/ Introduction and Motivation for studying Stochastic Processes – IIT Delhi
7. https://ocw.mit.edu/courses/mathematics/18-445-introduction-to-stochastic-processes-spring2015/lecture-notes/
8. https://www.stat.auckland.ac.nz/~fewster/325/notes/325book.pdf

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*High*	*High*	*High*	*High*	*High*
CO2	*High*	*Medium*	*High*	*Medium*	*Low*	*High*	*High*
CO3	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
CO4	*High*	*Medium*	*Medium*	*Medium*	*Medium*	*Medium*	*High*
CO5	*High*	*High*	*High*	*Medium*	*Medium*	*Medium*	*High*
CO6	*High*	*High*	*High*	*High*	*Medium*	*High*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO2	*Medium*	*High*	*High*	*Low*	*High*	*High*	*High*
CO3	*High*	*High*	*High*	*Medium*	*High*	*High*	*High*
CO4	*High*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO5	*High*	*Medium*	*High*	*High*	*Low*	*Medium*	*High*
CO6	*Medium*	*High*	*High*	*Medium*	*Low*	*High*	*High*
Correlation Level:	*Low*	*Medium*	*High*				

2. REGRESSION ANALYSIS

Course Code		**TITLE OF THE COURSE**	**L**	**T**	**P**	**C**
Elective		**REGRESSION ANALYSIS**	**4**	**0**	**0**	**4**
Prerequisites		Knowledge of correlation and regression Analysis	**Syllabus Version**		**2021-22**	

L: Lecture T: Tutorial P: Practical C: Credits

Course Objectives

The main objectives of this course are to

- Impart knowledge on regression models, their construction and interpretations.
- Instill the practice of validating the constructed models.
- Facilitate to investigate the properties of regression models.

COURSE OUTCOMES

On completion of the course, students will be able to:

CO No.	Expected Course Outcomes	Cognitive Level
CO1	Understand the fundamental concepts and a methods of Regression model.	K2, K3
CO2	Examine the model assumptions	K3
CO3	Construction of Simple and Multiple Linear models regression.	K3,K6
CO4	Investigate the presence of multicollinearity and to learn overcoming the issues.	K4,K5
CO5	Understand the concept of non-parametric methods and its applications	K3,K6
CO6	Develop computer programs for carrying out computations related to this course	K1- K6
K1: *Remember* **K2:** *Understand* **K3:** *Apply* **K4:** *Analyze* **K5:** *Evaluate* **K6:** *Create*		

Course Outline:

Unit – I

Simple Linear Regression Model – Definition, description of data model , parameters estimation using OLS method. Properties of OLS estimators. Residuals – Concept and Properties. Analysis, Interpretation and Applications of the model.

Unit – II

Effect of outliers in Simple Linear Regression Model – Model adequacy and residual plots – deletion of data-points – Transformation of variables to stabilize variance. Concept of Heteroscedasticity.

Unit – III

Multiple Regression Model: Concept and description of data model. Model parameter estimation using OLS – Predicted values and standard errors. Concept of partial F – Test. Selection of variables – Forwards selection procedure and Backward elimination procedure.

Unit - IV

Multicollinearity and its effects on inference and forecasting – Concept on sources of multicollinearity. Detection procedures of multicollinearity. Method of overcoming multicollinearity problem.

Unit - V

Non-parametric methods – Tests for randomness and test for goodness of fit. One sample tests : sign test, Wilcoxon signed rank tests. Two sample tests : run test, Kolmogorov – Smirnov's test. Median test and Mann-Whitney U test. Spearman's rank correlation test, Kurskall-Wallis Test.

UNIT VI

Contemporary issues: Experts' lectures – online seminars and webinars. [2 hours]

Note 1: Students will be trained to develop appropriate computer programmes in *R* and *Python* related to computations taught in this course.

Note 2: Examination shall be conducted on contents of UNIT I through UNIT V only.

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BOOKS FOR STUDY:

1. Gibbons, J.D., (1985).Non-Parametric Statistical Inference, 2nd Edition, Marcel Dekker, Inc., New York and Basel.
2. Montgomery, D.C., Peck, E.A., Geoffrey, G.V.(2012). Introduction to Linear Regression Analysis, 5th Edition, John Wiley & Sons, Inc.

BOOKS FOR REFERENCE :

1. Hadi, A.S. and Chakraborti, S., (2015). Regression Analysis by Example, 5th Edition, John Wiley & Sons, Inc.
2. Draper,N.R. and Simth,H.(1998).Applied Regression Analysis,John wiley
3. Gibbons, J.D., and Chakraborti, S., (2020). Nonparametric Statistical Inference, CRC Press.
4. Gujarati, D.(2004): Introduction to Econometrics. McGraw Hill, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ== P-07.Regression analysis I
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+u3y6UdbIvOJ97LFeSCmHQ== P-08.Regression analysis II

Mapping of Course Outcomes to Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*High*	*High*	*Low*	*Medium*	*High*	*High*	*Medium*
CO2	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO3	*High*	*High*	*Low*	*Medium*	*High*	*High*	*Medium*
CO4	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO5	*High*	*High*	*Medium*	*Medium*	*High*	*High*	*Medium*
CO6	*High*	*High*	*High*	*High*	*High*	*High*	*High*
Correlation Level: *Low* *Medium* *High*							

Mapping of Course Outcomes to Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO 6	PSO7
CO1	*Medium*	*Medium*	*High*	*High*	*Medium*	*High*	*High*
CO2	*Medium*	*High*	*Medium*	*Medium*	*High*	*High*	*High*
CO3	*Medium*	*High*	*High*	*High*	*High*	*High*	*Medium*
CO4	*High*	*Medium*	*High*	*High*	*High*	*High*	*Medium*
CO5	*Medium*	*High*	*High*	*Medium*	*Medium*	*High*	*High*
CO6	*High*	*High*	*High*	*High*	*High*	*Low*	*High*
Correlation Level: *Low* *Medium* *High*							

6.5 STATISTICS PRACTICAL – IV (Core)

Based on the course Statistical Inference-II, Design of Experiments,

6.6 STATISTICS PRACTICAL – V/ MINI PROJECT (Core)

Based on the course Statistical Quality Control, Operations Research

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Guideline for Practicals

Note:

I. Software Based:

The exercises in Major Practical courses for Semester-II, IV and V shall be carried out using statistical software.

II. Scientific Calculator Based/Software based

The following exercises shall be carried out in Semester VI using non-programmable scientific calculator/software.

Statistical Inference-II

1. Calculation of size and power of most powerful tests.
2. Testing the population proportion based on large sample.
3. Testing the equality of two population proportions based on large samples.
4. Testing the mean of normal populations when standard deviation is (i) known (ii) Unknown.
5. Testing the equality of means of two normal populations i) when variances are known and ii) with common but unknown variance.
6. Testing the variance of normal population.
7. Testing the homogeneity of variances of two normal populations.
8. Testing the independence of two attributes.
9. Non parametric test for one sample problems – runs test, sign test, Kolmogorov – Smirnov test.
10. Non parametric test for two sample problems – median test, Mann-Whitney U test and Wilcoxon's signed – rank test.

Design of Experiments

1. Carrying out ANOVA for one way classified data.
2. Carrying our ANOVA for two way classified data.
3. Analyzing completely randomized design.
4. Analyzing randomized block design.
5. Analyzing Latin square design.
6. Analyzing 2^2 factorial design.
7. Analyzing 2^3 factorial design.

Statistical Quality Control

1. Construction of control charts for mean and range ($\overline{X}$ and R charts)
2. Construction of control charts for standard deviation (σ chart)
3. Construction of control charts for fraction defectives (p chart)
4. Construction of control charts for number of defectives (d chart)
5. Construction of control charts for number of defects per unit (c chart)
6. Draw OC, AOQ and ATI curves for single and double sampling plans by attributes.

Operations Research

1. Solving linear programming problem applying graphical method, simplex method.
2. Finding initial basic feasible solution to transportation problem applying methods of North- West corner, row minima, column maxima, matrix minima method, Vogel's Approximation methods.
3. Solving 2 x 2 game with saddle point.
4. Solving 2 x 2 game applying dominance rules.

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