KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited 'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

Faculty of Science and Technology

Two Years PG Programme

M.Sc. Statistics

Programme structure and Syllabus

As per NEP-2020

With Effect from 2024-25

DEPARTMENT PROFILE

The Department of Studies in Statistics was founded in 1951 with the view of providing professionally competent academicians for Teaching, Research and providing training in application of Statistics. Over the years, Department of Studies in Statistics has developed into one of the major teaching – learning and research institute. The Department was supported by DST through its FIRST Programme from 2004-2009. The UGC has sanctioned UGC-DRS-SAP-I and BSR grants for development of infrastructure. With these funds, the Department maintains an excellent Library with books on Statistical Inference, Stochastic Modelling and their applications in related fields. The Department has two computer laboratories, which are extensively used for teaching and research. The faculty members of the department belong to diverse fields and are specialized in one or more areas of Statistics. Many of our Alumni are working as Statisticians, Analysts and Team leaders in Academic, Research institutes and Multinational Companies.

e-mail : statistics@kud.ac.in

At present the Department offers the following Courses:

1. **M. Sc. in Statistics**
2. **Ph. D in Statistics**

M. Sc. in Statistics
Eligibility :
The candidate with BA/B.Sc. Degree with Statistics or Mathematics or both as optional(s).
He/She should score at least 45% (40% incase of ST/ST in aggregate in the degree and also in the subject Statistics or Mathematics.

The Department offers two Open Elective Courses for Post Graduate Students across faculty.

i) Statistical Methods (for II Semester)
ii) Applied Statistics (for III Semester)

Discipline Specific Electives:

Semester-III
DSE-1A: Econometrics,
DSE-1B: Operations Research and Optimization Techniques
DSE-1C: Data Mining Techniques.

Semester-IV
DSE-2A: Time Series,
DSE-2B: Actuarial Statistics
DSE-2C: Statistical Machine Learning.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours/ week).
5. One practical batch consists of 10-12 students.

II. ALLOTMENT OF SPECIALIZATION:

While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization.

III. ATTENDANCE: 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.
2. Up to 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks (20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks (30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8th week and 10 marks for 14thweek of every semester.

V. Conduct of Examination:

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision

for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.

2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.
3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.
4. There shall be a single examiner for both even and odd semesters' Formative Practical examination.
5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical examination; one from internal and other shall be external examiner.

VI. Assessment:

1. **Theory papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.
2. **Project/Internship assessment**

A) **For100 marks Project/Internship assessment (Wherever applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 20 marks out of 100 marks Candidate has to submit two Progress Reports; each carries 10 Marks. i.e. 10 x 2= 20 marks.

ii. **Summative Assessment**: Project/Internship assessment carrying 80 marks out of 100 marks

a. Project Report : 35
b. Presentation : 25
c. Viva-voce : 20

B) **For150 marks Project/Internship assessment (Wherever applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks Candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

a. Project Report : 60
b. Presentation : 35
c. Viva-voce : 25

VII. Passing criteria:

1. There shall be no minimum passing marks for Formative assessment.

2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.
2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.

   CGPA=$(Credit_1 \times SGPA_1) + (Credit_2 \times SGPA_2) + (Credit_3 \times SGPA_3) + (Credit_4 \times SGPA_4)$ / Total credits of programme (sum of credits of 4 semesters).
7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the programme(Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

i. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard.

PROGRAMME OUTCOMES (POs):

The Syllabus is framed to meet the academic, social and organizational requirements.

1. It inculcates statistical thinking, practical and analytical skills relevant to the different areas.
2. The Post Graduates will be able to effectively use various statistical packages and computer languages.
3. The Post graduates will acquire ability to establish themselves as analysts in various sectors, viz. pharmaceuticals, banking, insurance, MNCS, industries, etc.

Karnatak University, Dharwad
M.Sc. in STATISTICS-Programme Structure
Effective from 2024-25

Sem	Type of Course	Theory / Practical	Course Code	Course Title	Instruction hour / week	Total hours / Sem	Duration of Exam	Marks			Credits
								Forma -tics	Summa -tive	Total	
I	DSC-1	Theory	A1STA001T	Linear Algebra and Real Analysis	04	60 hrs	03 hrs	20	80	100	04
	DSC-2	Theory	A1STA002T	Probability Theory	04	60 hrs	03 hrs	20	80	100	04
	DSC-3	Theory	A1STA003T	Sampling Theory and Demography	04	60 hrs	03 hrs	20	80	100	04
	DSC-4	Theory	A1STA004T	Statistics with R-Programming	04	60 hrs	03 hrs	20	80	100	04
	DSC-5	Practical	A1STA005P	Practicals based on A1STA001T **and** A1STA002T	08	120 hrs	04 hrs	20	80	100	04
	DSC-6	Practical	A1STA006P	Practicals based on A1STA003T **and** A1STA004T	08	120 hrs	04 hrs	20	80	100	04
								120	**480**	**600**	**24**
II	DSC-7	Theory	A2STA001T	Probability Distributions	04	60 hrs	03hrs	20	80	100	04
	DSC-8	Theory	A2STA002T	Theory of Point Estimation	04	60 hrs	03 hrs	20	80	100	04
	DSC-9	Theory	A2STA003T	Stochastic Processes and Python	04	60 hrs	03 hrs	20	80	100	04
	OEC - 1	Theory	A2STA201T	Statistical Methods	04	60 hrs	03 hrs	20	80	100	04
	DSC-10	Practical	A2STA004P	Practicals based on A2STA001T **and** A2STA002T	08	120 hrs	04 hrs	20	80	100	04
	DSC-11	Practical	A2STA005P	Practicals based on A2STA003T	08	120 hrs	04 hrs	20	80	100	04
								120	**480**	**600**	**24**

Sem	Type of Course	Theory / Practical	Course Code	Course Title	Instruction hour /week	Total hrs/Sem	Duration of Exam	Marks			Credits
								Formatics	Summative	Total	
III	DSC-12	Theory	A3STA001T	Testing of Hypotheses	04	60 hrs	03hrs	20	80	100	04
	DSC-13	Theory	A3STA002T	Multivariate Analysis	04	60 hrs	03hrs	20	80	100	04
	DSE-1	Theory	A3STA101T	Elective-1A: Econometrics	04	60 hrs	03 hrs	20	80	100	04
			A3STA102T	Elective-1B:Operations Research and Optimization Techniques							
			A3STA103T	Elective-1C: Data Mining Techniques							
	OEC - 2	Theory	A3STA201T	Applied Statistics	04	60 hrs	03 hrs	20	80	100	04
	DSC-14	Practical	A3STA003P	Practicals based on A3STA001T **and** A3STA002T	08	120 hrs	04 hrs	20	80	100	04
	DSC-15	Practical	A3STA004P	Practicals based on A3STA101T/ A3STA102T/ A3STA103T	08	120 hrs	04 hrs	20	80	100	04
***Student has to opt any one course of the above Electives**								**120**	**480**	**600**	**24**
IV	DSC-16	Theory	A4STA001T	Linear Models and Designs of Experiments	04	60 hrs	03 hrs	20	80	100	04
	DSC-17	Theory	A4STA002T	Statistical Quality Control and Reliability Theory	04	60 hrs	03 hrs	20	80	100	04
	DSC-18	Theory	A4STA003T	Regression Analysis and Computer Intensive Statistical Techniques	04	60 hrs	03 hrs	20	80	100	04
	DSE-2	Theory	A4STA101T	Elective-2A: Time Series Analysis	04	60 hrs	03 hrs	20	80	100	04
			A4STA102T	Elective-2B: Actuarial Statistics							
			A4STA103T	Elective-2C: Statistical Machine Learning							
	DSC-19	Practical	A4STA004P	Practicals based on A4STA001T **and** A4STA002T	08	120 hrs	04 hrs	20	80	100	04
	Project	Practical	A4STA005P	Project	08	120 hrs	04 hrs	20	80	100	04
***Student has to opt any one course of the above Electives**								**120**	**480**	**600**	**24**
							Total	**480**	**1920**	**2400**	**96**

*Each DSE theory shall have minimum two and maximum 3 papers and student shall select any one DSE each in III and IV semester.

M.Sc. in STATISTICS
SYLLABUS

Semester – I

Course Title: DSC 1: Linear Algebra and Real Analysis

Course Code : A1STA001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Provide a thorough knowledge in various aspects of linear algebra.
CO 2	:	Have an in depth knowledge in basics of vector algebra.
CO 3	:	Use important tools such as determinants, rank, inverse and generalized inverse in statistics.
CO 4	:	Acquire the knowledge of linear transformations, orthogonal bases and projections.
CO 5	:	Study the importance and methodologies of calculating eigen values and eigen vectors.
CO 6	:	Have ability to understand and solve emerging research problems using the tools studied in linear algebra.

Unit	Linear Algebra and Real Analysis	Total Hrs: 60
I	Vector spaces, subspaces, linear dependence and independence. Basis and dimension of a vector space, finite dimensional vector spaces. Gram- Schmidt orthogonalisation process, orthonormal basis and orthogonal projection of a vector. Linear transformations. Linear equations, generalized inverse, Moore - Penrose inverse,	**15 hrs**
II	Characteristics roots and Vectors, Cayley - Hamilton theorem, similar matrices algebraic and geometric multiplicity of characteristics roots, spectral decomposition of a real symmetric matrix, simultaneous reduction of a pair of real symmetric matrices, singular values and singular decomposition, Jordan decomposition. Real quadratic forms: reduction and classification of quadratic forms, triangular reduction of a positive definite matrix, extrema of quadratic forms, vector and matrix differentiation.	**15 hrs**
III	Introduction to real numbers, Construction, Completeness property, Archimedean property, countable and uncountable set. Definition of interior points, Closed sets, Adherent points, Accumulation points, Closure, Bolzano-Weirstrass Theorem. Convergent sequences in a metric space, Cauchy sequences, Complete metric space, Limit of a function, Continuous functions, Continuity of composite functions, Continuity and inverse image of open and closed sets, Functions continuous on	**15 hrs**

		compact sets, Connectedness.	
IV		Review of Riemann Integration, Riemann-Stieltjes integral: definition and examples, properties of the integral. Uniform continuity, fixed point theorem for contractions, sequences of functions, point wise convergence of sequences of functions. Uniform convergence of sequences of functions, uniform convergence and continuity, Cauchy condition for uniform convergence. Uniform convergence of infinite series of functions, Cauchy condition for uniform convergence of series, Weirstrass M-test, Dirichlet's test for uniform convergence, Uniform convergence and differentiation, Uniform convergence and integration **.**	**15 hrs**

Reference Books:

1. Graybill, F. A , Matrices with applications in statistics, 2nd edition, Wadsworth, 1983.
2. Rao, A. R and Bhimasankaram P , Linear Algebra, Tata McGraw Hill, 1992.
3. Searle, S. R., Matrix Algebra Useful in Statistics, Wiley, 1982.
4. W. Rudin, Principles of Mathematical Analysis, 3rd ed., McGraw-Hill, 2013.
5. T. Apostol, Mathematical Analysis, 2nd ed., Narosa Publishers, 2002.
6. Elias M. Stein and Rami Shakarchi, Real Analysis, Princeton Lectures, 2010.
7. Terrance Tao, Analysis I and II, Trim, Hindustan book agency, 2006.

Course Title: DSC 2: Probability Theory

Course Code : A1STA002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

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

CO 1	:	Understand the concepts of measure and probability measure.
CO 2	:	Provide an introduction to the basic notations and results of measure theory and how these are used in probability theory.
CO 3	:	Get expertise in analyzing random phenomenon through convergence of random variables.
CO 4	:	Know the importance of expectation and different types of inequalities associated with moments.
CO 5	:	Gain the knowledge of Strong Law of Large Numbers, Weak Law of Large Numbers, Central Limit Theorem and their applications.

Unit	Probability Theory	Total Hrs: 60
I	Classes of sets, sequence of sets, limit superior and limit inferior of a sequence of sets, fields, sigma fields, minimal sigma field, Borel sigma field on the real line. Measure and its properties, measurable functions and inverse functions, Lebesgue and Lebegue -Stieltje's measures on R. Probability measure, Additive property, properties related to sequences of events, Independent events, Conditional probability and Bayes' theorem.	**15 hrs**
II	Random variable, Distribution function of a random variable and its properties, Jordan's decomposition of distribution functions. Expectation of random variables, properties of expectation. Moments: definitions and simple properties, Moment inequalities – Chebychev's, Markov, Cauchy-Schwartz, Holder, Minkowsky, Liapunov and Jensen Inequalities, Interrelationships among the inequalities and their applications and simple problems on these inequalities.	**15 hrs**
III	Characteristic function: Definition and properties, inversion formula, uniqueness theorem, Levy's continuity theorem. Convergence in probability, convergence in distribution and their relationships, convergences in r^{th} mean, almost sure convergence, Borel- Cantelli lemma. Integration of a measurable function with respect to a measure: monotone convergence theorem, Fatou's lemma, dominated convergence theorem.	**15 hrs**
IV	Law of large numbers: Weak Law of large numbers- Chebychev's, Bernoulli's and Khintchine's Weak Law of Large Numbers, necessary and sufficient conditions for the WLLN. Strong law of large numbers: Kolmogorov's SLLN's for independent random variables and IID random variables. Central Limit Theorem: Lindeberg – Levy theorem, Linderberg – Feller theorem, Liapounov theorem, Relation between Liapounov and Linderberg – Feller forms.	**15 hrs**

Reference Books:

1. Ash, R. B. (2000). Probability & Measure Theory. Academic Press.
2. Athreya, K. B., & Lahiri, S. N. (2006). Probability theory, Hindustan Book Agency.
3. Bhat, B. R. (2007). Modern probability theory, New Age International.
4. Billingsley P. P. (1986). Probability and measure, Wiley.
5. Dasgupta, A. (2010) Fundamentals of Probability: A First Course, Springer, New York.
6. Mukhopadhy P. (2002). Theory of Probability, New central book agency, Calcutta.
7. Rohatgi, V. K., & Saleh, A. M. E. (2015). An introduction to probability and statistics. John Wiley & Sons.
8. Vardhan S. R. S. (2000). Probability Theory, New York University.

Course Title: DSC-3: Sampling Theory and Demography

Course Code : A1STA003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	**:**	Prepare questionnaires, plan the scheme of the survey, train investigators, collect primary data, tabulate and disseminate data.
CO 2	**:**	Identify the nature of population, sampling methodology to be adopted and recognize right tool for analysis.
CO 3	**:**	Deal with various non-sampling errors and carry out sampling surveys on sensitive issues.
CO 4	**:**	Have in depth knowledge about sources of demographic data and various fertility and mortality measures.
CO 5	**:**	Acquire knowledge of construction of life tables for various categories of demography.
CO 6	**:**	Study the importance and methodologies of population growth and projections.

Unit	**Sampling Theory and Demography**	**Total Hrs:60**
I	Concepts of Random Sampling, Sampling Design, Sampling Scheme and Sampling Strategy. Equal probability sampling schemes: SRS and Systematic Sampling Procedures Varying probability sampling schemes: Methods of drawing PPS samples, PPSWR, PPSWOR,Desraj's Ordered Estimates, Murty's unordered Estimates. I P P S sampling: Horvitz – Thompson Estimator and it's properties, Midzuno – Sen scheme of sampling, Rao – Hartly – Cochran (RHC) scheme of sampling	**15 hrs**
II	Other sampling schemes:Stratified sampling, Cluster sampling and Sub sampling. Estimation methods in sampling:Ratio and Regression Estimators with their properties. Double sampling procedures in Ratio, Regression estimators. Non- Sampling Errors: Errors in Surveys, Model for measurement of observational error. Hansen – Hurwitz, Deming's and Politz - Simons Techniques to handle non-response error RRT: Warner's Model	**15 hrs**
III	Demographic data: Sources of demographic data, coverage and content errors, use of balancing equation, Chandrasekaran and Deming formula to check completeness of registration data, Whipple's, Myers's, UN and Modified Indices, smoothing of age data. Measures of Mortality: Crude death rate, specific death rates, infant mortality rate, neonatal and perinatal mortality rates, standardized death rates, comparative	**15 hrs**

	mortality index. Measures of Fertility:Period and cohort fertility measures, use of birth order statistics, child – women ratio, Brass P/F ratio to estimate current levels of fertility, measures of reproduction and replacement. Sheps and Perrin stochastic human reproductive process.	
IV	Life Tables: Types of life tables, inter – relationships between life table functions, construction of life tables using Reed – Merrel and Greville's Method. Probability distribution of life table functions and their optimum properties. Population estimation and Projections: Mathematical, Statistical and Demographic Methods, Component method. Stable and Quasi – stable population: Derivation of Lotka's stable population model and its properties, Intrinsic growth rate and its derivation, age structure and birth rate of a stable population, mean length of generation, momentum of population growth, Quasi – stable population under changing fertility and mortality situations.	**15 hrs**

Reference Books:

1. Mukhyopadhyay. P (1998) Theory and Methods of Survey Sampling. Prentice Hall of India Pvt. Ltd.
2. Murthy M.N (1977) Sampling Theory and Methods. Statistical Publishing Society, Calcutta.
3. Singh and Chaudhary F.S(1986) Theory and Analysis of Sample Survey Designs. Wiley Eastern New Delhi.
4. Sukhatme P.V,Sukhatme B.V. Sukhatme S. and Ashok C (1984) Sampling Theory of Surveys with Applications. Indian Society of Agricultural Statistics, New Delhi.
5. Barclay G. W. (1968) Techniques of population analysis, John Wiley and sons, New York.
6. Biswas S (1988), Stochastic Processes in Demography and Applications, Wiley Eastern, New Delhi.
7. Ramkumar R (1986), Technical Demography, Wiley Eastern, New Delhi.
8. Shryock H.S, Siegel J.Sand Associates (1964) Methods and materials of demography (condensed edition) Academic press, London.

Course Title: DSC-4 : Statistics With R – Programming

Course Code : A1STA004T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

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

CO 1	:	Understand the basics in R programming in terms of constructs, control statements, string functions
CO 2	:	Write R-Programs for various statistical concepts.
CO 3	:	Carry out simulation to complex statistical problems.
CO 4	:	Use and interpret inbuilt tests in R-programming.
CO 5	:	Explore data files of R for various applications.

Unit	Statistics With R – Programming	Total Hrs:60
I	Introduction to R: R as a Statistical software and language, R preliminaries, methods of data input, data accessing or indexing. Graphics with R, getting help, saving, storing and retrieving data.	**15 hrs**
II	Some basic R functions: Absolute values, remainders, trigonometric, complex, round, floor, sort, rank, order, factorial, sum, prod functions. Summary Statistics. is, as, is.na, etc. factors, levels, etc. Control Programming. Vector and Matrices in R. Data entering and reading from files. Reading data from external files. Working with Packages.	**15 hrs**
III	Exploratory data analysis (EDA): Essential summaries of EDA, Graphical techniques in EDA (Box plot, Histogram, Histogram extensions and Rootogram, Pareto chart, Stem-and-leaf plot, Run chart, Scatter plot), Quantitative techniques in EDA: Trimean, Letter values. Exploratory Regression Models: Resistant line, Median polish.	**15 hrs**
IV	Analysis using R: problems based on descriptive statistics, probability distributions, simulation, statistical inference, correlation and regression, linear models and time series analysis.	**15 hrs**

Reference Books:

1. Goran Brostrom, Statistical Programming in R, Umea Universitet, Statistiska institutionen, Mandatory Reading instructions: Tillhandahalls elektroniskt.
2. D.M. Smith, W.N. Venables, The R Development Core Team, An Introduction to R.
3. John Braun, Duncan James Murdoch, A First Course in Statistical Programming with R, Cambridge, N.Y: Cambridge University Press: 2007:163s: ISBN: 978-0-521-87265-2 (inb.)

4. Brian D. Ripley, W.N.q (William N.) Venables, S Programming, New York: Springer: cop.2000:x,264s:ISBN: 0-387-98966-8(alk.paper).
5. John M. Chambers, Software for Data Analysis: Programming with R, New York, N.Y: Springer: cop. 2008: 498p: ISBN:978-0387-75935-7(hbk).
6. Prabhanjan N T, Suresh Ramaiah and Manjunath B G (2016) A Course in Statistics with R. Wiley.
7. Sudha G. Purohit, Sharad D. Gore and Shailaja R. Deshmukh (2008) Statistics Using R, Narosa Publishing House.

DSC-5: PRACTICAL : Linear Algebra and Real Analysis and Probability Theory
Course Code : A1STA005P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120hrs.**	**4hrs.**	**20**	**80**	**100**

Course Objectives: After completion of this course, the students, able to solve the various types of problems on the below listed topics. Gains understanding of the tools of linear equations, generalized inverse, eigen values and eigen vectors, various quadratic forms, diagonalization of a real symmetric and also simultaneous diagonalization of real matrices using statistical softwares.

List of Experiments:

1.	Examples on linear dependence and independence of vectors
2.	Examples on basis and dimension of a vector space
3.	Calculation of orthonormal basis and orthogonal projection of a vector
4.	Solutions for system of linear equations
5.	Examples on generalized inverses
6.	Finding characteristic roots and characteristic Vectors, application of Cayley - Hamilton theorem
7.	Examples for spectral decomposition and singular decomposition of a real symmetric matrix
8.	Problems for convergent sequences in a metric space and Cauchy sequences
9.	Problems for continuity and inverse image of open and closed sets
10.	Problems for Uniform continuity and sequences of functions
11.	Examples on uniform convergence of infinite series of functions
12.	Applications of Weirstrass M-test and Dirichlet's test for uniform convergence
13.	Sequence of Events.
14.	Probability Theory – I
15.	Probability Theory – II
16.	Probability Theory – III
17.	Probability Theory – IV
18.	Decomposition of Distribution Function.
19.	Probability inequality - I
20.	Probability inequality – II
21.	Characteristic Function – I
22.	Characteristic Function - II
23.	Central Limit Theorem – II
24.	Law of Large Numbers.

DSC-6 : PRACTICAL : Sampling Theory and Demography, and Statistics with R – Programming
Course Code : A1STA006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120hrs.**	**4hrs.**	**20**	**80**	**100**

Course Outcomes: The candidate will acquire practical knowledge on the applications of various sampling procedures and demographic techniques.

List of Experiments:

1.	Sampling Designs
2.	CTM and Lahiri's methods of obtaining PPS samples
3.	Desraj and Murthy's estimators
4.	IPPS and RHC procedures
5.	Ratio and Regression Estimators
6.	Double sampling
7.	Mortality measures – I
8.	Mortality measures – II
9.	Fertility measures
10.	Age heaping measures
11.	Life tables
12.	Population Estimation and Projection
13.	Data input, storing and retrieving
14.	Graphics with R
15.	Use of R-functions
16.	Vectors and Matrices
17.	Reading from files
18.	R - packages
19.	Exploratory data analysis
20.	Prediction using linear models
21.	Statistical tests.
22.	Simulation of random variables.

Formative Assessment	
Assessment Occasion/type	**Marks**
InternalAssessmentTest1	05
InternalAssessmentTest2	05
Assignment	10
Total	**20Marks**
Formative Assessment as per guidelines.	

Semester – II

Course Title: DSC-7 : Probability Distributions

Course Code : A2STA001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

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

CO 1	**:**	Understand the discrete and continuous probability distributions and their real life applications.
CO 2	**:**	Get expertise in understanding the advanced probability distributions and utilizing them to model the random phenomenon.
CO 3	**:**	Understand bivariate distributions and its applications in data analysis.
CO 4	**:**	Compute marginal and conditional distributions from joint distributions.
CO 5	**:**	Acquire the application knowledge of compound, Truncated, mixture and non-central probability.
CO 6	**:**	Get familiar with distributions of order statistics of various random variable and their applications.

Unit	**Probability Distributions**	**Total Hrs: 60**
I	Univariate discrete distributions: Bernoulli, Binomial, Poisson, Geometric, Hypergeometric, Negative binomial, Logarithmic series, Rectangular, Power series, Multinomial distribution and their properties.	**15 hrs**
II	Univariate continuous distributions: Normal, Lognormal, Cauchy, Uniform, Exponential, Logistic, Weibull, Double exponential, Gamma, Gumbel distribution and their properties.	**15 hrs**
III	Conditional, Compound, Truncated and Mixture of distributions. Functions of random variables and their distributions, distribution of quadratic forms under normality. Sampling Distributions: Central and Non-central chi-square, t and F distributions and their properties.	**15 hrs**
IV	Order Statistics: Distributions of order statistics and their properties with applications, Joint and marginal distributions of order statistics, distributions of range and median, conditional distribution of order statistics. Bivariate distributions: Normal, Exponential, Gamma distribution and their properties. Multivariate normal distribution.	**15 hrs**

Reference Books:

1. Bhuyan K. C. (2015). Probability Distribution Theory And Statistical Inference. New Central Book Agency, London.
2. David H. A. and Nagaraja H.N.(2003): Order Statistics, 3/e, John Wiley & Sons.
3. Dudewicz E.J and Mishra S.N. (1988). Modern Mathematical Statistics. Wiley
4. Johnson N. L. and Kotz S. (1972). Distributions in Statistics, Vol I, II and III, Houghton and Miffin.
5. Johnson N. L., Kemp A. W.. Kotz S.(2000). Multivariate Distributions - Wiley and sons, New york.
6. Rohatgi, V.K. (1984). An Introduction to Probability Theory and Mathematical Statistics,Wiley Eastern.

Course Title: DSC-8 : Theory of Point Estimation

Course Code : A2STA002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

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

CO 1	:	Acquire knowledge on various aspects of estimation including properties of an estimator.
CO 2	:	Learn various aspects of estimation including properties of an estimator.
CO 3	:	Have knowledge on various families of distributions and their advantages in obtaining estimators.
CO 4	:	Learn different methods of estimation and their advantages.
CO 5	:	Develop a logic to analyze the situation and apply appropriate statistics tools

Unit	Theory of Point Estimation	Total Hrs: 60
I	Prelimnaries: Problem of point estimation, highest concentration criterion, minimum MSE criterion, weak consistency, strong consistency, mean square consistency, Fisher consistency, CAN and BAN estimators. Likelihood Function, Group Families, Exponential class of densities and it's properties, Fisher Information.	**15 hrs**
II	Sufficiency: sufficient estimator, Neyman – Fisher factorization theorem, Minimal sufficient statistics and their construction, completeness, bounded completeness and relation with minimal sufficiency, ancillary statistics, Basu's theorem and it's Applications. Unbiasedness: Unbiased Estimator, asymptotically unbiased, Quenoulli's method of reducing bias, UMVUE and its characterization, Rao – Blackwell and Lehmann – Scheffe Theorem and their uses.	**15 hrs**
III	Lower bounds of variance of unbiased estimators: Cramer- Rao inequality for single and multi-parameter cases, Chapman - Robbins bounds and Bhattacharya bounds. Methods of Estimation: Method of moments, method of minimum chi-square, method of maximum likelihood and its properties, Method of scoring and its applications. Asymptotic efficiency of MLE.	**15 hrs**
IV	Nonparametric estimation: empirical distribution function, one and two sample location-scale problems, one and two sample U-statistics and their distributional properties. Bayesian estimation: Subjective probability, loss functions, prior and posterior distributions, Bayes estimators under different priors and loss functions.	**15 hrs**

Reference Books:

1. Kale B.K (1999) A first course on parametric inference. Narosa.
2. Lehmann E. L (1988) Theory of Point estimation. John wiley& Sons.
3. Rajagopalan M and Dhanvanthan P (2012) Statistical Inference, PHI Learning Private Ltd.
4. RohatgiV.Kand Saleh A.K.MD.E (2001) An introduction to probability theory mathematical Statistics. John Wiley and Sons, Inc. New York.
5. Zacks, S (1971) Theory of Statistical Inference. Wiley, Newyork.

Course Title: DSC-9: Stochastic Processes and Python

Course Code : A2STA003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Acquire knowledge of stochastic processes, modeling real life situations through stochastic processes.
CO 2	:	Study stochastic processes like Poisson, pure birth, Yule-Fuly, Birth and Death, Weiner, Branching processes.
CO 3	:	Know how better modeling can be made using stochastic processes.
CO 4	:	Develop critical Analysis capacity through stochastic processes.
CO 5	:	Know basics of Python
CO 6	:	Learn numerical solutions of problems involving differentiation and integration.
CO 7	:	Simulate stochastic processes using Python

Unit	Stochastic Processes and Python	Total Hrs: 60
I	Introduction to stochastic processes (SP), classification of SP according to state space and time domain. Finite and countable state Markov chains (MC), Chapman –Kolmogorov's equations, calculation of n-step transition probabilities and their limits, stationary distribution, classification of states, transient MC. Random walk and gambler's ruin problems.	**15 hrs**
II	Continuous time Markov processes: Poisson process, properties of Poisson process, Yule – Furry process, birth and death processes, Diffusion Processes, Kolmogorov's Forward and Backward Diffusion Equations, Wiener Process (Brownian Motion), Simple Properties of Wiener Process and First Passage Time Distribution	**15 hrs**
III	Renewal Theory: Elementary renewal theorem and applications, key renewal theorem and its uses, study of residual life time process, discrete time renewal theory. Branching process: Galton-Watson branching process, probability of ultimate extinction, distribution of population size, and statistical inference in MC and Markov process.	**15 hrs**
IV	Python Basics: The Python Interpreter, Comments, Simple Input & Output, Variables, Mathematical Operators, Lines in Python Control Structures, Functions, Files, Expanding Python. Basic Numerical Tools: Numeric Solution, Python Libraries, Numeric Integration, Differentiation, Numpy, Scipy and MatPlotLib. Stochastic Methods: The Random Walk, Diffusion and Entropy and problems	**15 hrs**

	Simulation: Python-Python Standard Library, Python's Ecosystem, Symbulate, Simpy, Simulation of stochastic processes: simulation of Poisson process, simulation of discrete time Markov chain, simulation of continuous time Markov chain.	

Reference Books:

1. Medhi J (1994), Stochastic Processes, 2nd edn., Wiley Eastern Ltd., New Delhi.
2. Bhat U.N. (1984), Elements of Applied Stochastic processes, 2nd edn., Wiley, New York.
3. Karlin S and Taylor H.M. (1975), A first course in stochastic processes, 2nd edn., Academic press, New York
4. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. An Introduction to Statistical Learning: with Applications in Python, Springer, 1st ed. 2023 eddition (September 8, 2023)
5. Swerdlov, A and Balakrinshan Sankararaman (2023) Stochastic Processes with Applications useing Python.
6. Jose U. (2019) Python for Probability Statistics and Machine Learning, 2nd edn. Springer

Course Title: OEC-01 : Statistical Methods (Open Elective)

Course Code : A2STA201T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Learn various methods of collecting and organizing data
CO 2	:	Understand statistical measures such as Central Tendency, Dispersion.
CO 3	:	Understand Measures of association between two variables and prediction of one variable knowing other variable.
CO 4	:	Use of statistical tests in decision making.

Unit	Statistical Methods (Open Elective)	Total Hrs: 60
I	Data: Introduction, collection of data, kinds of data, tabulation of data, diagrammatic and graphical representation of data with examples. Measures of central tendency: Introduction, arithmetic mean geometric mean, harmonic mean, median, mode, for grouped and ungrouped data with examples.	**15 hrs**
II	Measure of dispersion: Introduction, range, quartiles, interquartile range, mean deviation, variance, coefficient of variation for grouped and ungrouped data with examples Skewness and Kurtosis: Introduction, measures of Skewness and Kurtosis with examples. Correlation and regression: Scatter diagram, coefficient of correlation, fitting of linear regression, method of least squares, coefficient squares, relation between regression and correlation.	**15 hrs**
III	Concepts of Probability: Introduction, different approaches to definition of probability, probability of composite event, addition rule, multiplication rule, Bayes formula. Theoretical probability distributions: Binomial, Geometric, Poisson, Normal, Exponential.	**15 hrs**
IV	Testing of Hypothesis: Introduction, parametric tests, one sample and two sample z, t tests, paired t test, F test, X^2 test, test for correlation. Nonparametric tests: Run test, Sign test, Signed rank test, Wilcoxon's rank sum test, and Spearman's test for rank correlation.	**15 hrs**

Reference Books:

1. Das, M.N. (1993) Statistical Methods and concepts, Wiley Eastern Ltd.
2. Medhi, J (1992) Statistical Methods, New Age International Ltd.
3. Miller, I, Freund J.E. and Johnson R.A. (1992) Probability and Statistics for Engineers. Prentice Hall of India Private Ltd.
4. S. C. Gupta(2021) Fundamentals of Statistics. Himalaya Publishing House.

DSC-10 : PRACTICALS: Probability Distributions and Theory of Point Estimation

Course Code : A2STA004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120hrs.**	**4hrs.**	**20**	**80**	**100**

Course Objectives: Upon completion of this course, the students able to perform the below listed practicals. The candidate will practice working on computing various types of estimators to understand the usage of estimators in real life situations.

List of Experiments:

1.	Discrete Distributions – I
2.	Discrete Distributions – II
3.	Discrete Distributions – I
4.	Continuous Distributions – II
5.	Continuous Distributions - III
6.	Continuous Distributions - IV
7.	Continuous Distributions – V
8.	Truncated Distributions.
9.	Generation of Random Numbers - I
10.	Generation of Random Numbers – II
11.	Order Statistics.
12.	Bivariate Normal Distribution.
13.	Consistent Estimators
14.	Exponential family of distributions
15.	Fisher Information
16.	Sufficiency
17.	Minimal sufficiency and completeness
18.	UMVUE
19.	Lower bounds for variance of unbiased estimators
20.	Moment estimators
21.	MLE
22.	Empirical distribution and U-statistics
23.	Bayesian estimation - I
24.	Bayesian estimation - II

DSC-11 : PRACTICALS : Stochastic Processes and Python

Course Code : A2STA005P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120hrs.**	**4hrs.**	**20**	**80**	**100**

Acquaint with use of stochastic Models in different areas of applications of statistics.

List of Experiments:

1.	Classification of SP according to state space and time domain
2.	Calculation of transition probability matrices
3.	Calculation of n-step transition probabilities
4.	Problems on Poisson process
5.	Application of Brownian Motion
6.	Problems on renewal Theory
7.	Problems on branching process
8.	Problems on input & output variables and mathematical operators
9.	Lines in Python Control Structures, Functions, Files, Expanding Python
10.	Numerical Integration
11.	Numerical Differentiation
12.	Numpy, Scipy and MatPlotLib – I
13.	Numpy, Scipy and MatPlotLib -II
14.	Stochastic Methods-1: The Random Walk
15.	Stochastic Methods-2: Diffusion and Entropy
16.	Python's Ecosystem, Symbulate, Simpy-I
17.	Python's Ecosystem, Symbulate, Simpy-II
18.	Simulation of stochastic processes-I
19.	Simulation of stochastic processes-II
20.	Simulation of stochastic processes-III

Formative Assessment	
Assessment Occasion/type	**Marks**
InternalAssessmentTest1	05
InternalAssessmentTest2	05
Assignment	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

Semester – III

Course Title: DSC-12: Testing of Hypotheses

Course Code : A3STA001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Increases confidence in their ability to formulate different research problems
CO 2	:	Develops ideas and research skills
CO 3	:	Gets in-depth knowledge of various research tools in the form of parametric and non-parametric methods.
CO 4	:	Learn to construct UMA and UMAU confidence intervals, likelihood ratio tests, etc.
CO 5	:	Study the importance of sequential analysis using Wald's SPRT and its functions, OC and ASN.

Unit	Testing of Hypotheses	Total Hrs: 60
I	Introduction to testing of hypotheses: A test function, size and power function of a test. Neyman-Pearson lemma, Most Powerful (MP) test, Monotone Likelihood Ratio (MLR) Property and Uniformly MP test. Generalization of NP-lemma, UMPU tests, Similar tests. Tests with Neyman structure, UMP Unbiased Tests in the Presence of Nuisance Parameters (via conditioning) - UMPU Tests in k-Parameter Exponential Families. Basu's Theorem. Comparison of two binomial and Poisson populations.	**15 hrs**
II	Testing in linear models (simple and multiples linear regression model), Invariance tests, Locally most powerful (LMP) and LMP unbiased tests. Likelihood ratio (LR) and other tests: one sample, two sample and more than two samples, Chi-square tests, t-tests, F-tests, Asymptotic properties of LRTs and Applications of LRTs	**15 hrs**
III	Confidence intervals (CIs) and their connection with the tests of hypotheses. Uniformly Most Accurate (UMA) nand Uniformly Most Accurate Unbiased (UMAU) confidence intervals, Methods of finding CIs, shortest length CIs. Sequential Prabability Ratio Test (SPRT) and its properties. Wald's equation, OC and ASN functions. SPRT for testing hypothesis in binomial, Poisson, normal and exponential distributions and computation of OC and ASN functions.	**15 hrs**
IV	Nonparametric tests and distribution free methods: Sign test, Signed-rank test, Median test, Run test, Wilcoxon-Mann-Whitney test, Goodness of fit test, Kolmogorov – Smirnov tests, Chi-square Test of Independence, Tests involving rank correlation, Linear rank	**15hrs**

	statistics, Large sample properties and applications.	

Reference Books:

1. Lehmann E.L. (1986) Testing Statistical Hypothesis, Wiley, New York.
2. Rohatgi V.K. (1984) An Introduction to Probability Theory and Mathematical Statistics. Wiley Eastern, New Delhi.
3. Dudewicz E.J. and Mishra S.N. (1988) Modern Mathematical Statistics, Wiley and Sons, New York.
4. Rao C.R (1973) Linear Statistical inference. Wiley Eastern, New Delhi.
5. Wald A (1947) Sequential Analysis, Wiley New York.
6. Gibbons J.D. (1985) Non Parametric Statistical inference. Marcel Dekkar, New York.
7. Randles R.H. and Wolfe D.A. (1979) Introduction to Theory of Non-Parametric Statistics. Wiley, New York.

Course Title: DSC-13 : Multivariate Analysis

Course Code : A3STA002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Understand the distribution of Multivariate data.
CO 2	:	Understand the multivariate statistical tools.
CO 3	:	Identify and applying of multivariate techniques for data analysis
CO 4	:	Understand the application knowledge of Discriminant Analysis and Classification Problem
CO 5	:	Understand the various concepts of testing of hypotheses.

Unit	Multivariate Analysis	Total Hrs: 60
I	Random sampling from multivariate normal distribution, maximum likelihood estimators of parameters, distribution of sample mean vector. Wishart distribution and its properties, distribution of sample generalized variance. Null distribution of sample correlation coefficients, distribution of regression coefficients. Application in testing and interval estimation.	**15 hrs**
II	Total, Partial, Multiple correlation in the Multivariate setup – MLEs of Total, Partial and Multiple correlation coefficients. Sampling distributions of Total and Multiple Correlation in the null case. Hotelling T^2 -statistic, derivation and its distribution – Uses of T^2 -statistic , relation between T^2 and D^2 – Mahalanobis D^2- statistic and its distribution	**15 hrs**
III	Linear Discriminant Analysis: Classification and discrimination procedures for discrimination between two multivariate normal populations – sample discriminant function, tests associated with discriminant functions, probabilities of misclassification and their estimation, classification into two multivariate normal populations with equal covariance matrices.	**15 hrs**
IV	Principle component analysis, its properties and applications. Canonical variables and canonical correlations: definition, uses, estimation and computation. Cluster analysis: Definitions, Agglomerative hierarchical clustering methods, Multi-dimensional scaling methods. Introduction to Factor analysis, Path analysis, Correspondence analysis. Multivariate linear regression model, estimation of	**15 hrs**

	parameters, testing linear hypothesis about regression coefficients. Likelihood ratio criterion. Multivariate analysis of variance of one- way and two-way classified data.	

Reference Books:

1. Anderson, T. W. (1984). Introduction to Multivariate Analysis, John Wiley.
2. Härdle, W. K. &Simar, L. (2012). Applied Multivariate Statistical Analysis, Springer, New York
3. Härdle, W. K., Hlávka, Z. (2007). Multivariate Statistics: Exercises and Solutions, Springer, New York
4. Johnson R.A. & Wichern, D.W. (1988). Applied Multivariate Statistical Analysis, Prentice Hall Inc.
5. Kotz, S., Balakrishnan N. and Johnson N. L. (2000). Continuous Multivariate Distributions, Volume 1, Models and Applications, John Wiley & Sons,
6. Kshirsagar, A. M. (1983). Multivariate Analysis, Marcel Dekker.
7. Morrison, D.F. (1990). Multivariate Statistical Methods, McGraw Hill Co.
8. Timm, N. H. (2002), Applied Multivariate Analysis, Spring.

Course Title: DSE-1A : Econometrics

Course Code : A3STA101T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	**:**	Develop professional competence in analysis of economic and time series data.
CO 2	**:**	Understand the evolutionary practices of Linear/Multiple linear regression models, assumptions and consequences of violations of the requirements of the model.
CO 3	**:**	Achieve professional competency in the field of analysis of econometric models through simultaneous equation models.
CO 4	**:**	Acquaint with contemporary trends in estimation of econometrics models.

Unit	Econometrics	Total Hrs: 60
I	Introduction: Origin, definition, methodology, scope and limitations of econometrics. Types of data: cross section, time series, panel data, dummy variable, instrumental variable. The two – variable linear regression model: Relationships between economic variables, two variable linear regression model, least squares estimators. Multiple linear regression models: Model descriptions and assumptions, least squares estimators, selection of variables in multiple regression models.	**15 hrs**
II	Analysis of residuals**:** Presence of outliers, omitted variables, nonlinear relationship, correlated disturbances, heteroscedasticity. Heteroscedasticity: consequences and tests: White test, Goldfeld-Quandt test; Estimation: estimation with grouping of observations, estimation of the heteroscedasticity relation. Generalised least squares estimation. Multicollinearity: The plausibility of the assumption of non-multicolinear regresssors, consequences of multicollinearlty, tests for detecting multicollinearity, solutions for multicollinearity.	**15 hrs**
III	Autocorrelation: Introduction and plausibility of serial dependence, sources of autocorrelation, tests for autocorrelation, solutions for autocorrelation, methods for estimating the parameters of autocorrelation, serial correlation. Autoregressive and Distributed Lag Models**:** Autoregressive model, distributed lag model, methods of estimation of lagged models. Errors in variables Introduction, solution for single equation models, reverse regression, instrumental variable method,	**15 hrs**

	proxy variables. Linear regression with stochastic regressors, Instrumental variable estimation.	
IV	Causality Analysis: Definition of causality, Granger causality, Granger test for causality. Application of econometric methods: estimation of demand and supply function – production and cost function, consumption and investment functions. Simultaneous equation models**:** The problem of identification. Single equation methods of estimation: reduced form method or indirect least squares (ILS), the method of instrumental variables (IV), two-stage least squares (2SLS), limited information maximum likelihood (LIML), k-class estimators. System methods of estimation**:** Three-stage least squares (3SLS), full information maximum likelihood (FIML).	**15 hrs**

Reference Books:

1. Baltagi B.H. (2000) Econometrics, Springer.
2. Gujarati D.N. (2003) Basic Conometrics, McGraw-Hill.
3. Maddala G.S. (2002) Introduction to Econometrics, John Wiley.
4. Apte, P.G. (1990): Text book of Econometrics. Tata McGraw Hill.
5. Johnston, J. (2006). Econometric Methods, third edition, McGraw Hill.
6. Marno Verbeek, (2012): A guide to Modern Econometrics, 4/e,Wiley and Sons.
7. Nachane, D. M. (2006). Econometrics: Theoretical Foundations and Empirical Perspective, Oxford University Press.
8. Ramanathan, R. (2002). Introductory Econometrics with applications, 5/e, Thomson Asia Private Limited.
9. Wooldridge, J. (2012). Introductory Econometrics: A Modern Approach, 5/e, South-Western

Course Title: DSE-1B : Operations Research And Optimization Techniques
Course Code : A3STA102T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to understand:

CO 1	:	Linear programming and various methods to solve liner programming problem (LPP).
CO 2	:	Transportation problem (TP) and assignment problem and calculating minimum cost.
CO 3	:	About analyzing various kinds of queues and their waiting times.
CO 4	:	About various inventory models and obtaining economic order quantity under these models.
CO 5	:	Dynamic programming and critical path method and project evaluation and review techniques.
CO 6	:	Decision making in game theory highly used in economic perspectives.
CO 7	:	Applications of LPP and other concepts in various sectors like marketing research, industries, etc

Unit	Operations Research And Optimization Tecchniques	Total Hrs: 60
I	Linear programming: Definition and formation of LPP, Standard and canonical forms of LPP, Graphical and simplex methods, Charne's M and two-phase methods, duality of LPP, duality theorems, dual simplex method, economic interpretation of duality, sensitivity analysis.	**15 hrs**
II	Transportation and assignment problems: Definition and formation of TP and assignment problem, balanced and unbalanced TP, North west corner rule, matrix minima and Vogel's approximation methods, stepping stone and MODI methods, Hungarian method. Queuing Models: characteristics and classification of queues, Analysis of M/M/1, M/M/C queues with steady state probabilities.	**15 hrs**
III	Inventory Models: Deterministic EOQ Models (without shortage costs), probabilistic single period model with instantaneous demand (No Set up cost Model), models with price breaks (one & two price breaks), (s, S) policy. Dynamic programming: Principle of optimality, recursive equation approach, forward and backward recursive approach.	**15 hrs**
IV	Concepts of game theory: Zero-sum two - person games, saddle point, mixed strategies, graphical solution to 2Xm and mX2 games, Fundamental theorem of rectangular games, solution of games using LPP. Net works: Basic concepts and construction of network, time calculations, CPM and PERT	**15 hrs**

Reference Books:

1. Ackoff R. L. &Sasieni M. W. (1991) Fundamentals of operations Research. Wiley Eastern.
2. Bazarre M.S.&Zarvis J.J. (1977) Linear Programming & Network flows. John Wiley.
3. Gross D and Harris C.M (1974) Fundamentals of Queueing Theory. Wiley, New York
4. Gupta R.K. (1993) Operations Research Krishna Prakashan Mandir, Meerut.
5. Kantiswarup Gupta P.K and Man mohan (1977) Operations Research. S. Chand and Sons, New Delhi.
6. Mittal K.V. (1990) Optimization Methods. Wiley eastern Ltd. New Delhi.
7. Murty K.G. (1983) Linear Programming, John Wiley & Sons.
8. Taha H .A (1998) Operations Research. Prentice-Hall of India.

Course Title: DSE-1C : Data Mining Techniques

Course Code : A3STA103T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Basic concepts of data mining
CO 2	:	Data preprocessing
CO 3	:	Data warehousing and its applications
CO 4	:	Data association techniques to discover patterns in underlying data
CO 5	:	Data classification methods
CO 6	:	Cluster analysis and its applications
CO 7	:	Computational methods of data mining.

Unit	Data Mining Techniques (Optional)	Total Hrs: 60
I	Data Mining: Importance, Knowledge Discovery in Databases (KDD) process-search, induction, querying, approximation and compression. Kinds of data considered for data mining, basic data mining tasks, data mining issues, data mining models – predictive and descriptive models, interconnections between Statistics, Data mining, Artificial Intelligence and Machine Learning. Applications of data mining.	**15 hrs**
II	Data marts, data bases and data warehouses – OLTP systems, multidimensional models – data cubes, OLAP operations on data cubes, multidimensional schemes. Data pre-processing – data cleaning, data integration, data transformation and data reduction. Visualization techniques for multidimensional data – scatter plot matrix, star plots, Andrews plots, Chernoff faces, parallel axis plots. Association Rules: Multi-relational association rules - Generalized Association rule, Interval Information Association Rules, Quantitative Association Rules.	**15 hrs**
III	Supervised learning – classification and prediction: Different types of classifiers, decision tree, support vector machine, generalised linear models, Bayesian classifier, classification by back propagation, k-NN classifier, rule based classifier, frequent pattern based classifier, ID3 algorithm, CART. Unsupervised learning- Clustering, properties of clustering. Similarity and distance measures. Clustering methods - Partitioning Method-partitioning algorithms – k-means and k-mediods algorithms. Hierarchical Method-agglomerative approach and divisive	**15 hrs**

	approach, Density-based Method, Grid-Based Method, Model-Based Method, Constraint-based Method.	
IV	Computational methods useful in data mining: Expectation-maximization algorithm, genetic algorithm, Markov Chain Monte Carlo (MCMC) method. Resampling techniques-Gibbs sampler, Bootstrap sampling. Case studies.	**15 hrs**

Reference Books:

1. Jiawei Han, MIcheline Kamber(2002). Data Mining concepts and techniques. Morgan Kauffman Publishers.
2. Margret H Dunham(2005) Data Mining – Introductory and Advanced Topics. Pearson Education
3. Trvor Hastie, Robert Tibshirani and Jerome Freidman (2001). The Elements of Statistical Learning: Data Mining, Inference, Prediction, Springer, NewYork.
4. Michael Berthold, David J H and (Eds) (2003) Intelligent Data Analysis – An Introduction, Springer.
5. J P Marques de sa (2001) Pattern Recognition – Concepts, Methods and Applications, Springer.
6. Rajan Chattamvelli (2009) Data Mining Methods, Narosa Publishing House.

Course Title: OEC-2: Applied Statistics (Open Elective)

Course Code : A3STA201T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Understand to estimate Trend, Seasonal and Cyclic components of time series.
CO 2	:	Understand past and future behaviour of economic phenomena under study.
CO 3	:	Understand vital statistics related to human population.
CO 4	:	Forecast economic variables.
CO 5	:	Apply various samplings inspection plans to real world problems for both theoretical and applied research
CO 6	:	Analyse experimental designs through ANOVA
CO 7	:	Explain the concepts of Statistical Quality Control and associated techniques.

Unit	Applied Statistics	Total Hrs: 60
I	Time Series: Introduction, components of time series, measurement of trend, measurement of seasonal variations. Index Numbers: Introduction, price index numbers, quantity index numbers, chain index numbers, cost of living index number, time reversal test, factor reversal test.	**15 hrs**
II	Vital Statistics: Introduction, methods of obtaining vital statistics, mortality rates, fertility rates, measurement of population growth. Sampling Theory: Introduction, simple random sampling, stratified random sampling, systematic sampling, sampling and non-sampling errors.	**15 hrs**
III	Econometrics: Origin, definition, methodology, scope and limitations of econometrics. The two – variable linear regression model: Relationships between economic variables, two variable linear regression model, least squares estimators. Multiple linear regression models: Model descriptions and assumptions, least squares estimators, selection of variables in multiple regression model. Analysis of residuals. Analysis of Experiments: Introduction, principles of experimental design, ANOVA, completely randomized design, randomized block design.	**15 hrs**
IV	Control Charts (Process Control): Introduction, control charts for variables ($\bar{X}$ and R charts), control charts for attributes (p-chart), Control charts for number of defects per unit (C-chart), demerit control charts. Acceptance Sampling Plans (Product control): Basic terminologies: AQL, LTPD, AOQ, AOQL, ASN, OC curve, producer's risk, and consumer's risk. Single sampling plan, double sampling plan.	**15 hrs**

Reference Books:

1. R. Ramkumar (1986) Technical Demography, Wiley Eastern, New Delhi.
2. J. Medhi (1992) Statistical Methods. New Age International (P) Ltd. New Delhi.
3. M.N. Das (1993) Statistical Methods and Concepts. Wiley Eastern Ltd.
4. Irwin Miller, John E Fread and Richard A Johnson (1992) Probability and Statistics for Engineers. Prentice Hall of India New Delhi.
5. D.C. Montgomery (1991) Design and Analysis of Experiment. John Wiley and sons.
6. D.C. Montgomery (1996) Introduction to Statistical Quality Control, John Wiley and sons
7. Gujarati D.N. (2003) Basic Eonometrics, McGraw-Hill.
8. D.C. Montgomery and G. C. Runger(2014) Applied Statistics and Probability for Engineers.Wiley.

DSC-14: PRACTICALS : Testing of Hypotheses and Multivariate Analysis

Course Code : A3STA003P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120 hrs.**	**4 hrs.**	**20**	**80**	**100**

Course outcomes:

It improves their ability to handle and address the research problems in Statistics, Biology, Economics, Sociology, Anthropology etc. Learn applications of parametric and non-parametric methods. The students will be able to perform various Multivariate Analyses.

List of Experiments:

1.	Size of type-I and type-II error probabilities, and power of the test
2.	Most Powerful (MP) test
3.	Uniformly Most Powerful (UMP) test
4.	Uniformly Most Powerful (UMP) unbiased test for continuous distributions
5.	Locally most powerful (LMP) and LMP unbiased tests
6.	Likelihood ratio (LR) and other tests: one sample, two sample and more than two samples
7.	Applications of LRT: Tests for Chi-square goodness fit and contingency tables
8.	Uniformly Most Accurate (UMA) and Uniformly Most Accurate Unbiased (UMAU) confidence intervals
9.	SPRT for testing hypothesis in binomial and Poisson distributions and computation of OC and ASN functions
10.	SPRT for testing hypothesis normal and exponential distributions and computation of OC and ASN functions
11.	Sign test, Signed-rank test and Wilcoxon-Mann-Whitney test (two sample)
12.	Run test and Kolmogorov – Smirnov test (one and two sample)
13.	Multivariate Normal Distribution – I
14.	Multivariate Normal Distribution – II
15.	Discriminant Analysis and Classification Problems – I
16.	Discriminant Analysis and Classification Problems - II
17.	Hotelling's T^2 – statistic
18.	Tests concerning Covariance Matrices.
19.	Multivariate Regression Analysis.
20.	Principal Component Analysis.
21.	Multivariate Analysis – I
22.	Multivariate Analysis – II
23.	Factor Analysis.
24.	Cluster Analysis.

DSC-15: PRACTICALS : Econometrics/ Operations Research and Optimization Techniques/ Data Mining Techniques
Course Code : A3STA004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120 hrs.**	**4 hrs.**	**20**	**80**	**100**

Course Outcomes:

The candidate is able to understand practices in applications of Econometric Models in various economic problems / The candidate will acquire practical and working knowledge on various techniques of operations research and optimization techniques / The candidate will learn the use of software Data Mining Techniques.

List of Experiments:

Econometrics

1.	Simple linear regression- I
2.	Simple linear regression- II
3.	Multiple linear regression-I
4.	Multiple linear regression-II
5.	Selection of variables in multiple linear regression
6.	Problems on heteroscedasticity
7.	Problems on autocorrelation
8.	Problems on multicollinearity
9.	Problems on autoregressive
10.	Problems on distributed lag models
11.	Problems on proxy variables
12.	Problems on instrumental variables
13.	Problems on order and rank conditions of simultaneous equation models
14.	Problems on estimation of simultaneous equation models-I
15.	Problems on estimation of simultaneous equation models-II

Operations Research and Optimization Techniques

1.	Graphical method of solving LPP
2.	Simplex method
3.	Charnes Big M method
4.	Two-phase method
5.	Dual simplex method
6.	Sensitivity analysis
7.	Transportation problems
8.	Assignment problems
9.	M/M/1amd M/M/ C queues
10.	Deterministic and Probabilistic Inventory models
11.	Inventory models with price breaks
12.	Dynamic programming problem
13.	Graphical solution to games
14.	Solution of games using LPP
15.	CPM and PERT

Data Mining Techniques

1.	Data Mining Models
2.	Data Cubes
3.	Data Reduction
4.	Decision Tree for classification -I
5.	Decision Tree for classification -II
6.	Bayesian Classifier-I
7.	Bayesian Classifier-II
8.	k-NN classifier
9.	Visualization Techniques-I
10.	Visualization Techniques-II
11.	CART
12.	Clustering techniques-I
13.	Clustering techniques-II
14.	Association rule mining
15.	MCMC

Semester-IV

Course Title: DSC 16: Linear Models and Designs of Experiments

Course Code : A4STA001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Gain knowledge in basics of linear estimation
CO 2	:	Understand important tools of linear estimation in Gauss-Markov set-up.
CO 3	:	Acquire the knowledge of application of multiple linear regression in various fields.
CO 4	:	Study the importance of analysis of variance (ANOVA) technique and its different methodologies.
CO 5	:	Understand and solve different experimental designs such as RCBD, BIBD, PBIBD and Symmetric BIBD in emerging research problems.
CO 6	:	Understand factorial experiments and confounding techniques

Unit	**Linear Models and Designs of Experiments**	**Total Hrs: 60**
I	Gauss-Markov setup, estimability of linear parametric functions, conditions for estimability, normal equations and least squares estimation. Gauss-Markov (GM) Theorem under full rank and less than full rank linear model, Error and estimation spaces, their properties, Variance and covariance of least squares estimates. Estimation of error variance, Linear estimation in the correlated setup. Least squares estimates with restriction on the parameters, simultaneous estimates of linear parametric functions.	**15 hrs**
II	Testing of general linear hypothesis, Testing of hypotheses for one and more than one linear parametric functions, Confidence intervals and regions, Applications of GM theory to analysis of variance (ANOVA) model (one-way, two-way and two-way with more than one observation per cell). Power of F – Test, Multiple compararions and post-hoc tests: Bonferroni, Tukey and Scheffe simultaneous confidence intervals.	**15 hrs**
III	Complete designs: Randomized Complete Block Design (RCBD), Latin Square Design (LSD) and Missing Plot techniques. Estimation and exact analysis of one or two missing observation(s) in RCBD and LSD. Analysis of Covariance (ANCOVA): ANCOVA model for CRD and RCBD with single co-variate. General incomplete block designs; The intrablock analysis: notation and model, normal and reduced normal equations, The *C*- matrix and estimable functions, solving the reduced	**15 hrs**

	normal equations, analyses of variance. Balance, connectedness and orthogonality in relation to two – way designs.	
IV	Balanced Incomplete Block Design (BIBD): Necessary conditions, Intrablock analysis, Analysis of recovery of interblock information, *C*-matrix of BIBD, Properties of C-matrix. Partial and symmetric BIBD, and properties. Factorial experiments-symmetrical (2^n and 3^n) and asymmetrical factorial experiments, confounding in 2^n factorial experiments, Split – Plot designs. Introduction to Lattice designs and Crossover designs.	**15 hrs**

Reference Books:

1. Chakravarthy M.C. (1971) Mathematics of Design and Analysis of Experiments. Asia Publishing House.
2. Joshi, D.D. (1987) Linear Estimation and Design of experiments. Wiley Eastern.
3. Kshirsagar, A.M. (1983) Linear Models, Marcel Dekker.
4. Das M.N. and Giri, N.C. (1988) Design and Analysis of experiments. Wiley Eastern. Ltd.
5. Montgomery D.C. (1991) Design and Analysis of experiments, John Wiley and sons.
6. Ogawa, J (1974) Statistical Theory of the analysis of the experimental design. Marcel Dekker.
7. Rao C.R. (1985) Linear Statistical Inference and its applications. Wiley Eastern.
8. Searle S.R. (1971) Linear Models. John Wiley & Sons.

Course Title: DSC-17: Statistical Quality Control And Reliability Theory

Course Code : A4STA002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Develop professional competence in applications of statistical tools in industry.
CO 2	:	Develop control charts in various situations of quality improvement programs in industry.
CO 3	:	Use acceptance sampling plans as per the needs of the industry to optimize costs of quality maintenance.
CO 4	:	Model and assess reliabilities of components/systems under different setups and configuration of components.
CO 5	:	Use these tools in finance, insurance, health science, etc.

Unit	Statistical Quality Control And Reliability Theory	Total Hrs: 60
I	Process Control: Control charts: Basic principles, choice of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts. Control chart for $\bar{X}$ and R, $\bar{X}$ and s. OC function, ARL and PCR for $\bar{X}$ chart. Demerit control chart, Control charts using extreme values, Moving averages, Geometrically weighted moving averages. Group control charts. Multivariate quality control charts, sloping control lines. Use of sequential runs in constructing control limits, CUSUM charts and its relation with SPRT. Control charts versus ANOVA and Chi-square tests. Introduction to Six-Sigma Methodology. DMAIC cycle & case studies.	**15 hrs**
II	Product Control: Single, double and multiple sampling plans for attributes, curtailed sampling plans. OC, AOQ, ASN and ATI functions for these plans. Designing single and double sampling plans. Chain sampling plans. Continuous sampling plans, sequential sampling plans, Sampling plans for variables.	**15 hrs**
III	Reliability Theory: Life distributions, survival functions, failure rate, Integrated hazard function, residual life time, mean residual life time. Common Life Distributions: binomial, negative binomial, Poisson, exponential, Weibull, gamma, Pareto, linear failure rate, Makhem and log-normal distributions. Notion of aging: IFR, IFRA, DMRL, NBU, NBUE classes of life distributions and their dual classes. System reliabilities: Series, parallel, k-out-of-n, standby redundant systems and their reliabilities.	**15 hrs**

IV	Maintenance policies: Age replacement and Block replacement policies and their characteristics. Reliability modeling: Introduction to shock models, stress-strength models and proportional hazards models. Inference in Reliability: Life testing experiments, Type I and Type II Censoring schemes, likelihood functions based on these sampling schemes for exponential distribution. Reliability estimation (complete and censored samples) for exponential distribution, testing reliability hypotheses (exponential distribution).	**15 hrs**

Reference Books:

1. Montgomery D.C. (1996) Introduction to Statistical Quality Control, Wiley, New York.
2. Grant E.L. (1980) Statistical Quality Control McGraw Hill, New York.
3. Weetherhill G.B. and Brow D.W. (1991) Statistical Process Control. Chapman and Hall, London.
4. Barlow R.E. and Proschan F (1975) Statistical Theory of Reliability and Life Testing. Holt-Rinhart and Winston, New York.
5. Sinha S.K. and Kale B.K. (1990) Life Testing and Reliability Estimation. Wiley Eastern, New Delhi.
6. Mann N.R, Schaffer R.F and Singpurwalla N.D. (1974) Methods for Statistical Analysis of Reliability and Life Data. Wiley New York.
7. Zacks S (1992) Introduction to Reliability Analysis. Springer - Verlag, New York.
8. J.V. Deshpande and Sudha G. Purohit (2005) Life time data: Statistical Models and Methods. World Scientific.

Course Title: DSC-18: Regression Analysis and Computer Intensive Statistical Techniques

Course Code : A4STA003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Know the regression regression analysis, estimation and testing of parameters of the model selection methods.
CO 2	:	Know non-linear regression, estimation and testing in non-linear system, estimation with outliers.
CO 3	:	Learn Bootstrap methods and Jackknifing.
CO 4	:	Learn EM algorithm and its applications.
CO 5	:	Know the regression regression analysis, estimation and testing of parameters of the model selection methods.

Unit	Regression Analysis and Computer Intensive Statistical Techniques	Total Hrs: 60
I	Multiple regression model, Least squares estimate (LSE), Properties of LSE, Hypothesis testing, confidence and prediction intervals, General linear hypothesis testing. Dummy variables and their use in regression analysis. Residuals and their properties, methods of scaling residuals, residual diagnostics. Transformation of Variables: VST and Box-Cox power transformation. Variable Selection Procedures: R-square, adjusted R-square, Mallows' Cp, forward, backward selection methods, AIC, BIC	**15 hrs**
II	Nonlinear regression models: Non linear least squares, Transformation to a linear model, Parameter estimation in a non linear system, Statistical inference in non linear regression. Robust Regression: Influential observations, leverage, outliers, methods of detection of outliers and influential observations, estimation in the presence of outliers: M-estimator, Huber loss function, breakdown point, influence function, efficiency, Asymptotic distribution of M-estimator (Statement only), Mallows' class of estimators.	**15 hrs**
III	Bootstrap methods: Re-sampling paradigms, bias and standard errors, Bootstrapping for estimation of sampling distribution, confidence intervals, variance stabilizing transformation, bootstrapping in regression and sampling from finite populations Jackknife and cross-validation: Jackknife in sample surveys, jack-knifing in regression with hetero-scadisticity, cross-validation for tuning parameters.	**15 hrs**

IV	EM algorithm: Applications to missing and incomplete data problems, mixture models. Applications to Bayesian analysis. Monte Carlo EM algorithm MCMC methods in missing data. Smoothing with kernels: Density estimation, simple nonparametric regression. Failure rate. Permutation tests	**15 hrs**

Reference Books:

1. Draper N.R. and Smith, H. (1998): Applied Regression Analysis. 3rd ed Wiley
2. Wiesberg, S. (1985): Applied Linear Regression, Wiley.
3. Kutner, Neter, Nachtsheim and Wasserman (2003): Applied Linear Regression Models, 4th Edition, McGraw-Hill
4. Montgomery, D.C., Peck, E.A.,and Vining, G.(2012): Introduction to Linear Regression Analysis, 5th Ed . Wiley
5. Cook R.D. &WiesbergS.(1982): Residuals and Influence in Regression. Chapman and Hall.
6. Birkes, D and Dodge, Y. (1993). Alternative methods of regression, John Wiley & Sons.
7. Huber, P. J. and Ronchetti, E. M (2011) Robust Statistics, Wiley, 2nd Edition.
8. Seber, G. A., Wild, C. J. (2003). Non linear Regression, Wiley.
9. Fishman, G.S. (1996): Monte Carlo: Concepts, Algorithms, and Applications.(Springer).
10. Rubinstein, R.Y. (1981): Simulation and the Monte Carlo Method. (Wiley).
11. Tanner, M.A. (1996): Tools for Statistical Inference, Third edition. (Springer.)
12. Efron, B. and Tibshirani. R.J. (1993): An Introduction to the Bootstrap.
13. Davison, A.C. and Hinkley, D.V. (1997): Bootstrap Methods and Their Applications (Chapman and Hall).
14. Shao J. and Tu, D. (1995): The Jackknife and the Bootstrap. Springer Verlag.
14. McLachlan, G.J. and Krishnan, T. (1997): The EM Algorithms and Extensions.(Wiley.)
16. Simonoff J.S. (1996): Smoothing Methods in Statistics. (Springer).
17. Kennedy W. J. & Gentle J. E. (1980): Statistical Computing (Marcel Dekker)

Course Title: DSE-2A : Time Series Analysis

Course Code : A4STA101T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Get acquainted with the main concepts of Time Series theory and methods of analysis.
CO 2	:	Derive the properties of ARIMA and state-space models
CO 3	:	Choose an appropriate ARIMA model for a given set of data and fit the model using an appropriate package
CO 4	:	Compute forecasts for a variety of linear methods and models.
CO 5	:	Become skillful in analysis and modelling of stochastic processes of *ARMA* (*p*, *d*, *q*) models,
CO 6	:	Understand autoregressive models with distributed lags and their application in time series economics.
CO 7	:	Practice models using real time series economic data with R.

Unit	Time Series Analysis	Total Hrs: 60
I	Time-series as a discrete stochastic process. Stationarity, Main characteristics of stochastic processes; Means, Autocovariation, Autocorrelation functions and their properties. Exploratory Time Series Analysis: Tests for trend and seasonally, Exponential and Moving average smoothing. Hot Wiinters smoothing. Forecasting based on smoothing, adaptive smoothing. Moving Average (MA), Auto Regressive (AR), ARMA and AR integrated MA (ARIMA) models	**15 hrs**
II	Box-Jenkins methodology to identification of stationary time series models. Forecasting, trend and seasonality in Box-Jenkins models. Choice of AR and MA periods, Estimation of ARIMA models parameters. Forecasting, Residual analysis and diagnostic checking. Concept of Autoregressive, Moving Average, Autoregressive Moving Average models. Concept of Causality, invertibility, computation of π - weights and ψ - weights, computation of ACVF, ACF and PACF	**15 hrs**
III	Estimation of ARMA models: Yule-Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARMA Processes, Discussion (without proof) of estimation of mean, Auto-covariance and auto-correlation function under large samples theory. Introduction to SARIMA models. Non-stationary time series: Time series with non-stationary variance. Non-stationary mean. ARIMA (p,d,q) models. The use of Box-Jenkins methodology to determination of order of integration.	**15 hrs**

IV	Spectral analysis of weakly stationary process, Periodogram and Correlogram analysis. Computations based on Fourier transform. Spectral Decomposition of weakly AR process and representations as a one-sided MA process-necessary and sufficient conditions. Spectral Representation of the ACVF, Spectral density of an ARMA process, its computation for simple models. Introduction to ARCH and GARCH models. Properties and estimation under ARCH(1) and GARCH(1,1) model.	**15 hrs**

Reference Books:

1. Anderson, T. W (1971): The Statistical Analysis of Time Series, Wiley, N.Y.
2. Brockwell, P.J. and Davis, R. A. Time-Series: Theory and Methods (Second Edition), Springer-Verlag.
3. Box, G.E.P. and Jenkins, G.M. (1976): Time Series Analysis-Forecasting and control Hodlen-day, San Franciscor.
4. Kendall, Sir Maurice and Ord. J. K. (1990): Time Series (Third Edition) Edward Arnold.
5. Montgomery, D. C. and Johnson, L. A. (1977): Forecasting and Time Series Analysis, McGraw Hill.
6. Tsay R. S. Analysis of Financial Time Series, 3rd Ed. (Wil. Ser. in Prob. and Statistics)
7. Kendall, M.G. (1978) Time Series, Charler Graffin
8. Chatfield, C. (2004) The Analysis of Time Series - An Introduction, Sixth edition, Chapman and Hall.
9. Mills, T.C. The Econometric Modelling of Financial Time Series. Cambridge University Press, 1999

Course Title: DSE-2B : Actuarial Statistics

Course Code : A4STA102T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Learn various aspects of insurance and utility functions.
CO 2	:	Have knowledge on various insurance polices and calculation of their premiums.
CO 3	:	Have in-depth knowledge in computing life annuities, benefits premiums and benefit reserves.
CO 4	:	Help insurance companies to develop new advantageous polices.

Unit	Actuarial Statistics	Total Hrs: 60
I	Basic concepts and Life Tables: Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality, relation of life tables with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate life tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.	**15 hrs**
II	Probability Models: Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations. Distribution of aggregate claims, compound Poisson distribution and its applications. Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.	**15 hrs**
III	Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due.	**15 hrs**
IV	Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportion able premiums, commutation functions, and accumulation type benefits. Payment premiums, apportion able premiums, commutation functions accumulation type	**15 hrs**

	benefits. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums, reserves on an apportion able or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions. Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses. Claim amount distributions, approximating the individual model, stop-loss Insurance.	

Reference Books:

1. Dickson, David C. M., Hardy, Mary R. and Waters, Howard R (2009) Actuarial Mathematics for life contingent risks, International series on actuarial science, Cambridge
2. Deshmukh S. R (2009) An Introduction to Actuarial Statistics, University Press.
3. Newton L Bowers, Jr; Gerber Hans, U; Hickman James, C; Jones Donald A; Nesbitt Cecil, J. (2000) – Actuarial Mathematics – The Society of Actuaries, Schaumburg, Illinois, U.S.A.
4. Robin Cunningham, Thomas N. Herzog, Richard L. (2011) Models for Quantifying Risk, 4th Edition, ACTEX Publications,
5. Spurgeon E. T. (1972) Life Contingencies, Cambridge University Press.

Course Title: DSE-2C : Statistical Machine Learning

Course Code : A4STA103T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE	**Theory**	**04**	**04**	**60hrs.**	**3hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

CO 1	:	Demonstrate the understanding of basic concepts of statistical machine learning.
CO 2	:	Apply classification algorithms for qualitative data.
CO 3	:	Analyse high dimensional data using principal component regression learning algorithms.
CO 4	:	Construct classification and regression trees by random forests.
CO 5	:	Create a statistical learning model using support vector machines.

Unit	Statistical Machine Learning	Total Hrs: 60
I	Statistical learning: definition-prediction accuracy and model interpretability supervised and unsupervised learning, assessing model accuracy, important problems in data mining: classification, regression, clustering, ranking, density estimation- Concepts: training and testing, cross-validation, overfitting, bias/variance tradeoff, regularized learning equation-simple and multiple linear regression algorithms.	**15 hrs**
II	Classification algorithms: Logistic model, training and testing the model, linear discriminant analysis, quadratic discriminant analysis. Use of Bayes' theorem, k- nearest neighbours , Naive Bayes', Adaboost.	**15 hrs**
III	Linear model selection and regularization: Optimal model-shrinkage methods - ridge and lasso regression. Dimension reduction methods: principal component (PC) regression and partial least square (PLS) regression. Non-linear models: regression splines-polynomial , Generalized additive models.	**15 hrs**
IV	Tree-based methods: Decision tree, regression trees, bagging, random forests, boosting - classification trees, boosting-tree versus linear models.	**15 hrs**

Reference Books:

1. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112, p. 18). New York: springer.
2. Gutierrez, D. D. (2015). Machine learning and data science: an introduction to statistical learning methods with R. Technics Publications.
3. Müller, A. C., & Guido, S. (2016). Introduction to machine learning with Python: a guide for data scientists. "O'Reilly Media, Inc.".
4. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.

DSC-19 : PRACTICALS : Linear Models and Designs of Experiments, SQC and Reliability Theory

Course Code : A4STA004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**08**	**120 hrs.**	**4 hrs.**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course students will be able to:

5.

IT provides an idea of formulation of linear models and estimation of parameters. It facilitates the practical knowledge of ANOVA models and designs of experiments. Also gives the applications these tools in laboratory and agricultural experiments. The candidate will practically learn the working of control charts in different situations, use of professional knowledge of acceptance sampling plans, reliability theory in industry and health science.

List of Experiments :

1.	Estimability of a linear parametric functions for full rank matrix
2.	Estimability of a linear parametric functions for full rank matrix
3.	Linear estimation under restriction
4.	Testing of general linear hypothesis
5.	Application of Gauss- Markov theory to one-way and two -way clasifications
6.	Estimation of simultaneous confidence intervals
7.	Estimation of missing observation and exact analysis in RBD and LSD
8.	Application of ANCOVA for CRD with single covariate
9.	Construction of incomplete block designs and C-matrix
10.	Intrablock analysis of BIBD
11.	Analysis of 2^3 and 2^4 factorial experiments
12.	Analysis of confounding in 2^4 factorial experiment and split-plot design
13.	Construction of control chart $\bar{X}$ and R,
14.	Construction of control chart $\bar{\bar{X}}$ and s
15.	Construction of Control charts using extreme values,
16.	Construction of Control charts using Moving averages,
17.	Construction of Control charts using Geometrically weighted moving averages.
18.	Group control charts.
19.	Single and Double sampling plans.
20.	Design of Single and Double sampling plans.
21.	Numerical examples of IFR and DFR distributions.
22.	Series and Parallel system reliabilities.
23.	Estimation of reliability for complete and censored samples.
24.	Testing reliability hypotheses

DSC-20 : PROJECT (PRACTICALS):
Course Code : A4STA005P

Course Outcomes (COs): At the end of the project students will be able to:

CO 1	**:**	Identify and select the problem
CO 2	**:**	Identify the variables required to study the problem
CO 3	**:**	Identify the sampling methods, number of samples required to collect the data
CO 4	**:**	Identify the tools and software to be used for effective analyses
CO 5	**:**	Draw conclusions and write the report

Question paper pattern for Theory		
1.	Five (05) questions each of two (02) Marks	10 Marks
2.	Six (06) Questions (Out of eight) each of Five (05) Marks	30 Marks
3.	Four (04) Questions (Out of Five) each of Ten(10) Marks	40 Marks
	Total	**80 Marks**