RAJAH SERFOJI GOVERNMENT COLLEGE

(AUTONOMOUS AND NAAC "A" GRADE & DST-FIST College)
THANJAVUR-613005

PG DEPARTMENT OF STATISTICS

PG PROGRAMME: M.Sc., STATISTICS

CBCS- COURSE PATTERN (2022-2023 onwards)

BOARD OF STUDIES

2022-2023 (DATE: 18.08.2022)

SEMESTER WISE DISTRIBUTION OF PAPERS (COURSES)

RAJAH SERFOJI GOVT. COLLEGE (AUTONOMOUS), THANJAVUR – 61 3 005.

Reaccredited of A Grade by NACC
(Affiliated to Bharathidasan University , Tiruchirapalli)
Thanjavur -613 005 , Tamilnadu, India.

BOARD OF STUDIES IN STATISTICS
MINUTES OF THE MEETING HELD ON 18TH AUGUST'2022

The meeting of the Board of Studies in Statistics, for the Academic year 2022 -2023 was held on 18th August at 10.AM at Department of Statistics, Rajah Serfoji Govt. College (Autonomous), Thanjavur -613 005.

The following members attended the meeting:

S.No	NAME	MEMBERS	ADDRESS	SIGNATURE
1.	Prof. V. Murugesan	Chairperson	Asst. Professor and HOD, Department of Statistics, RSGCA, Thanjavur -5	
2.	Dr. H. Alexis Selvaraj	Subject Expert & University Nominee	Asst. Professor and HOD, Department of Statistics, Thanthai Periyar Govt. Arts and Science College (A), Tiruchy - 23	
3.	Dr. M. Vijayakumar	Subject Expert & Academic Council Nominee	Associate Professor, Department of Statistics, Annamalai University, Chidambaram – 608 002	18/8/22
4.	Dr. R. Arumugam	Subject Expert	Assistant Professor, Department of Mathematics, Periyar Maniammai University, Thanjavur -613403	18.8.22
5.	Mr. P. Jayakumar	Industialist	Survey Supervisor, Ministry of Statistics, NSSO, (FOD) Thanjavur (SR). – 613007	18/8/22
6.	Mr. N. Arokiya Joseph Antony	Alumini	Statistician & Management, Meenakshi Mission Hospital, Thanjavur - 5	18.8.22
7.	Prof. M. Rajan	Faculty Member	Department of Statistics, RSGCA, Thanjavur -5	18/8/22

V.MURUGESAN, Chairperson, BOS and Head, Department of Statistics, Rajah Serfoji Government College, called the meeting to order and the following business was transacted.

1. Discussions for the new structure for B.Sc, M.Sc Programmes, were made in the context of LOCF suggestive syllabus of UGC and proposed syllabus of Integrated Board of Studies of TANSCHE. Due care is taken in framing the syllabus in such a way that 75% of the contents of the mandatory courses as specified by the TANSCHE are included in the present syllabus. Each course content is set by the teacher, who is presently teaching that course or who is specialized in that particular course. They needs of the locality, relevance, and the UGC/LOCF/TANSCHE statutory requirements, are all taken into consideration while framing the syllabus and are counter-checked by the Teacher who is the immediate senior to the teacher who has set the same.

RESOLUTION [No: BOS /STAT/2022-23/1] unanimously resolved to approve the changes made in the course structure and contents of the B.Sc, M.Sc programmes

Which will be implemented from the present academic year 2022-2023

2. Discussions for the reversion of the course credits for the B.Sc /M.Sc Programmes incorporating the Extra Credit Courses for Advanced Learners were made extensively. The extra credit courses were implemented from the academic year 2020-21. These courses were introduced to improve the knowledge base of the students in their own Discipline. These are self study courses and are optional. For UG, two courses with extra credit and for PG, two courses with extra credit are included. There should be no standing arrears for opting Extra Credit Courses and similarly, Students are not permitted to write the course as arrear, if he/she fails in the courses with extra credit. In the 5th &6th semesters of the UG Programmes and PG Programme for 3rd & 4th semesters, these self-study extra credit courses are offered. On par with other part-IV courses, each self-study Extra Credit Courses also carries two credits, instead of four credits, as were awarded so far. For the UG programme, statistical softwares and non parametric techniques are the two self-study courses offered during the 5th and 6th semester respectively which may be pursed to add extra credits. Similarly, for the PG programme, Research methodology and Industrial statistics are self-study courses offered during the 3rd and 4th semester respectively, which may be pursued to add extra credits.

RESOLUTION [No.: BOS/STAT/2022-23/2] Unanimously resolved to introduce two new Extra Credit Courses for Advanced Learners separately for UG and PG

programme which are self-study In nature. Instead of choosing one Major Elective Course as an Extra Credit Course choice, it is resolved to offer two specific Extra Credit Courses, with two credits each, for each programme, from this Academic Year 2022- 23 onwards.

3. Discussion for the revision of three Discipline-specific electives were made. Two Discipline-specific electives are offered in UG the 5th semester and one in 6th semester. The Discipline-specific electives are to be chosen by the students, from the alternate choices. DSE1 set comprises of Operations research, Real analysis and matrix theory and simulation techniques. DSE2 set comprises of Indian official statistics, Econometric methods and Psychological and educational statistics and DSE3 set comprises of Regression analysis, Reliability and survival analysis and Programming C.

RESOLUTION [No.: BOS/STAT/2022-23/3] Unanimously resolved to introduce Discipline-specific electives, as mentioned in the course structure and it is suggested to add more choices in these electives in the next BOS meeting, as the contents are yet to be framed.

4. Discussions regarding the sector specific Skill based electives took place in the meeting. Presently, only one skill based paper in the 3rd 4th and 5th semesters. From the batch 2022-23 onwards, introduction of sector specific skill enhancement electives were suggested. Accordingly, the options are offered in all the three semesters. If a student chooses a skill based electives, in the next two semesters also. In the UGC-LOCF syllabus, there is an option for Statistics for Competitive Examinations, M.S. Excel and Office Automation As we have three field oriented courses as Discipline Specific Electives, three Derivatives papers are given as option C.

RESOLUTION [No.: BOS/STAT/2022-23/4] Unanimously resolved to introduce to specific Skill based elective courses with three sets containing three courses each, to be studied in the three semesters namely 3rd 4th and 5th semesters, in lines with the UGC-LOCF.

5. Discussions were made exhaustively on the feedback of the Students regarding the Curriculum and the need for more Practical papers/internship is understood. In the UG programme, Internship is given as an optional extra credit opportunity, in the fifth semester. In the PG programme, Internship is now made as an essential inbuilt core course component, which is expected to give exposure to the real-world statistics field and hands-on training in the field of the choice of the students.

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RESOLUTION [No: BOS/STAT/2022-23/5] Unanimously resolved to recommend more Practical components in all the papers in the curriculum, wherever possible, and to introduce Internship programme as an optional extra credit for the PG programme in the third semester, subject to the approval of the forthcoming Academic Council.

6. Deliberation regarding offering the allied papers was made. From the academic year 2018-19 onwards, three allied courses, namely, Statistics for Mathematics-I and III and Allied statistical practical for as the three allied courses are being offered to the students of first year B.Sc, Mathematics Programme.

The Board of Studies of statistics department may decide to continue with the statistics allied courses or to have three courses again Optimization technique-I and II and Allied statistics practical-II from the batch 2022-23 or to go for three statistics courses for the second year students from the academic year 2024-25. So, whatever be the course of action, the Board of Studies of Statistics, decided to suggest three new allied courses namely, Numerical methods, Vital statistics and Allied practical as the three allied courses to the second-year students.

EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POST GRADUATE COURSES

Rajah Serfoji College (Autonomous), Thanjavur-5, a pioneer in higher education in Thanjavur district, Tamil Nadu (India), strives to maintain and uphold the academic excellence. It also enhances academic mobility and enriches employability. The educational system preserves the identity, autonomy and uniqueness of every department and reinforces student centric curriculum designing and skill imparting. The statistics department adheres to achieve and accomplish the following objectives.

Optimal utilization of resources both human and material for the academic flexibility leading to excellence. Students experience or enjoy their choice of courses and credits for their horizontal mobility.

The existing curricular structures as specified by TANSCHE facilitate the uniqueness of the choice based credit system.

Human excellence in specialized areas

Thrust in internship and / or projects as a lead towards research and

The multi-discipline nature of the curriculum system caters to the needs of stake-holders, especially the employers.

Credit system:

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The credits and hours of each course of a programme are given in the table of Programme Pattern. However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses, a student must earn a minimum of 90 credits as mentioned in the programme pattern table. The total number of minimum courses offered by the Department is given in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

OBE is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities and assessments should all help the students achieve the specific outcomes

Outcome Based Education, as the name suggests depends on Outcomes and not Inputs. The outcomes in OBE are expected to be measurable. In fact each Educational Institute can state its own outcomes. The ultimate goal is to ensure that there is a correlation between education and employability

Outcome -Based Education (OBE): is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve, stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels.

Some important aspects of the Outcome Based Education Course: Outcome based education course is defined as a theory, practical or theory cum practical subject studied in a semester.

Course Outcomes (COs): Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

Programme: is defined as the specialization or discipline of a Degree.

Programme Outcomes (POs): Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

Programme Educational Objectives (PEOs): The PEOs of a programme are the statements that describe the expected achievement of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after Graduation.

Some important terminologies repeatedly used in LOCF. Core Courses (CC)

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Elective Courses (DEC)

Elective course may be offered by the main discipline/subject of study is referred to as Discipline Elective Course (DEC). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

DEC: Five courses are offered, two courses are semester IV

One DEC Course may be offered as interdisciplinary course among the department (Common Core Course) at the PG level.

Generic Elective Courses

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

Generic Elective courses are designed for the students of other disciplines. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Two GE Courses are offered one each in semesters I and II.

(Open to the students of other Departments)

Self-paced Learning: It is a course for two credits. It is offered to promote the habit of independent/self learning of Students. Since it is a two credit course, syllabus is framed to complete within 45 hours. It is not taught in the regular working hours.

Field Study/Industrial Visit/Case Study: It has to be completed during the fifth semester of the degree programme. Credit for this course will be entered in the fifth semester's marks statement.

Internship: Students must complete internship during summer holidays after the fourth semester. They have to submit a report of internship training with the necessary documents and have to appear for a viva-voce examination during fifth semester. Credit for internship will be entered in the fifth semester's mark statement.

Extra Credit Courses: In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL and etc.

Post Graduate Programme Pattern:

The Post Graduate degree programme consists of the following vital components. They are as follows:

Part-III: Core Course (Theory, Practical, Discipline Electives, Compulsory and optional courses, Project Work and viva-voce, Extra credit courses, Internship and field visit / industrial visit/Case Study)

Part-III: DEC – Discipline Elective Courses (DEC)

Part-IV: Generic Elective Courses

MID-Semester & Model End – Semester Test

Centralized – Conducted by the office of COE

1. Mid-Semester Test (2 Hours each) and Model End-Semester Test: (3 Hours each); will have Descriptive elements; with the below mentioned question pattern Part-A, Part-B and Part-C.

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No.	Level	Parameter	Description
1	K1	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision

QUESTION PATTERN FOR MODEL SEM AND SEMESTER EXAMINATION			
Sections	**Question Pattern**	**Marks**	**Total Marks**
SECTION -A	TWO questions from each unit, (No choice)	(10x2 =20)	20
SECTION -B	TWO question from each unit, (Either or type)	(5x 5 = 25)	25
SECTION -C	ONE question from each unit, (3 out of 5)	(3x10 =30)	30
		TOTAL MARKS	75

Blue Print of Question Pattern For Semester Examination						
Duration: 3. 00 Hours.						Max Mark : 100
K- Levels	K1	K2	K3	K4	K5	Total Marks
SECTION-A (2-Marks,Nochoice) (10x2=20)	10					20
SECTION-B (5- Marks)(Eithe or Type) (5x2=25)			5			25
SECTION-C (10 Marks) (3 Out of 5) (3x10=30) Courses having only K4 And K5 Levels				3		30
Total	10		25	30		75

EVALUATION - GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by semester Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) respectively. These two are calculated by the following formulae:

$GPA(Grade\ Point\ Average) = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$ And $WAM(weighted\ Average\ Mark) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$

Classification of Final Results

Marks Range	Grade Point	Corresponding Grade	Classification of Final Result
90 and above	10	O	Outstanding
80 and above but below 90	9	A+	Excellent
70 and above but below 80	8	A	Very Good
60 and above but below 70	7	B+	Good
50 and above but below 60	6	B	Above Average
Below 50	N.A	RA	Re-appearance

Credit based weighted Mark System is adopted for the individual semesters and cumulative semesters in the column 'Marks secured' (for 100)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

The Programme Outcomes (POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight and the weakest is
This relation is defined by using the following table.

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

Mean Scores of COs = Sum of values/Total No.of POs & PSOs		Mean Overall Score = sum of mean scores/ Total No. of Cos.	
Result	Mean Overall Score	< 1.2	Low
		≥ 1.2 and < 2.2	Medium
		≥ 2.2	High

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

CRITERIA OF COURSE

Duration of the Course The duration of the M. Sc., STATISTICS course is two years which comprise of four semesters. A candidate who has been admitted to the course shall appear all the four semester examinations during the course of study. On successful completion of all the examinations, he / she shall qualify himself/herself for the award of the degree in M.Sc., STATISTICS.

A candidate who has acquired a degree in B.Sc., Statistics or B.Sc., Mathematics with Statistics as an allied and ancillary subject or as one of the subjects or B. Sc., in Mathematics with Computer Applications having Statistics as one of subjects shall be permitted to join M. Sc., STATISTICS course.

VISION

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

MISSION

The department of Statistics aims to instill and inspire the domain knowledge on theoretical and applied aspects of Statistics in a broader spectrum. It intends to impart awareness on the importance of the conceptual framework of statistics across diversified fields and to afford practical training on the applications of statistical methods for carrying out analysis of data using sophisticated statistical software. The curriculum of post-graduate programme of the department is designed in such a way to cater the needs of the stakeholders to get placements in industries and institutions on successful completion of the course and to provide them ample skill and opportunities to meet the challenges at the national level competitive examinations. The departments strive to enhance its potentials and capabilities to provide good quality education in statistics by acquiring recognition of our institution.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

On successful completion of the M. Sc. Statistics program, the graduates will be able to:

1. Get employment in government, public, private, industrial, health, business, banking, agricultural and educational sectors
2. Expand their knowledge to set their career in research and higher studies
3. Comprehend the statistical concepts and principles for interdisciplinary research
4. Nurture advancement in statistical theory and applications
5. Acquire proficiency in adopting statistical software for data analysis

PROGRAMME OBJECTIVES

1. To imbibe strong foundation of statistics in students.
2. To familiarize students with basic to high-level statistical concepts.
3. To update students with mathematical tools that aid in statistical theory.
4. To teach/strengthen students' knowledge of spreadsheets, programming languages and statistical software packages.
5. To promote application-oriented pedagogy by exposing students to real world data.
6. Preparing students for statistics related competitive exams and motivated them.
7. To make students do projects this prepares them for jobs ahead.

PROGRAMME OUTCOMES (POs)

On successful completion of this course, the graduates will be able to

PO-1: Apply the knowledge of Statistics, science, arts and management principles to the solution of complex problems.

PO-2: Devise solutions for intricate problems and plan system components or processes that meet the specified needs with appropriate consideration for the society, health, safety, cultural, societal, and environmental considerations.

PO-3: Use innovation-based knowledge and creative methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO-4: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO-5: Comprehend the influence of the proficient clarifications in societal and environmental context for sustainable development.

PO-6: Pertain ethical principles and entrust to professional ethics and responsibilities.

PO-7: Function effectively as an individual, and in assorted teams.

PO-8: Communicate effectively on various activities and make effective presentations.

PO-9: Exhibit comprehension and understanding of the programmes and apply them in a multidisciplinary environment.

PO-10: Be familiar with the need for and have the training and skill to engage in self regulating and life-long learning in the broadest perspective of hi-tech change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO-1: Students will be enriched with technical skills used in statistical data science, data analytics through projects including big data

PSO-2: Students are enhanced with the skills of creating taxonomy of cognitive domain in Statistics(Knowledge, Comprehension, Application, Analysis, Synthesis, evaluation)

PSO-3:Students will learn numerical aptitude applying both qualitative and quantitative knowledge for their future career.

PSO-4: Students are stimulated with self learning skills that help them in research work in future and also to perform in NET, SLET and GATE.

PSO-5: Students are groomed up with the present and advanced analytical skills that help them to be an entrepreneur or advisor in Data analytics and Predictive Modeler domain.

PSO-6: Students can utilize their statistical skills, computation and comprehensive knowledge in other disciplinary courses and projects.

PSO-7: Students can increase their competency and perform well in government and Central government jobs for statistics like ISS (Indian Statistical Service), UPSC.

PSO-8: Students can synthesize their statistical expertise in Medical research, Finance and can work as a prominent part in the medical survey, research analytics.

PSO-9: Students will be incorporated with the knowledge of data impurity and handling them with statistical techniques and well known with the automation of building a new statistical model with the criteria, assumptions and appropriateness

PSO-10: Students will be able to do Statistical softwares which will be very useful for their research programs.

PSO-11: Elective papers in PG Programme enable the students to face the real time applications and more useful for the students to do their research programs in future.

RAJAH SERFOJI GOVERNMENT COLLEGE (AUTOMONOUS)

THANJAVUR - 613005

M.Sc., STATISTICS COURSE STRUCTURE

(For the students admitted from the academic year 2022 - 2023 onwards)

PART	CODE	COURSE	TITLE	INST. HRS	CREDIT	EXAM HRS	MARKS		TOTAL
							IA	AE	
I SEMESTER									
III	**A1PST1**	**CC1**	Measure and Probability Theory	6	4	3	25	75	100
III	**A1PST2**	**CC2**	Advanced Sampling Theory	6	4	3	25	75	100
III	**A1PST3**	**CC3**	Advanced Distribution Theory	6	4	3	25	75	100
III	**A1PSTP1**	**CC4**	Statistics Practical – I (Based on CC2 & CC3)	5	3	3	40	60	100
III	**A1PSTEL1A**	**DEC1**	Real Analysis and Linear Algebra	5	4	3	25	75	100
	A1PSTEL1B		Official Statistics						
	A1PSTEL1C		Econometrics						
IV		**GEC1**		2	2	3	25	75	100
			TOTAL	**30**	**21**				**600**
II SEMESTER									
III	**A2PST5**	**CC5**	Statistical Inference-I (Estimation Theory)	6	4	3	25	75	100
III	**A2PST6**	**CC6**	Multivariate Analysis	6	4	3	25	75	100
III	**A2PST7**	**CC7**	Linear Model and Design of Experiments	6	4	3	25	75	100
III	**A2PSTP2**	**CC8**	Statistics Practical – II (Based on CC5, CC6 & CC7)	5	3	3	40	60	100
III	**A2PSTEL2A**	**DEC2**	Linear Regression Analysis	5	4	3	25	75	100
	A2PSTEL2B		Introduction to Data Mining Tools						
	A2PSTEL2C		Statistical Survey Analysis						
IV		**GEC2**		2	2	3	25	75	100
			TOTAL	**30**	**21**				**600**

PART	CODE	COURSE	TITLE OF THE PAPER	INST. HRS	CREDIT	EXAM HRS	MARKS		TOTAL
							IA	AE	
			III SEMESTER						
III	A3PST9	CC9	Statistical Inference-II (Testing of Hypothesis)	6	4	3	25	75	100
III	A3PST10	CC10	Stochastic Process	6	4	3	25	75	100
III	A3PST11	CC11	Demography	6	4	3	25	75	100
III	A3PSTP3	CC12	Statistics Practical – III Based on CC9 & CC11	5	3	3	40	60	100
III	A3PSTEL3A	EC3	Statistical Software Packages (SPSS)	5	4	3	25	75	100
	A3PSTEL3B		Big Data Analytics						
	A3PSTEL3C		Bayesian Inference						
IV		SS1	Soft Skills	2	2	3	25	75	100
	A3PSTEC1	ECC1		-	2	3	-	100	100
III			Internship	-	2	-	-	-	-
			TOTAL	30	25				600
			IV SEMESTER						
III	A4PST13	CC13	Statistical Quality Control	6	4	3	25	75	100
III	A4PSTP4	CC14	Statistics Practical – IV (Based on CC13 & EC4)	6	3	3	40	60	100
III	A4PSTPW	CC15	Project Work	6	4	-	20	80	100
III	A4PSTEL4A	DEC4	Advanced Operations Research	5	4	3	25	75	100
	A4PSTEL4B		Non Parametric Techniques						
	A4PSTEL4C		Advanced Numerical Analysis						
III	A4PSTEL4D	DEC5	Computer Programming With C++	5	4	3	25	75	100
	A4PSTEL4E		Deterministic Inventory Models						
	A4PSTEL4F		Statistical Analysis Based on R -Language						
		SS2	Soft Skills	-	2	3	-	100	100
IV	A3PSTEC2	ECC2		2	2	3	25	75	100
			TOTAL	30	23				600
			GRAND TOTAL		90				2400

HOD
H.O.D of Statistics
Rajah Serfoji Govt. College (Auto)
Thanjavur-5.

COE
CONTROLLER OF EXAMINATIONS
RAJAH SERFOJI GOVERNMENT COLLEGE (AUTONOMOUS)
THANJAVUR - 613 005.

COURSE STRUCTURE

COURSE	No. of Papers x Credit	Total Credit
Core Courses	11 x 4=44 4 x 3 = 12	56
Elective Courses	5 x 4	20
GEC	2x2	4
SS1	2x2	4
ECC	2x2	4
Internship	1 x 2	2
Total	27	90

Separate Passing Minimum is prescribed for Internal and External

a) The Passing minimum for CIA shall be 40% out of 25 marks (10 marks)

b) The Passing minimum for Autonomous Examinations shall be 40% out 75 marks (30 marks)

c) The Passing minimum not less than 50% in the aggregate

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
I	6	4	English	III	A1PST1
CC 1	MEASURE AND PROBABILITY THEORY				

Course Objectives:

1. To impart knowledge in the measure and probability theory.
2. To develop skills and to acquire knowledge on basic concepts of Lebesgue Measure, the Lebesgue Integral, Measurable Functions, L p - spaces, Minkowski inequalities, Holder inequalities, Convergence and completeness.
3. To illustrate probabilistic pre-requisites are required for building statistical models.

Course outcomes:

At the end of the course, the Students will be able to		Cognitive Level (K Level)
CO -1	Knowledge and understanding: understanding basic concepts of measure and integration theory.	K1, K2
CO -2	Application: measure theory is a part of the basic curriculum since it is crucial for understanding the theoretical basis of probability and statistics.	K2
CO -3	To learn how to analysis the measure and measurable functions, definition of random variable, distribution function and concepts of convergence of distribution.	K2
CO -4	Transferable skills: Ability to use abstract methods to solve problems. Ability to use a wide range of references and critical thinking.	K3
CO -5	Solve the problems based on WLLN, SLLN and CLT. Understanding of the characteristics functions and related results.	K4

Unit-I	(Hours 15) Events, algebra of sets, Fields: - σ fields; Borel fields, Intersection and union of field's monotone fields and necessary properties- minimal monotone class.
Unit-II	(Hours 20) Function, inverse function, measurable function, Borel function, induced - σ field, indicator functions, elementary function, concept of random variable, Borel function of a vector random variable, Limits of random variables, continuity property of probability space, induced probability space, probability as a measure.

Unit-III	(Hours 20) Distribution function, Properties, Jordan decomposition theorem, distribution function of a random vector, Marginal and conditional distributions, correspondence theorem (statement only) empirical distribution function, Expectation properties - Cramer Rao - inequality, Holder's inequality, Cauchy Schwartz's inequality, Minkowski inequality, Jenson's inequality, Basic inequality.
Unit-IV	(Hours 20) Convergence of random variables. Types of convergences: Monotone convergence theorem, Dominated convergence theorem, Characteristic function, properties, some inequalities on characteristic functions, inversion theorem and simple problems.
Unit-V	(Hours 15) Limit theorems, Law of large numbers, Weak law of large numbers, Bernoulli, Poisson and Khinchine's law of large numbers; Strong law of large numbers, Levy-Cramer theorem, Central limit theorem, De-Moivre-Laplace, Liapounov's, Lindberg-Levy theorems. Statement of Lindberg-Feller theorem.

Text Books

1. Bhat, B. R. (2009). Modern Probability Theory – An Introductory Text Book, Third Edition (Reprint), New Age International Private Ltd., New Delhi.
2. Mark Fisz. Probability theory and mathematical statistics
3. Basu, A. K. (2012). Measure Theory and Probability, Prentice Hall India Learning Private Limited, New Delhi.
4. Halmos, P. R. (1978). Measure Theory, (First Edition in 1950), Second Printing, SpringerVerlag, NY.

Reference Books

1. de Barra, G. (2000), Measure Theory and Integration, New Age International Private Ltd., New Delhi.
2. Rohatgi, V. K., and Saleh, A.K.M.E. (2015), An Introduction to Probability and Statistics, Third Edition, John Wiley & Sons, NY.

E-LEARNING RESOURCES

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

1. https://nptel.ac.in/courses/111/101/111101005/
2. https://nptel.ac.in/courses/111/102/111102111/
3. https://nptel.ac.in/courses/111/102/111102111/
4. https://www.math.uni-bielefeld.de/~grigor/mwlect.pdf
5. https://en.m.wikipedia.org/wiki/Probability_theory

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks: 75 Exam duration: Three Hours

Part A: 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B: 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C: 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	A1PST1	CC1: Measure And Probability Theory	6	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	1	2	3	2	3	2	2	2.3
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	2	1	2	2	2	3	2.0
CO-5	3	1	1	3	2	1	2	2	2	3	2.0
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction:**	**Part**	**Sub. Code**
I	6	4	English	III	A1PST2
CC 2	ADVANCED SAMPLING THEORY				

Course Objectives:

1. To learn scientific view to conduct the survey in proper way to collect the data about specific perspective.
2. To Learn variety of probability and non probability sampling methods for selecting a sample from a population.

Course Outcomes:

At the end of the course the Students will be able to		Cognitive Level (K Level)
CO -1	Understand the basic principles underlying survey design and estimation.	K1
CO -2	Apply the different sampling methods for designing and selecting a sample from a population.	K2
CO -3	Implement Cluster sampling, Ratio and Regression estimation in real life problems.	K3
CO -4	To apply various sampling methods for agricultural data.	K4
CO -5	To use practical applications of ratio and regression method of estimation.	K4

Unit-I	**(18 Hours)** Simple random sampling with and without replacement. Simple random sampling for proportions- Properties of estimates of mean and variance - confidence limits- Estimation of sample size for proportions, Estimation of sample size.
Unit-II	**(18 Hours)** Stratified random sampling - methods of allocation- Relative precision of stratified random sampling with simple random sampling- Estimation of gain in precision due to stratification – stratified sampling for proportions- Estimation of sample size.
Unit-III	**(18 Hours)** Systematic random sampling- linear systematic sampling- Circular systematic sampling-Estimation of the variance- comparison of systematic sampling with SRS and stratified sampling- Concept of ratio and regression estimators.

Unit-IV	**(18 Hours)** Cluster sampling- Equal cluster sampling- Estimator of mean and its variance- relative efficiency of cluster sampling. Optimum cluster size- Multi-stage sampling - Two-stage sampling with equal first-stage units- Estimator of mean and its variance. Two-stage sampling with unequal first stage units- Estimators of mean and its variance.
Unit-V	**(18 Hours)** Multistage sampling – Double sampling for stratification – Optimal allocation – Double sampling for difference estimator – Double sampling for ratio estimator - Double sampling for regression estimator.

Text Books

1. Moorthy, M.N. (1967) Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
2. Daroga Singh and F.S.Chowdry. Theory and Analysis of sampling survey design, New age international (p) ltd, New Delhi.

Reference Books

1. Cochran, W.G. (1984) Sampling Techniques, John Wiley & Sons, NY.
2. Des Raj (1978), Sampling Theory, Tata-McGraw Hill, New Delhi.
3. Sampath, S. (2000). Sampling Theory and Methods, Narosa Publishing Company, New Delhi.
4. Sukhatme, P. V., and Sukhatme, B. V. (1970). Sampling Theory of Surveys with Applications, Asia Publishing House, New Delhi.

E-LEARNING RESOURCES

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

1. https://nptel.ac.in/courses/111/104/111104073/
2. https://nptel.ac.in/content/storage2/courses/111104073/Module14/Lecture42.pdf
3. https://www.mooc-list.com/tags/sampling-methods
4. https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/referencespapers.aspx?referenceid=1452788
5. https://archive.org/stream/in.ernet.dli.2015.137862/2015.137862.Sampling-Theory-And-Methods_djvu.txt
6. http://www.mim.ac.mw/books/S.%20Sampath%20Sampling%20theory%20and%20methods%202001.pdf

Question Paper Pattern Maximum Marks:75 Exam duration: Three Hours

Note: Question Patterns based on theory part only.

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course								Hours	Credits
I	A1PST2	CC2: ADVANCED SAMPLING THEORY								6	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	1	1	3	3	3	3	1	2.4
CO-2	2	2	2	3	1	2	3	2	3	3	2.3
CO-3	3	2	2	3	1	3	3	2	3	3	2.2
CO-4	3	2	2	3	1	3	3	2	3	3	2.5
CO-5	3	2	3	2	1	3	2	3	2	1	2.2
Mean Overall Score											2.32 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
I	6	4	English	III	A1PST3
CC 3	ADVANCED DISTRIBUTION THEORY				

Course objectives:

1. To learn basic and advanced techniques in distributions and their properties, characteristics.
2. To present the general theory of statistical distributions as well as the standard distributions found in statistical practice.
3. Understanding through real-world statistical applications.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand the most common discrete and continuous probability distributions and their real life applications.	K1
CO -2	Apply compound, Truncated, mixture and non-central probability distributions to solve problems.	K2
CO -3	Analysis marginal and conditional distributions from joint distributions.	K3
CO -4	Acumen to apply standard discrete probability distribution to different situations.	K3
CO -5	Get familiar with transformation of univariate and multivariate densities. Understanding of distribution helps to understand the nature of data and to perform appropriate analysis.	K4

(18 Hours)

Unit-I: Binomial, Poisson, Negative Binomial and Geometric Distributions – Definitions, properties, moments, m.g.f , c.f, cumulants, additive properties and recurrence relations - applications.

(18 Hours)

Unit-II: Pascal, Polya, Hyper-Geometric and Multinomial Distributions – Definitions, properties, moments, m.g.f , c.f, cumulants, additive properties and recurrence relations its applications.

(18 Hours)

Unit-III: Uniform, Normal, Laplace, Weibull, Logistic, and Cauchy distributions and Power series (concept only) – Definitions properties, moments and its applications.

(18 Hours)

Unit-IV: Concept of Sampling distributions, Non-central Chi-Square, t and F distributions and their properties.

(18 Hours)

Unit-V: Order Statistics, Distribution of Smallest and largest observations. Distribution of Range and Median. Distribution of r^{th} order statistic. Joint distribution of two order statistics. Joint distribution of several order statistics.

Text Books

1. Rohatgi V.K. (1984). Introduction to Probability Theory and Mathematical Statistics, John Wiley Sons, NY.
2. Gupta, S.C. & Kapoor,V.K.(1977) Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

Reference Books

1. Hogg, R.V., McKean, J. W., and Craig, A. T. (2012). Introduction to Mathematical Statistics, Seventh Edition, Pearson Education, London.
2. Johnson, N. L., and Kotz, S. (1972). Distributions in Statistics, Princeton University Press, Princeton.
3. Johnson, N. L., Kemp, A.W., and Kotz, S. (2005). Univariate Discrete Distributions, Third Edition, John Wiley and Sons, New York.

E-LEARNING RESOURCES

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

1. https://swayam.gov.in/nd2_cec20_ma01/preview
2. https://nptel.ac.in/courses/111/104/111104032/
3. https://minerva.it.manchester.ac.uk/~saralees/statbook2.pdf
4. https://www.dcpehvpm.org/E-Content/Stat/FUNDAMENTAL%20OF% 20 MATHEMATICAL%20STATISTICS-S%20C%20GUPTA%20&%20V%20K%20 KAPOOR.pdf

PEDAGOGY

➢Formal face-to-face lectures

➢Chalk and Talk

➢ Problem solving and allow time for students to resolve problems in understanding of lecture material.

Question Paper Pattern Maximum Marks: 75 Exam duration: Three Hours

Note: Question Patterns based on theory part only.

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course						Hours	Credits
I	A1PST3			CC3: Advanced Distribution Theory						6	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	3	3	2	1	2.2
CO-2	1	3	3	1	2	3	2	3	3	1	2.2
CO-3	3	2	1	3	3	2	3	1	3	3	2.4
CO-4	3	2	2	3	3	2	2	1	3	3	2.4
CO-5	3	1	1	3	3	1	3	1	3	3	2.2
Mean Overall Score											2.3 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
I	5	3	English	III	A1PSTP1
CC 4	STATISTICS PRACTICAL – I (Based on CC2 and CC3)				

Course Objectives:

1. Practiced into the sampling methods and distribution techniques based on relevant data.
2. This course is based on both Based on CC2 and CC3 and will provide practical knowledge to the students on various topics elaborated in these two courses so that they can apply the relevant concepts to real life problems.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level (K Level)**
CO -1	Estimate the parameter of a distribution from sample and give conclusions.	K1
CO -2	Hands on experience in implementation of concepts in Measure and Probability theory.	K2
CO -3	Analyse and Solve the problems related to distribution function.	K3
CO -4	Apply various sampling techniques in real life problems.	K3
CO -5	Practice and Implement various sampling methods, Single stage and two stage clusters in real life problems.	K4

Distribution Theory

- Probability Models - Binomial Distribution, Poisson Distribution, Negative Binomial Distribution, Geometric Distribution, Pascal Distribution, Polya Distribution.
- Hyper-Geometric Distribution, Multinomial Distribution, Uniform Distribution.
- Power series Distribution, Laplace Distribution and Weibull Distribution.
- Normal Distribution, Logistic Distribution and Cauchy Distribution.

Sampling Theory

- Sample size estimation – Simple Random Sampling
- Stratified Random Sampling with Allocations
- Systematic sampling.
- Single stage cluster sampling (equal size) method.
- Two Stage cluster with equal probability.

Pattern of Practical :

Practical Exam duration: Three Hours

Internal Marks: (Model Practical: 25 Marks + Observation Note:10 + Record Note: 5 = 40 Marks)

Practical Exam (Lab): 4X15=60 marks.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
I	A4PSTP1	CC4 -STATISTICS PRACTICAL – I (Based on CC2 & CC3)							5	3
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	1	2	3	2	3	2	2	2.3
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	2	1	2	2	2	3	2.0
CO-5	3	1	1	3	2	1	2	2	2	3	2.0
Mean Overall Score											2.2 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
I	5	4	English	III	A1PSTEL1A
DEC1	REAL ANALYSIS AND LINEAR ALGEBRA				

Course Objectives:

1. The aim of the course is to introduce fundamental concept of real analysis such as sequence, series of real numbers and their convergence, continuity, differentiability of real valued functions.
2. To learn the basic ideas of abstract algebra and techniques with proof in pure mathematics and further, it can be use in many other courses.
3. The main objective of this subject is to cultivate a mathematical aptitude and nurture the interests of the students towards problem solving aptitude.

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	To understand the concept of Sets, elements and Real valued functions.	K1
CO-2	Students will be able to demonstrate basic knowledge of key topics in classical real analysis..	K2
CO-3	Describe the basic difference between the rational and real numbers. Give the definition of concepts related to metric spaces such as countability, compactness, convergent etc.	K2
CO-4	Be Familiar With Advanced Concepts About Matrices Over Field, Understand Basic Results About Matrices Over Commutative Rings.	K3
CO-5	Apply computational techniques for generalized eigen value problems and for computing general functions of a matrix.	K4

Unit-I	(15 Hours) Sets and elements- Operations and sets, functions - Real valued function- equivalence, countability and areal numbers. Sequence – definition, limit, convergent, divergent, bounded and monotone sequences. Series – definition – convergence and divergence.
Unit-II	(15 Hours) Definition of the Riemann integral – Existence of the Riemann integral – Properties of the Riemann integral – Derivatives – Rolle's theorem
Unit-III	(15 Hours) Rank of a matrix- Elementary transformation. Elementary matrices- Echelon matrix- Hermits canonical form- Sylvester's law- Frobenius inequality- certain results on a rank of an idempotent matrix. Theory of linear equations.
Unit-IV	(15 Hours) Generalized inverse of a matrix- different classes- properties-properties of Moore and Penrose- Applications of generalized inverse in the solution of system of linear equations solution of linear equations. Least square properties of Moore and Penrose generalized inverse applications of M-P inverse for the solution of optimization problems.
Unit-V	(15 Hours) Eigen values and Eigen vectors- spectral decomposition of a symmetric matrix- Cayley- Hamilton theorem. Quadratic forms and inequalities- classification- positive semi-definite- Gram matrix- Quadratic form into sum of squares- Lagrange's method.

Text Books

1. Goldberg, R. R. (1976). Methods of Real Analysis, Oxford & IBH Publishing Company, New Delhi

2.Biswas.S- Topics in Algebra in Matrices Ch.4:1-9; Ch.5:full; Ch.6:1-9; Ch.7:1,4; Ch.8:1-5.

3. Ranjit Singh and Arora, *First course in Real Analysis*, Sultan Chand, 1974.

4. Graybill, F.A. (1983). Matrices and Applications in Statistics, Wadsworth Publishing Company, Belmont, California, USA.

5. Rudin, W. (1985). Principles of Mathematical Analysis, McGraw-Hill, New York

6. Narayanan and Manickavasagam pillai, *Ancillary Mathematics*, 2009.

Reference Books

1. Ajit Kumar and Kumaresan, S. (2014). A Basic Course in Real Analysis, Chapman and Hall/CRC Press.

2. Arora, S. (1988). Real Analysis, Satya Prakashan Mandir, New Delhi.

3. Malik, S.C., and Arora, S. (2009). Mathematical Analysis, Second Edition, New Age International, New Delhi.

4. Rao, A. R., and Bhimasankaram, P. (2000). Linear Algebra, Second Edition, Hindustan Book Agency, Hyderabad.

E -LEARNING SOURCES

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

1. https://www.jirka.org/ra/realanal.pdf
2. http://synechism.org/primer/primer-real-analysis.pdf
3http://www.astronomia.edu.uy/progs/algebra/Linear_Algebra,_4th_Edition_(2009)LipschutzLipson.pdf
4. https://nptel.ac.in/courses/111/101/111101134/ 5 https://nptel.ac.in/courses/111/106/111106051/
5. https://dlscrib.com/download/goldberg-r-methods-of-real-nalysis_588e2ade6454a7ab7035c2cc_pdf

Question Paper Pattern

Note: Question Patterns based on theory part only. (Unit 3 and Unit 4: Theory 50% and simple problems 50%)

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
I	A1PSTEL1A	DEC1: Real Analysis and Linear Algebra							5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
I	5	4	English	III	A1PSTEL1B
DEC1	OFFICIAL STATISTICS				

Course Objectives:

1. Uunderstand the functioning of government and policies.
2. Promote human resource development in the official statistics and encourage research and development in theoretical and applied statistics.
3. Execute the data handling tasks in various government records
4. To impart knowledge about the various Statistical organizations in India.

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	Recognize the statistical organizations of India	K1
CO-2	Understand the existing price statistics	K2
CO-3	Acquire the knowledge on Indian official statistical system	K2
CO-4	Estimate the national income using different methods.	K3
CO-5	Examine different methods of collecting population census.	K4

(15 Hours)

Unit–I: Official Statistics: Definition – Growth of Indian Statistics – Statistical organizations of India: Central Statistical Organisation (CSO) – Divisions of Central Statistical Organisation – Functions – Publications.

(15 Hours)

Unit–II: National Sample Survey Organisation (NSSO): Divisions of NSSO – Functions of NSSO – Procedure for collection of information – Agriculture Statistics, Yield Statistics – Official series: Traditional method, Random Sampling Method – NSS Series – Forest Statistics, Fisheries Statistics – Defects in agricultural Statistics.

(15 Hours)

Unit–III: National income: Definition – Methods of estimating national income: The Income method, the Output method and the Expenditure method – Uses of National income estimates – Difficulties of estimation.

(15 Hours)

Unit–IV: Social accounting: Population statistics – Sources – Different methods of collecting population census – Methods of enumeration – Merits and demerits of De Facto method, Merits and demerits of the De Jure system.

(15 Hours)

Unit –V: Price Statistics: Wholesale prices, Retail prices, Uses and limitations of price statistics. Industrial Statistics: Main Sources of industrial Statistics – Limitations.

Text Books

1. R.S.N. Pillai and V. Bagavathi, *Statistics*, 3rd Edition, S.Chand & Company, New Delhi.
2. Central Statistical Organization, *Statistical Systems in India*, Department of Statistics, Ministry of Planning, New Delhi, 2011
3. Goon, A.M. Gupta, M.K and Das Gupta, B, *Fundamentals of Statistics*, Volume II, The World Press Private Limited, Calcutta, 1986.

Reference Books

1. Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan.
2. C. S. O. (1990). Basic Statistics Relating to the Indian Economy.
3. C.S.O. (1995). Statistical System in India.
4. C. S. O. (1999). Guide to Official Statistics.
5. Mukhopadhyay, P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India.

Web Resources

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

1. https://www.classcentral.com/course/swayam-macro-economics-19942
2. https://www.classcentral.com/course/swayam-economics-of-health-and-health-care-14023
3. Present Indian Statistical system: Organisation | Ministry of Statistics and Program Implementation | Government of India (mospi.nic.in)
4. National Sample Survey Office (NSSO) | Ministry of Statistics and Program Implementation | Government of India (mospi.nic.in)
5. National Income: Definition, Concepts and Methods of Measuring National Income (yourarticlelibrary.com)
6. Census of India - Census Operations (censusindia.gov.in)
7. Industrial Statistics | Ministry of Statistics and Program Implementation | Government of India (mospi.nic.in)

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course					Hours	Credits
I	A1PSTEL1B			DEC1: OFFICIAL STATISTICS					5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
I	**5**	**4**	**English**	**III**	**A1PSTEL1C**
DEC1	**ECONOMETRICS**				

Course objectives:

1. The purpose of this course is to give students a solid foundation in econometric techniques, various functions for economic analysis and future forecasting.
2. Know the Scope and objectives of Econometrics
3. Understand models of Econometrics and estimation of parameters of econometric models
4. Understand the regression analysis.

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K Levels)
CO-1	Identify the point estimation method for normal and non-normal cases.	**K1**
CO-2	Classify the divisions of econometrics	**K2**
CO-3	Choose the first and second order random process	**K3**
CO-4	Utilize the applications of Markov process	**K3**
CO-5	Distinguish the auto correlation and cross correlation types.	**K4**

Unit I: (15 Hours)

Econometrics – Introduction, methodology of Econometrics Interpretation on regression – statistical versus deterministic – nature ad sources of data – Accuracy of data – Measurement of scales of variables – the role of computers.

Unit II: (15 Hours)

Two variates regression model: Concept of population regression function – the meaning of the term linear – stochastic specification of PRF - significance of the stochastic disturbance term – sample regression function.

Unit III: (15 Hours)

The method of least square – classical linear regression model properties of LS estimates – Gauss-Markov theorem (without proof) – C efficient of determination.

Unit IV: (15 Hours)

Regression analysis and analysis of variance - using application of Regression analysis, Prediction - reporting the results of Regression analysis - evaluating the results of Regression analysis.

Unit V: (15 Hours)

Regression through origin - Regression on standard variables - functional forms - log linear model - semi log models - reciprocal models - Choice of functional form.

Text Book

1. Gujarati, D.N. and Sangeetha (2008), Basic Econometrics , McGraw Hill Co, New Delhi.

2. J.Johonston (1984),Economic methods , M cGraw Hill Co, New Delhi.

3. Ronald J. Wonnacott and Thomas H. Wonnacott (1979) Econometris, Wiley Series.

4. Johnson, A.C., Johnson, M. B., and Buse, R. C. (1987). Econometrics: Basic and Applied, Maxmillan.

Reference Books

1. Koutsoyannis. A (2001). Theory of Econometrics, Palgrave Macmillan.

2. Singh, S. P., Parashar, A. K., and Singh, H. P. (1999) Econometrics and Mathematical Economics, S.Chand & Co., Private Limited, New Delhi, India.

E-Learning Sources

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

1. https://www.dynamictutorialsandservices.org/2014/05/business-economics-meaning-naturescope .html
2. https://en.wikipedia.org/wiki/Instrumental_variables_estimation#Interpretation_as_twostage_least_squares
3. https://www.yourarticlelibrary.com/economics/mahalanobis-growth-model-and-heavyindustry-strategy-ofdevelopment/38376#:~:text=It%20was%20sector% 20C% 202% 20representing %20household %20and,of%20employment%20opportunities. %20In%20keeping %20with%20this%20appro ach%5D
4. http://www.worldcat.org/identities/lccn-n77006068
5. https://books.google.com/books/about/Econometric_Methods.html?id=_iy7AAAAIAAJ

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer All Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer All Questions (Either or type Two questions from each unit)

Part C 3 x 10 = 30 Answer Any Three Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	AIPSTELIC	DECISION ECONOMETRICS	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

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Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	A1PSTEL1C	DEC1: ECONOMETRICS	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
I	2	2	English	III	A1PSTGE1
GEC 1	PROFESSIONAL STATISTICS				

Course Objectives:

1. The objective of this course is to equip the students of with knowledge of Time series in real life.
2. The students with some important but useful concepts on topics in time series analysis

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	Acquire the knowledge of time series data and its applications.	K1
CO-2	Outline the demand analysis.	K2
CO-3	Estimate the Seasonal Indices by different methods.	K2
CO-4	Compute the different index numbers in real life problem.	K3
CO-5	Analyze the importance of good index number.	K4

Unit – I **(6 Hours)**

Analysis of Time Series – definition and uses, Additive and Multiplicative Models in Time Series, Components of Time Series - Secular Trend, Seasonal variation, Cyclic Variations and Irregular fluctuations- Definition and Concepts.

Unit – II **(6 Hours)**

Measurement of Trend – Graphic method, Method of Semi-Averages, Method of Moving Averages and Method of Least Squares - Fitting of Straight line trend (theory and problems).

Unit–III **(6 Hours)**

Index Numbers – Definition and Uses, Types of Index Numbers, Problems involved in the construction of Index Numbers. Construction of Simple Index Numbers. – Simple aggregate method and Simple average of Price Relatives using A.M & G.M.

Unit–IV **(6 Hours)**

Construction of Weighted Index Numbers – Laspeyres, Paasches, Dorbish and Bowley, Marshall - Edge worth and Fisher's Ideal Index Numbers(Problems).

Unit – V **(6 Hours)**

Tests of adequacy of a good Index Number – Time Reversal Test, Factor Reversal Test (Definition with problems)- Unit test and Cyclic test (concept only).

Text Books and Reference

S,C .Gupta and V.K. Kapoor (2013): Fundamental of Applied Statistics. - Sultan Chand & Sons, New Delhi.

Gupta S.P (1995) , Statistical Methods, Sultan Chand & Sons, New Delhi.

Goon A.M, Gupta M.A and Das Gupta (1987) , Fundamentals of Statistics, Sultan Chand & Sons, New Delhi.

E-Learning Sources

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

http://nkcs.org.np/nast/catalog/opac_css/index.php?lvl=publisher_see&id=1775

https://www.bookdepository.com/Fundamentals-Mathematical-Statistics-Gupta-S-C-Gupta/9788180545283

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours		Credits
I	A1PSTGE1			GEC1: Professional Statistics				2		2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
II	**6**	**4**	**English**	**III**	**A2PST5**
CC 5	**STATISTICAL INFERENCE – I (Estimation Theory)**				

Course objectives:

1. To analyse the need for estimation techniques in Communication and Signal Processing
2. To analyse estimation problems and apply suitable estimation and detection techniques.
3. To Analyse signal or parameter estimation techniques are preferred and develop
4. Estimation techniques that is suitable for the context from a wider perspective
5. To Analyse impact of white Gaussian noise on Detection of Signals

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels K- Levels
CO-1	Identify and understand the characteristics of a good estimator	K1, K2
CO-2	Outline the different methods of point estimation	K2
CO-3	Solve problems to find a good estimator using MLE and MVUE	K3
CO-4	Construct interval estimates for small and large samples	K3
CO-5	Calculate the prior and posterior distributions	K4

Unit-I	(18 Hours) Introduction- unbiasedness, consistency, efficiency and sufficient estimators - Sufficient statistics, Neyman, Fisher Factorisation theorem, the existence and construction of minimal sufficient statistics, Minimal sufficient statistics and exponential family.
Unit-II	(18 Hours) Sufficiency and completeness, sufficiency and invariance unbiased estimation: Minimum variance unbiased estimation, locally minimum variance unbiased estimators, Rao Blackwell – theorem.
Unit-III	(18 Hours) Completeness- Lehmann Scheffe theorems, Necessary and sufficient condition for unbiased estimators Cramer- Rao lower bound, Chapman -Robbins inequality.
Unit-IV	(18 Hours) Maximum likelihood estimation, computational routines, strong consistency of maximum likelihood estimators, Asymptotic Efficiency of maximum likelihood estimators, Best Asymptotically Normal estimators, Method of moments.
Unit-V	(18 Hours) Baye's and minimax estimation: The structure of Baye's' rules, Baye's' estimators for quadratic and convex loss functions, minimax estimation, interval estimation.

Text Books

V.K.Rohatgi etal(2002) : An introduction to probability and statistics, John Wiley.
Lehmann, E.L. (1983): Theory of point estimation, John Wiley.
Zacks, S. (1971) : The theory of statistical inference, John Wiley.
Rao, C.R. (1973) : Linear statistical inference and its applications, Wiley Eastern, 2nd ed.

Reference Books

Ferguson, T.S. (1967): Mathematical statistics, A decision theoretic approach, Academic press, New York and London.
Lindley, D.V. (1965): Introduction to probability and statistics, Part 2, Inference, Cambridge University Press.
Dudewicz, E. J., and Mishra, S. N. (1988). Modern Mathematical Statistics, John Wiley & Sons,

E – Learning Sources

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

1. https://swayamprabha.gov.in/index.php/Syllabus/detail/10774
2. https://swayam.gov.in/nd1_noc20_ma19/preview
3. https://nptel.ac.in/courses/111/105/111105043/
4. https://www.researchgate.net/publication/238879726_An_Introduction_to_Probability_Theory_and_Mathematical_StatisticsAn_Introduction_to_Probability_Theory_and_Mathematical_Statistics

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer All Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer All Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any Three Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code		Title of the Course						Hours	Credits
II	A2PST5		CC5-Statistical Inference – I (Estimation Theory)						6	4
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	3	2	2	3	3	3	2	1	2.4
CO-3	3	2	2	1	3	3	3	3	2	1	2.3
CO-4	2	1	2	2	3	3	3	3	3	1	2.3
CO-5	3	3	3	3	2	2	2	3	2	2	2.5
Overall Mean Score											2.3 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
II	6	4	English	III	A2PST6
CC 6	MULTIVARIATE ANALYSIS				

Course Objectives:

1. To learn and develop scientific view to deal with multidimensional datasets and its uses in the analysis of research data.
2. To understand the extensions of univariate techniques to multivariate frameworks and learn to apply dimension reduction techniques used in the data analysis.
3. Understand the characteristics of multivariate quantitative research, including strengths and weaknesses
4. Understand the principles, characteristics of the multivariate data analysis techniques

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels K- Levels
CO-1	Understand multivariate normal distribution and their real life applications.	K1, K2
CO-2	Understand Wishart distribution, Hotelling T^2 and Mahalanobis D^2 statistic.	K2
CO-3	Implement dimension reduction techniques using software on real life problems.	K3
CO-4	Demonstrate knowledge and understanding of the basic ideas behind discriminant and clustering analysis techniques with applications.	K3
CO-5	Gaining the knowledge for the Multiple and Partial Correlation and their tests of significance, Multivariate Normal Distribution and its properties	K4

Unit-I	(18 Hours) Multivariate normal distribution and its properties- Marginal and conditional distributions- Maximum likelihood estimation of the mean vector and its covariance matrix, total, partial and multiple correlation coefficients and their distributions (only null case).
Unit-II	(18 Hours) Hotelling T^2 statistic- Mahanalobis D^2 statistic and their distributions & applications- testing the significance of mean vector and equality of mean vectors when the covariance matrices are: (i) known (ii) unknown.
Unit-III	(18 Hours) Wishart distribution- definition, derivation and properties, generalized variance definition and distribution.

Unit-IV	(18 Hours) Concept of classification problem - standards of good classification - classification into one of two normal populations- Baye's procedure of misclassification probabilities - Discriminant analysis- Fisher's discriminant function.
Unit-V	(18 Hours) Principal component analysis, definition- properties and extraction of the components- Canonical correlations and Canonical variables and their evaluation.

Text Books

1. Anderson, T.W. (1983): An introduction to Multivariate analysis, (2nd Edn) John Wiley.
2. Johnson, A.R. and Wichern, W.D. (1988): An introduction to applied multivariate analysis, Prentice Hall, India
3. Morrison, D. F. (2004). Multivariate Statistical Methods, Fourth Edition, Duxbury Press, CA

BOOK FOR REFERENCES:

1. Anderson, T. W. (2003): An Introduction to Multivariate Statistical Analysis, 3rd edition, John Wiley & Sons.
2. Hair, J.F., Anderson, R.E., Tatham. R.L. and Black, W.C. (2006): Multivariate Data Analysis, 5th edition, Pearson Education, Asia.
3. Anderson, T.W. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Edition, John Wiley.
4. Everitt B, Hothorn T, 2011. An Introduction to Applied Multivariate Analysis with R,Springer. 5. Barry J. Babin, Hair, Rolph E Anderson, and William C. Blac, 2013, Multivariate Data Analysis, Pearson New International Edition.
5. Jambu, M., and Lebeaux, M.-O. (1983). Cluster Analysis and Data Analysis, North-Holland, NY.

E – LEARNING RESOURCES:

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

1. https://nptel.ac.in/courses/111/104/111104024/
2. https://nptel.ac.in/courses/111/105/111105091/
3. https://nptel.ac.in/courses/106/106/106106139/
4. https://www.classcentral.com/course/swayam-applied-multivariate-analysis-13898
5. https://www.fun-mooc.fr/courses/cours v1:agrocampusouest+40001EN+ession06/about
6. https://online.stat.psu.edu/stat505/lesson/4
7. http://www2.math.uu.se/~thulin/mm/L7.pdf
8. http://staffwww.itn.liu.se/~aidvi/courses/06/dm/lectures/lec8.pdf

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for course outcomes, programme objective, Programme Specific outcomes

Semester	Course Code					Title of the Course				Hour	Credit
II	A2PST6					CC 6-Multivariate Analysis				6	4
Course Outcomes (COs)	Programme objectives (POs)					Programme Specific Outcomes (PSOs)					Mean Course of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO -1	2	2	2	3	3	2	3	2	2	2	2.3
CO -2	2	3	2	2	2	2	2	3	2	3	2.3
CO -3	3	2	3	3	2	2	2	2	2	2	2.3
CO -4	2	3	2	2	3	3	3	2	2	2	2.4
CO -5	2	2	2	2	2	2	2	3	2	3	2.2
Mean Overall Score											**2.3 (High)**

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
II	6	4	English	III	A2PST7
CC 7	LINEAR MODELS AND DESIGN OF EXPERIMENTS				

Course objectives:

1. To learn the basic principles in the design of simple experiments.
2. To learn different tests for comparing pairs of treatment means, ANCOVA, factorial experiments, fractional factorial experiments, confounding, BIBD, PBIBD with solving real life examples.
3. To learn the applications of different designs in agriculture.
4. The course includes a review of the modest probability and statistics background necessary for conducting and analyzing scientific experimentation.

Course Outcomes:

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	acquire the knowledge about the factorial experiments	K1
CO-2	understand the basic concepts in design of experiments	K2
CO-3	carry out one way and two way Analysis of Variance	K3
CO-4	use appropriate experimental designs to analyze the experimental data	K4
CO-5	give statistical interpretation of the experimental results obtained	K5

Unit-I	(18 Hours) Linear models- least squares estimation- estimability of a linear parametric function. Best linear unbiased estimate (BLUE) for Gauss-Markoffs set up- Gauss- Markoffs Theorem. Tests of linear hypothesis and its applications. LSD – and its analysis- missing plot technique- Analysis of non-orthogonal data.
Unit-II	(18 Hours) Factorial experiment- Effects and interactions in 2^2, 3^2,3^3 experiments. Total and partial confounding. System of confounding for 2^2 , 2^3experiments Analysis of Split Plot design.
Unit-III	(18 Hours) Balanced incomplete block design (BIBD). Concept of connectedness and balancing- Intra block analysis of BIBD. Recovery of inter block information.

Unit-IV	Partially Balanced Incomplete Block Deign (PBIBD) of two associate classes. Parametric relations and intra block analysis of PBIBD. Yuden square design (concept only)	(18 Hours)
Unit-V	Response surface design – definition - Linear and second order response surface designs. Concept of Lattice, weighing, Balanced and Partially Balanced designs.	(18 Hours)

Text Books

Graybill, F.A. *An introduction to Linear Statistical Models*, McGraw Hill, New York.
Joshi, D.D. *Linear Estimations and Design of Experiments*, Wiley Eastern Ltd, New Delhi.
Das, M.N. and Giri, N.C. *Design and analysis of experiments*, Wiley Eastern Ltd

Reference Books

Aloke Day *Theory of Block Design*, Wiley Eastern Ltd, New Delhi.
Doughlas,C. Montgomery:*Design and analysis of Experiments*,John Wiley& Sons,8thed-2013.
Oscar Kempthrone, *Design and analysis of experiments*, John Wiley and Sons, 1952.

E – LEARNING RESOURCES:

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

1. https://nptel.ac.in/courses/110/105/110105087/
2. https://nptel.ac.in/courses/111/104/111104075/
3. https://nptel.ac.in/courses/110/105/110105087/

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course					Hours		Credits
II	A2PST7	CC-7 Linear Models and Design of Experiments					6		4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	2	3	1	2	3	2	3	2	2	2.2
CO-2	2	3	2	2	3	2	2	2	2	3	2.3
CO-3	3	2	1	2	2	1	3	2	3	2	2.1
CO-4	2	2	2	3	2	2	2	2	2	2	2.1
CO-5	2	2	2	3	2	2	3	2	3	2	2.3
Overall Mean score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
II	5	3	English	III	A2PSTP2
CC8	STATISTICS PRACTICAL – II (Based on CC5, CC6 and CC7)				

Course Objectives:

1. Practiced into the help of decision making the statistical data based on the statistical inference, multivariate analysis and design of experiment techniques.
2. This course is based on both Based on CC5, CC6 and CC7 and will provide practical knowledge o the students on various topics elaborated in these two courses so that they can apply the relevant concepts to real life problems.

Course Outcomes:

CO. No	CO – Statements On successful completion of this course, students will be able to	Cognitive Level (K Level)
CO -1	Estimate the parameter of a distribution from sample and give conclusions.	K4
CO -2	Hands on experience in implementation of concepts in Probability distributions.	K4
CO -3	Analyse and Solve the problems related to multivariate analysis.	K4
CO -4	Apply various field techniques in design of experiments real life problems.	K4,K5

Statistical Inference (15 Hours)
Region and power curves concerning testing of hypothesis on the parameters of the following distributions when alternatives are one sided as well as two sided. ➢ Binomial Distribution ➢ Normal Distribution ➢ Exponential Distribution
Multivariate Analysis (30 Hours)
Hotelling's T^2 Statistic (a) Testing for $\mu = \mu_0$ (b) Testing $\mu_1 = \mu_2$

Mahalonobis D^2 Statistics, Testing for equality of means, Discreminant functions, Principal component analysis.
Linear Models and Design of Experiments (30 Hours)
Greaco Latin Square Design - Split plot and Strip plot techniques 2^n and 3^n factorial experiments with and without, total and partial confounding - BIBD – PBIBD

Pattern of Practical :

Practical Exam duration: Three Hours

Internal Marks: (Model Practical: 25 Marks + Observation Note:10 + Record Note: 5 = 40 Marks)

Practical Exam (Lab): 4X15=60 marks.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
II	A2PSTP2	CC8: STATISTICS PRACTICAL - II	5	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	2	3	1	2	3	2	1	2	2	2.0
CO-2	2	3	2	2	3	2	2	2	2	3	2.3
CO-3	2	3	2	2	3	2	2	2	2	3	2.3
CO-4	3	2	2	2	2	1	3	2	3	2	2.2
CO-5	2	2	2	3	2	2	2	3	2	2	2.2
Mean Overall Score											2.2 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
II	5	4	English	III	A2PSTEL2A
DEC2	LINEAR REGRESSION ANALYSIS				

Course objectives:

1. To develops a deeper understanding of the linear and non-linear regression model and its limitations.
2. To learn how to develop regression model and apply for the specific perspective data appropriate manner.
3. To understand the practical applications of the various regression models and Time series.
4. Regression analysis is the most common statistical modeling approach used in data analysis and it is the basis for advanced statistical modeling.
5. In this course, students will learn the use of different useful tools used in regression analysis. They will learn about simple and multiple linear regression, non-linear regression and generalize linear models (GLM) including logistic regression.

Course Outcomes:

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	Understand multiple linear regression models with applications. Apply simple linear regression model to real life examples.	K1
CO-2	Apply Multiple linear Regression models and its implementation in real life situation	K2
CO-3	Understand the concept and real life applications of Multicollinearity and autocorrelation.	K3
CO-4	Gaining the knowledge for generalized and weighted least squares and Robust regression models	K4
CO-5	Develop a deeper understanding of the linear regression model and validation of Regression Models	K5

Unit-I	(15 Hours) Simple linear Regression model - Least square estimation of the parameters- Estimation of β_0 and β_1- properties of the least square estimators - Estimation of σ^2- Hypothesis testing on the slope and intercept. Estimation by Maximum likelihood method - Interval estimation in simple linear regression: Confidence Intervals on β_0,β_1 and σ^2.
Unit-II	(15 Hours) Multiple linear Regression models - Estimation of model parameters-Least Square estimation of the Regression co-efficient-Properties of least square estimators- Estimation of σ^2 – Maximum Likelihood Estimation - Hypothesis testing in multiple linear regression, confidence interval of multiple regression co-efficient.
Unit-III	(15 Hours) Multicollinearity - Sources of multicollinearity - methods for dealing with multicollinearity - Ridge Regression – Specification bias.
Unit-IV	(15 Hours) Generalized and weighted least squares-Robust regression - Properties of Robust estimators - Non-linear regression models - Generalized linear models- Logistic regression model - Link function and linear predictors.
Unit-V	(15 Hours) Validation of Regression Models – validation techniques, analysis of model coefficient and predicted values, collecting fresh data- confirmation runs, data splitting and data from planned experiments.

Text Books

1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, third edition, John Wiley and Sons, Inc.
2. Zar, J.H. (2006): Biostatistical Analysis, fourth edition, Pearson education.
3. Douglas C. Montgometry (2012)Introduction to Linear Regression Analysis.
4. Iain Pardoe (2012): Applied regression Modeling, second edition, Wiley

Reference Books

1. Draper, N.R. and Smith, H. (2003): Applied Regression Analysis, third edition, John Wiley and Sons, Inc.
2. Johnston, J. (1984): Econometric methods, third edition, McGraw Hill International.
3. A. Sen, M. Srivastava, Regression Analysis — Theory, Methods, and Applications, Springer- Verlag, Berlin, 2011.

E – LEARNING RESOURCES:

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

1. http://home.iitk.ac.in/~shalab/regression/Chapter2-Regression Simple Linear Regression Analysis.pdf
2. http://www.mit.edu/~6.s085/notes/lecture3.pdf
3. https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/NCSS/Nonlinear_Regression.pdf
4. https://data.princeton.edu/wws509/notes/c4.pdf
5. http://home.iitk.ac.in/~shalab/regression/Chapter15-Regression- Poisson Regression Models.pdf

Question Paper Pattern

Maximum Marks: 75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for course outcomes, programme objective, Programme Specific outcomes

Semester	Course Code					Title of the Course				Hour	Credit
II	A2PSTEL2A					DEC2 - Linear Regression Analysis				5	4
Course Outcomes	Programme objectives (POs)					Programme Specific Outcomes (PSOs)					Mean Course
	PO -1	PO -2	PO -3	PO -4	PO -5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO -1	2	2	2	3	3	2	3	2	2	2	2.3
CO -2	2	3	2	2	2	2	2	3	2	3	2.3
CO -3	3	2	3	3	2	2	2	2	2	2	2.3
CO -4	2	3	2	2	3	3	3	2	2	2	2.4
CO -5	2	2	2	2	2	2	2	3	2	3	2.2
Mean Overall Score											2.3

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
II	**5**	**4**	**English**	**III**	**A2PSTEL2B**
DEC2	**INTRODUCTION TO DATA MINING TOOLS**				

Course Objectives:

1. To learn basic data mining techniques and their handling using R software.
2. To introduce the basic concepts and techniques of data mining.
3. To develop skills of using recent data mining software for solving practical problems.

Course Outcomes:

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	Understand the necessity of data mining	**K1**
CO-2	Recall basic concepts, methods, and applications of cluster analysis	**K1**
CO-3	Learn various types of visualization techniques	**K2**
CO-4	Articulate the different patterns in association	**K3**
CO-5	Classify the given data set for analysis	**K4**

Unit-I	(15 Hours) Data types – Measures of similarity and dissimilarity - Hierarchical Clustering Methods.
Unit-II	(15 Hours) k-means and k-methods clustering methods – Clustering Validity measures
Unit-III	(15 Hours) Fuzzy c-means – Fuzzy Clustering Validity Measures – Decision Trees – Building a decision tree – Tree induction algorithm
Unit-IV	(15 Hours) Splitting of nodes based on information gain and Gini index - Nearest Neighbor classifiers – kNN algorithm – Naïve Bayesian classifier
Unit-V	(15 Hours) Association rules mining-Basics-Apriori algorithm-Pruning and candidate generation- Rule mining.

Text Book

Tan, T., Steinbach, M. and Kumar, V. (2006): Introduction to Data Mining, Pearson Education.
Gupta, G.K. (2008): Introduction to Data Mining with case studies, Prentice – Hall of India Pvt. Ltd.
Daniel T. Larose (2006): Data Mining: Methods and Models, John Wiley and Sons.
Han, J. and Kamber, M. (2006): Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publishers.

Reference Books

Paolo Gludici (2003): Applied Data Mining: Statistical Methods for Business and Industry, John Wiley and sons.
Rajan Chattamvelli (2009): Data Mining Methods, Narosa Publishing House, New Delhi.

E – LEARNING RESOURCES:

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

1. https://swayam.gov.in/nd1_noc20_cs92/preview
2. https://swayam.gov.in/nd2_cec19_cs01/preview
3. https://nptel.ac.in/courses/106/105/106105174/
4. Data Mining Tutorial: What is | Process | Techniques & Examples (guru99.com) ch4.pdf
5. Data Visualization - A Complete Introduction | OmniSci

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course					Hours	Credits				
II	A2PSTEL2B	DEC2 - Introduction to Data Mining Tools					5	4				
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	1	1	3	3	3	3	1	2.4
CO-2	2	2	2	3	1	2	3	2	3	3	2.3
CO-3	3	2	2	3	1	3	3	2	3	3	2.2
CO-4	3	2	2	3	1	3	3	2	3	3	2.5
CO-5	3	2	3	2	1	3	2	3	2	1	2.2
Mean Overall Score											2.32 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
II	**5**	**4**	**English**	**III**	**A2PSTEL2C**
DEC 2	**STATISTICAL SURVEY ANALYSIS**				

Course Objectives:

1. Students should know the steps involved in qualitative data collection.
2. Students should know the types of qualitative data typically collected in a qualitative study.
3. Identify and discuss the role and importance of research in the social sciences.
4. This course describes the various methods used for modeling and evaluating survival data.

Course Outcomes:

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Level (K –Levels)
CO-1	Understand the basic concepts of statistical survey and planning of survey	K1
CO-2	Gaining the knowledge of census survey and sampling methods	K2
CO-3	Gaining the knowledge for data collection methods and sources	K2
CO-4	Learn Quantitative and Qualitative data types.	K3
CO-5	analyze the conditional likelihood	K4

Unit-I	(15-Hours) Organizing a statistical survey- Planning the survey, Executing the survey - Drafting an effective questionnaire, difference between questionnaire and schedule.
Unit-II	(15-Hours) Sampling - Census and Sample method. Sampling and Non-sampling errors.
Unit-III	(15-Hours) Collection of data - Primary data - methods of collecting primary data. Internet Survey and Telephone Survey. Secondary data - methods of collecting secondary data and precautions while using secondary data.
Unit-IV	(15-Hours) Classification of data – Types of Classification - Chronological classification, Geographical classification, Quantitative classification and Qualitative classification. Formation of discrete frequency distribution and Formation of continuous frequency distribution.
Unit-V	(15-Hours) Tabulation of data - Parts of a table and general rules of tabulation. Types of tables - simple and complex table, Machine tabulation and Cross tabulation – Practical Survey and Report Writing.

Text Book and Reference

Gupta. S.P, Statistical Methods, Sultan Chand & Sons, New Delhi.

R.S.N.Pillai and V.Bagavathi – Statistics

E – LEARNING RESOURCES:

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

1. https://www.goodreads.com/book/show/26249338-statistical-methods?from_search=true&rating=2
2. NPTEL. [https://swayam.gov.in/nd1_noc20_bt28/preview]
3. [https://swayam.gov.in/nd2_cec20_ma05/preview
4. www.healthknowledge.org.uk

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course						Hours	Credits
II	A2PSTEL2C	DEC 2 : STATISTICAL SURVIVAL ANALYSIS						5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	2	2	3	3	3	2	2	2.6
CO-2	2	1	1	2	1	2	3	2	2	2	1.8
CO-3	2	1	2	2	2	2	2	2	3	1	1.9
CO-4	1	2	2	3	3	2	2	2	2	3	2.2
CO-5	3	2	3	3	3	3	2	2	2	3	2.6
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
II	2	2	English	III	A2PSTGE2
GEC 2	ADVANCED MICROSOFT EXCEL				

Course Objectives:

This advanced Excel course syllabus is designed for the intermediate excel user who desires to learn more advanced skills. Learn the most advanced statistical formulas, functions, charts and types of financial analysis to be an Excel power user.

Students learn:

Students who have intermediate skills with Microsoft Excel 2019 who want to learn more advanced skills or students who want to learn the topics covered in this course in the 2019 interface.

Course Outcomes

CO No.	CO–Statements	Cognitive Level (K –Levels)
	On successful completion of this course, students will be able to	
CO-1	Understand the basic concepts of Microsoft Excel course, and Use Consolidation to summarise and report results from multiple worksheets	K1
CO-2	Enter and edit data. Modify a worksheet and workbook. Work with cell references.	K2
CO-3	Gaining the knowledge for Manipulate data lists using Outline, Auto filter and PivotTables	K2
CO-4	Learn to use functions and formulas. Use advanced functions and productivity tools to assist in developing worksheets	K3
CO-5	Analyze and practices statistical methods used to excel work sheet	K4

(6 –Hours)

Unit I: Excel Introduction - About Excel - The Excel Environment - The Title Bar - The Ribbon - Scroll Bars - The Microsoft Office Button, The Quick Access Toolbar - The Formula Bar - The Workbook Window - The Status Bar- The Workbook View Buttons - The Zoom Slider - The Mini Toolbar - Keyboard Shortcuts.

(6 –Hours)

Unit II: Excel functions: Basic functions: Sum, Average, Max, Min, Count, Counta. Mathematical Functions: Sumif, Sumifs, Countif, Averageif, Averageifs, NestedIF, IFERROR statement, AND, OR, NOT.

(6 –Hours)

Unit III: Protecting Excel: File level production, work book, worksheet protection.

(6 –Hours)

Unit IV: Charts: Tree map, line charts, bar charts and pie diagrams. Histogram and Frequency polygons.

(6 –Hours)

Unit V: Statistical Measures: Measures of central tendencies, Measures of dispersions, correlation and regression analysis, Analysis of variance (one and two way analysis).

Text books and Reference

How to Do Everything with Microsoft Office Excel (2003) By Guy Hart – Davis.

Excel 2019 All-in-One for Dummies, Greg Harvey 1st edition, For Dummies,

E – LEARNING RESOURCES:

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

Excel 2019 Bible by **Michael Alexander** (Author), **Richard Kusleika** (Author), **John Walkenbach** (Author), 1th edition, Wiley.

https://www.amazon.in/Excel-Microsoft-Comprehensive-Guide-Advanced/ dp/9389024153

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
II	A2PSTGE2	GEC 2 - Advanced Microsoft Excel							2	2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	2	2	1	2	1	2	2	2.1
CO-2	1	2	2	2	3	2	3	2	2	2	2.1
CO-3	2	1	1	2	2	2	2	2	3	1	1.8
CO-4	3	3	3	3	3	2	2	2	2	3	2.6
CO-5	3	2	3	3	3	3	2	2	1	3	2.5
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
III	**6**	**4**	**English**	**III**	**A3PST9**
CC9	**STATISTICAL INFERENCE – II (Testing of Hypothesis)**				

Course Objectives:

Transformations and moments of random variables for the familiar of distributions.
Inequalities and convergence theorems, sufficient statistics by using the various powerful tests.

Course Outcomes:

By the end of this Programme, the students will be able to		**Cognitive Level**
CO -1	To obtained the gained the SPRT procedure for using the various most powerful invariant tests.	K1
CO -2	To provide the knowledge of parametric and non parametric tests.	K2
CO -3	Understand problem of statistical inference, problem of testing of hypothesis and construct SPRT in case of Binomial, Poisson, and Normal Distribution.	K3
CO -4	Understand Generalized Neyman Pearson lemma, unbiased test, and their existence in case of exponential family and similar tests and tests with Neyman structure.	K4
CO -5	Developed the knowledge for the field for fundamental lemma's and theorems.	K4

Unit-I	(18 Hours) Uniformly most powerful tests, the Neyman-Pearson fundamental Lemma, Generalization of the fundamental lemma Distributions with monotone likelihood ratio. Problems
Unit-II	(18 Hours) Unbiasedness for hypothesis testing, similarly and completeness, UMP unbiased tests for multi parameter exponential families, comparing two Poisson and Binomial populations, testing the parameters of a normal distribution (unbiased tests).
Unit-III	(18 Hours) Symmetry and invariance, maximal invariance, most powerful invariant tests.
Unit-IV	(18 Hours) Sequential Probability ratio test – fundamental relations among the quantities α, β, A *and* B - determination of the constants A and B in practice - Sequential Probability ratio test OC and ASN function - Simple Problem.
Unit-V	(18 Hours) Non parametric tests – Empirical distribution function - one problem –Kolmogorov Smirnov, Mann- Whitney test - two sample problem – Kolmogorov Smirnov , Mann-Whitney test and Median test.

Text Books and Reference

V.K. Rohatgi (2002) : An introduction to probability and statistics, John Wiley.
Lehmann, E.L. (1986) : Testing of statistical hypothesis, John Wiley.
Ferguson, T.S. (1967) : Mathematical statistics, A decision theoretic approach, Academic press.
Abraham Wald (1947) Sequential Analysis,Dover Publications, INC, Mincola, New York.

Books for Reference

1. Kendall, M. and Stuart, A, *The advanced theory of Statistics*, Vol.II, Charles Griffin, 1961.
2. Rohatgi, V.K, *Statistical Inference*, John Wiley and Sons, 2003.
3. Hogg,R.V, Craig. A.T. and Tannis, *Introduction to Mathematical Statistics*, PrenticeHall, Eng
4. Dudewicz. E.J and Mishra.S.N, *Modern Mathematical Statistics*, John Wiley and Sons, 1988.
5. Rao, C.R. (1973) : Linear statistical inference and its applications, Wiley Eastern, 2nd ed.
6. Gibbons, J.D. (1971) : Non-parametric statistical inference, McGraw Hill.

E – LEARNING RESOURCES:

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

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=34 Paper: P-04.Statistical Inference I P-05.Statistical Inference II
2. https://nptel.ac.in/courses/103/106/103106120/ Introduction to Statistical Hypothesis Testing – IIT Madras

PEDAGOGY

➢ Formal face-to-face lectures
➢ Discussions
➢ Practical applications using statistical softwares.

Question Paper Pattern

Note: Question Patterns based on theory and simple problems only.

Maximum Marks:75 Exam duration: Three Hours
Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course						Hours	Credits
III	A3PST9	CC– 9: Statistical Inference-II (Testing of Hypothesis)						6	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	3	2	3	3	3	2	3	2	2.6
CO-3	2	3	2	2	2	3	3	2	3	2	2.4
CO-4	3	2	1	3	3	1	3	1	3	3	2.3
CO-5	3	1	1	3	3	1	2	1	2	3	2.0
Mean Overall Score											2.3(High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
III	**6**	**4**	**English**	**III**	**A3PST10**
CC10	**STOCHASTIC PROCESSES**				

Course Objectives:

1. To learn and to understand stochastic processes predictive approach.
2. To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.
3. This paper deals with theoretical and applications of stochastic processes. The concept of Markov chain, stationery probability distribution, birth process, Poisson process, Renewal processes – renewal function are covered in detail.

Course Outcomes

CO No.	CO-Statements On successful completion of this course, students will be able to	Cognitive Levels (KLevels)
CO-1	Understand the stochastic processes, Markov chains. List the types of stochastic processes	**K1**
CO-2	Identify the transition probability matrices and various types of states.	**K1**
CO-3	Skills: The student is able to formulate simple stochastic process models in the time domain and provide qualitative and quantitative analyses of such models.	**K2,K3**
CO-4	Understand renewal theory and branching processes with applications. Apply the Poison process in real situations	**K3,K4**
CO-5	Solve differential equations for distributions and expectations in time continuous processes and determine corresponding limit distributions.	**K4,K5**

Unit-I	(18 Hours) Introduction to stochastic processes-classification of stochastic processes, Markov processes-Markov chain-Transition probabilities, transition probability matrix. Chapman-kolmogorov Equations, calculation of n-step Transition probability and its limit.
Unit-II	(18 Hours) Classification of states-Recurrent and Transient states,Transient Markov Chain,Random Walk and Gambler's Ruin Problem.Continuous Time Morkov Process: Poission Processes,Birth and Death Processes,Kolmogorov's Differencial Equations,Applications.

Unit-III	(18 Hours) Branching Processes -Galton-Watson Branching Process-Properties of Generating Functions- Extinction Probabilities- Distribution of Total Number of Progeny, concept of Weiner Process.
Unit-IV	(18 Hours) Renewal Processes -Renewal process in Discrete and Continuous Time - Renewal Interval -Renewal Function and Renewal Density-Renewal Equation-Renewal theorems: Elementary Renewal Theorem. Probability Generating Function of Renewal Processes.
Unit-V	(18 Hours) Stationary Processes :Discrete Parameter Stochastic Process -Application to Time Series ,Auto -covariance and Auto-correlation functions and their properties, Moving Average ,Autoregressive, Autoregressive Moving Average ,Autoregressive Integrated Moving Average Processes. Basic ideas of residual analysis, diagnostic checking ,forecasting.

Text Books

1.Karlin,S.and Taylor,H.M (1975): A First Course in Stochastic Processes, Second Edition, Academic press, Inc., NY.

2 Medhi,J .(2017):Stochastic processes,Fourth Edition New age International Private Ltd,New Delhi.

3. Fuller, W.A. (1976): Introduction to Statistical Time Series, John Wiley, NY.

4. Anderson, T.W., (1971): The Statistical Analysis of time Series, Wiley, NY.

5. Kendall, M.G., and Stuart,A.(1966): The advanced Theory of Statistics, Vol.3, charles Griffin.

Books for Reference

Hoel P.M.G., Port S.C.& Stone C.J.,*Introduction to Stochastic processes*,Universal Book Stall, 1991.

Parzen, E, *Stochastic processes*, Holden-Day,1962.

Cinlar, B, *Introduction to Stochastic processes*, Prentice Hall,1975.

Adke, S.R. & Manjunath, S.M., *An introduction to Finite Markov Processes*, Wiley Eastern, 1984.

E – LEARNING RESOURCES:

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

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=34 Paper: P-10. Stochastic Processes and Time Series Analysis - ISI, Kolkata
2. https://nptel.ac.in/courses/111/103/111103022/ Stochastic Processes – IIT Guwahati
3. https://nptel.ac.in/courses/111/102/111102098/ Introduction and Motivation for studying Stochastic Processes – IIT Delhi
4. https://ocw.mit.edu/courses/mathematics/18-445-introduction-to-stochastic-processes-spring2015/lecture-notes/
5. https://www.stat.auckland.ac.nz/~fewster/325/notes/325book.pdf
6. https://www.ctanujit.org/uploads/2/5/3/9/25393293/_a_first_course_in_stochastic_models_by_darksiderg.pdf

7. https://fliphtml5.com/nenmorphism-ui/wp-contents/Stochastic%20Process%20J%20Medhi%20Second%20Edition/LDJ913

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type/Two questions from each unit)

Part C 3 x10 = 30 Answer **Any Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course						Hours	Credits
III	A3PST10			CC10: STOCHASTIC PROCESSES						6	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	3	2	3	1	3	2	3	2.5
CO-2	1	3	3	2	2	3	1	3	2	3	2.3
CO-3	2	1	2	2	2	2	3	2	3	2	2.1
CO-4	1	2	2	1	3	2	3	2	3	1	2.0
CO-5	3	3	2	3	1	2	2	2	2	3	2.3
Mean Overall Score											2.2 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
III	6	4	English	III	A3PST11
CC 11	DEMOGRAPHY				

Course Objectives:

1. To identify appropriate sources of data and to perform basic demographic analyses using various techniques across populations.
2. To learn the main theories used to understand population studies and societal change.
3. Gain the knowledge of vital events of fertility, mortality, migration and life tables and their relevant field theory and practical situations.

Course Outcomes

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	Identify appropriate sources of data with basic vital statistics analyses	K1
CO-2	Relate the population with standardized death rates	K2
CO-3	Utilize the mortality table to find the survival and death rates	K3
CO-4	Analyze the birth rate used to describe fertility in the populations	K3
CO-5	Distinguish between Incidence and Prevalence rates	K4

Unit-I	(18 Hours) Census: Essential features information available from Indian census. Registration: Vital statistics system, deficiencies. Sample Survey: Major Demographic surveys.
Unit-II	(18 Hours) Crude and age specific marriage, divorce and widowhood rate, singulate mean age marriage. Definition: Computation of crude birth rate, general fertility rate, age specific fertility rate, total fertility rate, gross reproduction rate.
Unit-III	(18 Hours) Definitions- computation of crude death rate, age-specific death rate, infant mortality rate, perinatal mortality rate, neo-natal mortality and post neo natal mortality rate. Direct and indirect standardization, construction of life tables and their uses.
Unit-IV	(18 Hours) Net reproduction rate, stable population intrinsic birth rate, death rate and growth rate, stable age distribution mean length of generation.
Unit-V	(18 Hours) Population Estimation: Component method, use of national sample surveys and registrations, cohort -component method, mathematical methods, forward – reverse survival procedure. Projection of total population and age sex composition: mathematical methods, component methods, age sex diagrgated methods.

Text Books

Shyrock,H.S,. Siegal, J.S. et. al(1976) : Studies in population , The Methods and Materials of Demography, Academic Press.

Gupta, S. C., and Kapoor, V. K. (2016). Fundamentals of Applied Statistics, Sultan Chand & Sons Private Limited, New Delhi.Goon, A. M., Gupta, M. K., and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II, Ninth Edition, World Press, India.

Mukhopadhyay, P. (2011): Applied Statistics, Second Edition, Books and Allied (P) Ltd., IndiaBhende, A and T.Kanitkar (1988) : Principles of population studies , Himalaya publications.

Books for Reference

1. Peter R Cox, *Demography*, 5th Edition, Vikas Publishing House (1979).
2. Agarwal S.N, *India's Population Problems*, Tata McGraw Hill, 1981.
3. Srinivasan, K, *Basic Demographic Techniques and Applications*, Sage Publications (1998).

E - LEARNING RESOURCES:

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

1. https://nptel.ac.in/courses/109/104/109104045/
2. https://swayam.gov.in/nd1_noc19_hs39/preview
3. https://nptel.ac.in/courses/109/104/109104150/

Note : Question Patterns based on theory part only.

PEDAGOGY

- Formal face-to-face lectures
- Discussions
- Practical applications using R.

Question Paper Pattern Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer All Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer All Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any Three Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course						Hours	Credits
III	A3PST11			CC11: DEMOGRAPHY						6	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	3	3	2	1	2.2
CO-2	2	3	1	2	3	2	3	2	3	2	2.3
CO-3	3	2	1	3	3	1	2	2	3	3	2.3
CO-4	3	1	1	3	3	1	2	1	3	3	2.1
CO-5	3	1	2	3	3	1	2	1	2	3	2.1
Mean Overall Score											2.2 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
III	5	3	English	III	A3PSTP3
CC 12	STATISTICS PRACTICAL – III (Based on CC9 and CC11)				

Course objectives:

1. It assists the students practically to make use of the statistical data, based on the statistical inference for testing of hypothesis and demographical data.
2. This course is based on both Based on CC9 and CC11 and will provide practical knowledge to the students on various topics elaborated in these two courses so that they can apply the relevant concepts to real life problems.

Course Outcomes:

CO No.	CO–Statements On successful completion of this course, students will be able to	Cognitive Levels (K-Levels)
CO-1	Understand Hypothesis various advanced statistical techniques for modelling and exploring practical situations.	K4
CO-2	Solving the problems related to testing of hypothesis (Large sample & small sample test)	K4
CO-3	Practiced in real life problems based on Likelihood ratio tests, locally most powerful tests and Non parametric tests.	K3
CO-4	To Provide hands on experience in implementation of concepts in Demography.	K3
CO-5	Real life data implementation of various demographic concepts as outlined above through practical assignments.	K4

Statistical inference – II	**(45 Hours)**

Testing of Hypothesis:

- Uniformly Most Powerful Tests
- Distributions with monotone likelihood ratio testing the mean and variance of a Normal distribution.
- Symmetry and invariance, Maximal invariance
- Most powerful invariant tests.
- Likelihood ratio tests, locally most powerful tests and
- Non parametric tests.

Demography	(45 Hours)

Measurement of Fertility:

- Crude Birth Rate (CBR),
- General Fertility Rate (GFR),
- Specific Fertility Rate (SFR) and
- Total Fertility Rate (TFR).

Measurement of Mortality:

- Crude Death Rate (CDR),
- Specific Death Rate (SDR),
- Infant Mortality Rate (IMR),
- Standardized Death Rate (SDR- Direct And Indirect Method) and
- Life Tables.

Pattern of Practical
Practical Exam duration: Three Hours
Internal Marks: (Model Practical: 25 Marks + Observation Note: 10 + Record Note: 5 = 40 Marks)
Practical Exam (Lab): 4X15=60 marks.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	A3PSTP3	CC12 – STATISTICS PRACTICAL – III (Based on CC9 and CC11)	5	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO- 1	PO- 2	PO-3	PO- 4	PO- 5	PSO- 1	PSO- 2	PSO- 3	PSO- 4	PSO- 5	
CO-1	2	3	3	1	2	3	2	3	2	2	2.3
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	2	1	2	2	2	3	2.0
CO-5	3	1	1	3	2	1	2	2	2	3	2.0
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
III	5	4	English	III	A3PSTEL3A
DEC 3	STATISTICAL SOFTWARE PACKAGES (SPSS)				

Course Objectives:

1. Understand how to start SPSS.
2. Define a variety of statistical variables.
3. Enter basic data into SPSS.
4. Carry out a statistical analysis that can test hypotheses.
5. To learn statistical techniques and their implementation using comprehensive SPSS software.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand statistics environment related software packages.	K1
CO -2	Get familiar with SPSS software and understand SPSS	K2
CO -3	Create and edit the data files, plot graphs using SPSS.	K3
CO -4	Compute descriptive statistics using SPSS.	K3
CO -5	Perform inferential statistical analysis through SPSS.	K4

Unit-I	(15-Hours) Introduction to SPSS - Opening files - File extension - Working with Data - Summarizing Data and Printing - Descriptive statistics for qualitative and quantitative data – Graphs and Charts.
Unit-II	(15-Hours) Measures of dispersions- Correlation Analysis – Simple Correlation – scatter diagram,- Multiple correlation analysis with SPSS
Unit-III	(15-Hours) Simple Regression – scatter diagram, Simple Regression – Estimation and Interpretation of results, Multiple Regression Scatter plot Matrix – Multiple Regression with SPSS
Unit-IV	(15-Hours) Time Series Analysis and Forecasting – Linear Trend – Non – Linear Trend – Seasonality –Forecasting with Linear Trend and regression Models - Index Numbers with SPSS
Unit-V	(15-Hours) Testing of Hypothesis – Chi-square test, Student's t test and F test with SPSS

Text Books and Reference

SPSS for Windows Step by Step: A simple Guide and Reference, 10.0 update (3rd edition) by **Darren George and Paul Mallery**

An Introductory Guide to SPSS for Windows by **Eric L. Einpruch**

How to Do Everything with Microsoft Office Excel (2003) By **Guy Hart – Davis**

Websites:

www.spss.com\Help, www.stata.com, www.spss.org

Help manuals of SPSS version 10

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Semester	Course Code	Title of the Course					Hours				Credits
III	A3PSTEL3A	DEC 3 - Statistical Software Packages (SPSS)					5				4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	1	1	3	3	3	3	1	2.4
CO-2	2	2	2	3	1	2	3	2	3	3	2.3
CO-3	3	2	2	3	1	3	3	2	3	3	2.2
CO-4	3	2	2	3	1	3	3	2	3	3	2.5
CO-5	3	2	3	2	1	3	2	3	2	1	2.2
Mean Overall Score											2.32 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
III	**5**	**4**	**English**	**III**	**A3PSTEL3B**
DEC 3	**BIG DATA ANALYTICS**				

Course Objectives

1. The chief aim of data analytics is to apply statistical analysis and technologies on data to find trends and solve problems.
2. Data analytics has become increasingly important in the enterprise as a means for analyzing and shaping business processes and improving decision-making and business results.
3. Improved Decision Making: Data Analytics eliminates guesswork and manual tasks. Be it choosing the right content, planning marketing campaigns, or developing products.

Course Outcomes

CO No.	CO-Statements	Cognitive Levels (K -Levels)
	On successful completion of this course, students will be able to	
CO-1	Understand big data using statistics	**K1,K2**
CO-2	Describe the hadoop ecosystem	**K2,K3**
CO-3	Discuss the role of survival analysis in data analytics	**K2,K3**
CO-4	Explain few features of mangodb	**K3**
CO-5	Analyze machine learning algorithms	**K4**

UNIT-I	**(15 Hours)** **Machine Learning:** Introduction - Machine Learning Algorithms - Regression Model - Clustering - Collaborative Filtering - Association Rule Mining - Decision Tree.
UNIT-II	**(15 Hours)** **Introduction:** Big data – Characteristics, Evolution, Definition, Challenges - Classification of Analytics – Challenges in collecting and validating big data - Terminologies used in big data environments.
UNIT-III	**(15 Hours)** **Interacting with Hadoop ecosystem:** NoSQL – Uses, Types, Databases, Advantages, and Use in industry - NoSQL vendors, SQL versus NoSQL - NewSQL - Comparison of SQL, NoSQL and NewSQL.
UNIT-IV	**(15 Hours)** **Mango DB :** Introduction - Using Java Script Object Notation - Creating a Unique key - Support for Dynamic Queries - Storing Binary data - Replication - Sharing - Updating Information In - Place.
UNIT-V	**(15 Hours)** **Python:** Introduction – Basic Elements – Objects, Expressions and Numerical Types – Variables and Assignment – Python IDE's – Branching Programs – Strings and Input–A Digression about Character Encoding – Iteration

1. Seema Acharya & Subhashini Chellappan, Big Data and Analytics, Bhushan Print line, 2018.
   Unit-I:Chapter 12 (Sec: 12.1, 12.1.1- 12.2.5)
   Unit-II:Chapter- 2 (Sec: 2.1, 2.2, 2.3); Chapter: 3- (Sec:3.3,3.5,3.6,3.7,3.12,3.12.1,3.12.2)
   Unit-III Chap-4 (Sec: 4.1.1- 4.1.3, 4.1.5, 4.1.7- 4.1.11);Chap5-(Sec: 5.13, 5.13.1-5.13.4)
   Unit-IV Chapter 6 (Sec: 6.1, 6.2, 6.2.1-6.2.7)
2. John V. Guttag, Introduction to Computation and ProgrammingUsing Python with Application to Understanding Data, The MIT Press, Cambridge, Massachusetts, London, England, 2016.**Unit-V** Chapter2 (Sec: 2.1, 2.1.1, 2.1.2)

Books for Reference

1. Multiple Authors, Big data analysis for Dummies, Dummies Press, 2011.
2. Anurag Srivatsava, Hadoop Blueprints, PACKT, 2014.
3. Dipayan Dev, DL with Hadoop, PACKT, 2015.
4. Multiple Authors, Hadoop Fundamentals, Packet Publications, 2012.

E – LEARNING RESOURCES:

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

1. https://jan.newmarch.name/IoT/BigData/Big%20Data%20For%20Dummies.pdf
2. https://www.immagic.com/eLibrary/ARCHIVES/EBOOKS/I111025E.pdf

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code		Title of the Course						Hours	Credits
III	A3PSTEL3B		DSE 3 :BIG DATA ANALYTICS						5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes(PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	3	1	2	1	3	3	2.1
CO-5	3	1	1	3	3	1	2	1	3	3	2.1
Mean Overall Score											2.3 (High)

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
III	5	4	English	III	A3PSTEL3C
DEC 3	BAYESIAN INFERENCE				

Course Objectives:

The course aims to introduce the concept of Bayesian inference, concept of loss functions, risk function, prior and posterior distribution and their application in various real fields.

Course Outcomes:

At the end of the course the Students will be able to		Cognitive Level
CO -1	Understand the concepts of prior and posterior distributions	K1,K2
CO -2	Be able to differentiate between classical and Bayesian inference.	K1,K2,K3
CO -3	Applications of various loss and risk functions.	K3
CO -4	Be able to apply the concept of Bayesian inference in different fields of applications.	K3,K4
CO -5	Develop the Bayesian frame work for data analysis and its flexibility and be able to demonstrate.	K4

Unit-I	(15 Hours) Bayesian point estimation: as a prediction problem from posterior distribution. Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0-1 loss.
Unit-II	(15 Hours) Generalization to convex loss functios. Evaluation of the estimate in terms of the posterior risk. theorem – prior and posterior distributions. Conjugate priors and Jeffrey's priors, examples.
Unit-III	(15 Hours) Bayesian interval estimation : Credible intervals. Highest posterior density regions. Interpretation of the confidence coefficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval.
Unit-IV	(15 Hours) Bayesian testing of hypotheses : Specification of the appropirate form of the prior distribution for a Bayesian testing of hypothesis problem. Prior odd,s Posterior odds.
Unit-V	(15 Hours) Bayes factor for various types of testing hypothesis problems depending upon whether the null hypothesis and the alternative hypothesis are simple or composite.

Text Book and References:

Berger,J.O. : Statistical decision theory and Bayesian analysis, Springler Verlag.
Robert, C.P. and Casella, G.Monte Carlo : Statistical methods, Springer Verlag.
Leonard, T. and Hsu, J.S.J. : Bayesian methods, Cambridge University press.
Degroot, M.H. : Optimal statistical decisions, McGraw Hill.
Bernando, J.M. and Smith, A.F.M. : Baysian theory, John Wiley and sons.
Robert, C.P : The Bayesian choice : A decision theoretic motivation, Springer.

E – LEARNING RESOURCES:

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

https://onlinecourses.swayam2.ac.in/imb21_mg33/preview

https://www.cse.iitk.ac.in/users/piyush/courses/bml_winter17/bayesian_ml.html

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
III	A3PSTEL3C	DEC3- BAYESIAN INFERENCE							5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO1	PO-2	PO-3	PO-4	PO-5	PSO1	PSO2	PSO3	PSO4	PSO-5	
CO-1	2	2	3	1	2	3	2	3	2	2	2.2
CO-2	2	3	2	2	3	2	2	2	2	3	2.3
CO-3	3	2	1	2	2	1	3	2	3	2	2.1
CO-4	2	2	2	3	2	2	2	2	2	2	2.1
CO-5	2	2	2	3	2	2	3	2	3	2	2.3
Overall Mean score											2.2 (High)

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	RAJAH SERFOJI GOVT. COLLEGE (AUTONOMOUS) (NAAC "A" GRADE & DST-FIST College) M.Sc., STATISTICS Programme (Under CBCS & LOCF) (Syllabus for students admitted from 2022-2023 onwards)				
Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
III	**2**	**2**	**English**	**IV**	
SS1	**ACTUARIAL STATISTICS**				

Course Objectives:

1. To learn the life tables used in insurance products.
2. To learn the concept of interest, different life insurance products, life annuities, net premiums.
3. To motivate students to prepare for exams required for employment in the actuarial science profession.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	To gain the knowledge of the actuaries and an insurance industry. And obtain the financial field and medical immunization program analysis.	K1,K2
CO -2	Understand the utility theory, insurance products and life tables.	K1,K2,K3
CO -3	Understand the concept of interest.	K3
CO -4	Understand the concept of life insurance and the existing insurance products of different insurance company.	K4
CO -5	Know life annuities, net premium and net premium reserves.	K4

Unit-I	(6 Hours) Actuarial statistics –definition –Role of statistics in insurance companies and business organizations –utility function –concave function – concept of risk – Risk models for short term periods – Life tables.
Unit-II	(6 Hours) Effective Rate of Interest – Nominal Rate of Interest – Force of Interest –Relationship between i.i(m) and Present value – Effective and Nominal Rate of Discount.
Unit-III	(6 Hours) Annuity – Types of annuity - Present values of Immediate Annuity, Annuity-due, Increasing and Decreasing Annuities. Continuous Annuity.
Unit-IV	(6 Hours) Investment analysis –Time value of money – Methods of investment analysis: Traditional methods, Discounted cash flow methods with problems
Unit-V	(6 Hours) Investment under certainty (Risky investments) – certainty-equivalent method approach – Statistical distribution method – Expected value of NPV – Variance of NPV (with problems).DMT of Zero Coupon Bond.

Text Books and Reference

Shailaja D Deshmukh. Actuarial statistics – university press (India) pvt.Ltd. Hyderbad.
(Units covered: 1,2,3&5)

Kanti Swarup, P.K. Gupta & Man Mohan: Operations Research – Sultan Chand & Sons
(Units covered: 4& first two topics in 5)

ASI Study material for subject – 102, (Units covered: form third to end in 5)

E-Learning Resources

https://www.amazon.in/Actuarial-Statistics-Introduction-Using-R/dp/8173716900

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course						Hours	Credits
III		SS1 - ACTUARIAL STATISTICS						2	2
Course Outcomes	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	3	2	2	3	3	3	2	1	2.4
CO-3	3	2	2	1	3	3	3	3	2	1	2.3
CO-4	2	1	2	2	3	3	3	3	3	1	2.3
CO-5	3	3	3	3	2	2	2	3	2	2	2.5
Overall Mean Score											2.3 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**6**	**4**	**English**	**III**	**A4PST13**
CC 13	**STATISTICAL QUALITY CONTROL**				

Course Objectives

1. Understand the application of statistics in industrial environment.
2. Acquire knowhow on manufacturing process changes and process variability.
3. Attain proficiency in process capability analysis,
4. Instruct theory and practice of product control methodology.
5. Comprehend the importance of reliability theory in industries.

CO No.	**CO–Statements** On successful completion of this course, students will be able to	Cognitive Levels (K –Levels)
CO-1	identify and solve engineering problems	K1
CO-2	understand the basic concepts of quality control and quality management	K2
CO-3	understand the concepts of reliability and maintainability	K2
CO-4	construct charts for variables and Attributes	K3
CO-5	inspect the various sampling plans	K4

Unit-I **(18 Hours)**

Introduction to Statistical Quality Control: Meaning - benefits, basis of Statistical quality control - Causes of variation – difference of causes of variation, process control and Product control - Process capability - Control limits, specification limits and Statistical tolerance.

Unit-II **(18 Hours)**

Process Control: Control Charts – Major parts of control chart, Control chart for variables-Mean, R, s charts, Run charts, Revised control charts. Control charts for attributes -p, np, c charts - CUSUM control charts.

Unit-III **(18 Hours)**

Product Control: Principle of acceptance sampling plans. Producer's risk and Consumer's risk. Single sampling plan, Double sampling plan and their OC, ASN, ATI, AOQ, AOQL functions. Concept - Published Sampling Plans MIL STD 105E.

Unit-IV **(18 Hours)**

Reliability: Concept, measures, components and systems, coherent systems, reliability of systems - serial and parallel systems - Accelerated life testing, reliability estimate based on failure times and stress strength analysis.

Unit-V **(18 Hours)**

Quality Systems and Quality Assurance: Concept of Total Quality Management - Inspection, Quality Control and Quality Assurance. Systems approach for Quality – ISO 9000 Standards - Implications and requirements - Quality Audits.

Books for Study

1. Gupta S.P. & Kapoor V.K., Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi, 4th Revised Edition, 2019. **Unit-I** Chapter 1 (Sec: 1.1 to 1.5). **Unit-II** Chapter 1 (Sec: 1.6 to 1.10). **Unit-III**Chapter 1 (Sec: 1.11 to 1.12)
2. Montgometry, D.C., Introduction to Statistical Quality Control, John Wiley and Sons, 8th Edition 2019.**Unit-III** Chapter 14 (Sec: 14.4) Mahajan, Statistical Quality Control, Dhanpatrai & Sons, 2016. **Unit- IV&** Chapter 13
3. ISO 9000 standards, Issued by Bureau of India.**Unit-V**Chapter17 (Sec:17.1-17.11&17.16 - 17.8)

Books for Reference

1. Mann, Schafer & Singpurwarla, *Methods for Statistical Analysis of Reliability & life data*, John Wiley & sons, New York, 1974.
2. Feigunbaum, A.V., *Total Quality Control*, 3rd Ed, McGraw Hill, 1991.
3. Juran, J.M., *Quality Control Handbook*, McGraw Hill, 1998.

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

1.http://bmepedia.weebly.com/uploads/2/6/6/8/26683759/unit_4_quality_control.pdf
2. http://www2.ing.unipi.it/lanzetta/stat/Chapter20.pdf
3. https://www.win.tue.nl/~adibucch/2WS10/SPClecturenotes.pdf
4 .https://wps.prenhall.com/wps/media/objects/7117/7288732/65767_28_SuppG.pdf
5. https://www.cs.odu.edu/~zeil/cs795SR/Papers/TextBook/Appendix_B.pdf
6. https://www.ravenshawuniversity.ac.in/Study_Materials/Statistics_PG/PG 2nd Year / reliability.pdf
7. https://nptel.ac.in/courses/116/102/116102019/

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
IV	A4PST13	CC13: STATISTICAL QUALITY CONTROL	6	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	2	3	1	2	3	2	1	2	2	2.0
CO-2	2	3	2	2	3	2	2	2	2	3	2.3
CO-3	2	3	2	2	3	2	2	2	2	3	2.3
CO-4	3	2	2	2	2	1	3	2	3	2	2.2
CO-5	2	2	2	3	2	2	2	3	2	2	2.2
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**6**	**3**	**English**	**III**	**A4PSTP4**
CC 14	**STATISTICS PRACTICAL – IV** (Based on CC13 & DEC4)				

Course objectives:

1. It assists the students practically to make use of the statistical data, based on the statistical quality control and Operations Research.
2. This course is based on both Based on CC13 and EC4 and will provide practical knowledge to the students on various topics elaborated in these two courses so that they can apply the relevant concepts to real life problems.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand MP and UMP test.	K1
CO -2	Apply different designs in real life situations.	K2
CO -3	Train to Draw controls charts and apply acceptance sampling plans in industry point of view.	K3
CO -4	Enables to solve suitable problems of LPP and implement practical cases of decision making under different environments.	K3
CO -5	Hands on experience in implementation of concepts in Statistical Inference, Linear Regression analysis and Operations Research.	K4

Statistical Quality Control	**(45 Hours)**
Control Charts for $\bar{X}$ Chart, R-Chart, np-Chart, U-Chart, d-chart. Acceptance sampling plan – Attributes (OC, AOQ, ASN: Single and Double sampling), Sequential sampling plans – Moving - average and moving average range charts. O.C. Curves for control charts.	
Operations Research	**(45 Hours)**
Linear programming problem – Graphical method, simplex method. Transportation problem – Balanced and Unbalanced problems – North - West corner rule, Least cost method, Vogel's approximation method, Test for optimality – MODI method. Assignment problem – Hungarian method. Sequencing problem with n-jobs and 2 machines, n-jobs and 3 machines.	

Pattern of Practical :

Practical Exam duration: Three Hours

Internal Marks:

(Model Practical: 25 Marks + Observation Note:10 + Record Note: 5 = 40 Marks)

Practical Exam (Lab): 4X15=60 marks.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	A4PSTP4	CC14 –STATISTICS PRACTICAL – IV (Based on CC13 & DEC4)	6	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	1	2	3	2	3	2	2	2.3
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	2	1	2	2	2	3	2.0
CO-5	3	1	1	3	2	1	2	2	2	3	2.0
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**6**	**4**	**English**	**III**	**A4PSTPW**
CC 15	**PROJECT WORK**				

Course Objective:

To enable the students to apply the statistical techniques for solving real-life problems.

A good project goes a long way in providing practical training to the students. They get an opportunity through the project to apply some of the vital theoretical concepts and techniques that had learnt in the previous semesters.

On most of the occasions, socio-economic survey market research surveys, Biostatistics and Medical related researches are periodically conducted by government agencies, private organizations. So, it is proposed to offer good project topics to the students in these practical areas. The students will be thoroughly trained through the project not only in scientific selection of sample for data collection, but also in identifying and applying appropriate statistical techniques in their projects.

The board evaluation strategy of the project will entitle the allocation of appropriate marks to the project report preparation and the remaining marks to the project viva-voce, as indicated below:

The maximum marks for the project/dissertation report and viva – voce examination shall be fixed as 100, which is split with the following components:

Internal Assessment Marks by the Project/Dissertation Guide: 20 marks

Evaluation of Project/Dissertation Report jointly by the External Examiner and the Guide Conduct of Viva-Voce Examination: 80 marks

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Pattern of Practical :

Practical Exam duration: Three Hours

Internal Marks:

(Model Practical: 25 Marks + Observation Note:10 + Record Note: 5 = 40 Marks)

Practical Exam (Lab): 4X15=60 marks.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	A4PSTP4	CC14 -STATISTICS PRACTICAL – IV (Based on CC13 & DEC4)	6	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	1	2	3	2	3	2	2	2.3
CO-2	2	3	3	2	2	2	3	3	3	2	2.5
CO-3	3	2	1	3	3	2	3	2	3	2	2.4
CO-4	3	1	1	3	2	1	2	2	2	3	2.0
CO-5	3	1	1	3	2	1	2	2	2	3	2.0
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**6**	**4**	**English**	**III**	**A4PSTPW**
CC 15	**PROJECT WORK**				

Course Objective:

To enable the students to apply the statistical techniques for solving real-life problems.

A good project goes a long way in providing practical training to the students. They get an opportunity through the project to apply some of the vital theoretical concepts and techniques that had learnt in the previous semesters.

On most of the occasions, socio-economic survey market research surveys, Biostatistics and Medical related researches are periodically conducted by government agencies, private organizations. So, it is proposed to offer good project topics to the students in these practical areas. The students will be thoroughly trained through the project not only in scientific selection of sample for data collection, but also in identifying and applying appropriate statistical techniques in their projects.

The board evaluation strategy of the project will entitle the allocation of appropriate marks to the project report preparation and the remaining marks to the project viva-voce, as indicated below:

The maximum marks for the project/dissertation report and viva – voce examination shall be fixed as 100, which is split with the following components:

Internal Assessment Marks by the Project/Dissertation Guide: 20 marks

Evaluation of Project/Dissertation Report jointly by the External Examiner and the Guide Conduct of Viva-Voce Examination: 80 marks

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Semester	Hours / Week	Credit	Medium of Instruction	Part	Sub. Code
IV	5	4	English	III	A4PSTEL4A
DEC4	ADVANCED OPERATIONS RESEARCH				

Course Objectives:

1. To develop the optimization techniques that will be useful in the personal and professional life.
2. To learn the mathematical formulation of complex decision-making problems and arrives at optimal or near-optimal solutions using different techniques of operations research.
3. To impact knowledge in concepts and tools of operations research.
4. To understand mathematical models used in operations research.
5. To apply these techniques constructively to make effective business decisions.

Course Outcomes:

At the end of the course the Students will be able to		Cognitive Level
CO -1	Understand basics and formulation of linear programming problems and appreciate their limitations; solve linear programming problems using graphical method.	K1,K2
CO -2	Gain knowledge about sequencing problems, travelling salesman problem and various methods to solve sequencing problems.	K2
CO -3	Analyse and Solve artificial variable technique, duality theory, revised simplex method, sensitivity analysis, transportation and assignment problems.	K3
CO -4	Evaluate and apply simplex method to solve real life problems	K3,K4
CO -5	Be able to build and solve Game theory, PERT/ CPM, simulation, investment analysis with real life applications.	K4

Unit-I	(15-Hours) The General Linear Programming Problem (GLPP): Properties and Solutions of the LPP; Graphical Method, Theory and Computational Algorithm of Simplex Method, Duality Theorem.
Unit-II	(15-Hours) Transportation problem; Balanced and Unbalanced problems; Mathematical Model of Transportation Problem; Methods for finding initial basic feasible solution; North-West Corner rule, Least cost method, Vogel's approximation method, Test for Optimality; Modi method. Assignment problem; Hungarian method.
Unit-III	(15-Hours) Sequencing Problem with 'n' jobs and 2 machines, problems with 'n' jobs and 3 machines. Integer programming- Branch and Bound method, Dynamic programming – principles of optimality, recursive equation approach, characteristic of dynamic programming problem.
Unit-IV	(15-Hours) Game theory: Two person Zero sum games; Pure strategy; Mixed strategy ; Dominance; m x n games; Graphical solution. CPM; PERT; float and Slack; Advantages of Networks.
Unit-V	(15-Hours) S-S policy for inventory, Inventory problems: definition, concepts of various costs - inventory models: EOQ model with constant rate of demand; EOQ model with different rates of demand; estimation of EOQ in some simple cases.

Text Books and Reference

Taha, H.A.(2007).Operation Research – An Introduction, 8th Edn. Prentice Hall.

Sharma, S (2006). Introductory Operations Research, Discovery Publishing House.

Starr, M.K. and Miller D.W. Inventory Control Theory and Practice, Prentice Hall.

Wagner, H.M Principles of Operations Research with applications to managerial decision Prentice-Hall.

TEXT BOOKS :

1. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, third edition, John Wiley and Sons, Inc.
2. Zar, J.H. (2006): Biostatistical Analysis, fourth edition, Pearson education.
3. Douglas C. Montgometry (2012)Introduction to Linear Regression Analysis.
4. Iain Pardoe (2012): Applied regression Modeling, second edition, Wiley

E-LEARNING RESOURCES

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

1. https://en.wikipedia.org/wiki/Linear_programming
2. https://www.geeksforgeeks.org/transportation-problem-set-1-introduction
3. https://en.wikipedia.org/wiki/Network_analysis_%28electrical_circuits%29 https://books
4. library.net/files/books-library.online-01251340Yz1V8.pdf
5. https://link.springer.com/chapter/10.1007/978-3-319-07863-2_55

Note : Question Patterns based on theory part only .

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
IV	A4PSTEL4A	DEC4-Advanced Operations Research							5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	2	2	1	3	2	3	1	2	2.2
CO-2	2	3	3	2	1	3	3	2	1	2	2.2
CO-3	3	2	3	2	2	3	3	2	1	2	2.3
CO-4	3	3	3	2	1	3	3	3	1	2	2.4
CO-5	3	3	3	2	3	3	2	2	2	3	2.6
Mean Overall Score											2.34 (High)

PEDAGOGY

- Formal face-to-face lectures
- Chalk and Talk
- Problem solving and allow time for students to resolve problems in understanding of lecture material.

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**5**	**4**	**English**	**III**	**A4PSTEL4B**
DEC4	**NON PARAMETRIC TECHNIQUES**				

Course Objectives:

1. Awareness of advanced theoretical and applied information supported by the statistical sources.
2. The significance and impact of statistical methods on the social dimensions of inter disciplinary studies.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	We are able to acquire the knowledge of statistics its scope and importance in various areas such as medical, engineering, agricultural and social sciences.	K1,K2
CO -2	Gaining the knowledge of other social types of data reflecting quality characteristics including the concepts of independent and association between two or more attributes.	K2
CO -3	Analyse non parametric statistical techniques	K3
CO -4	Formulate test and interpret various hypothesis test for location, scale and independence problems.	K4
CO -5	The students will have knowledge of Various one sample tests NPT such as test of randomness ,Sign test ,Kolmogorov Smirnov (KS) test and Kaplan –Meier Estimator	K4

Unit-I	(15-Hours) Rank tests for comparing two treatments, Wilcoxon ranksum tests, Asymptotic null distribution of Wilcoxon statistics, Siegel-Tukey and Smirnov tests.
Unit-II	(15-Hours) Power of Wilcoxon rank, sum tests, Asymptotic power, comparison with students t-test, estimating the treatment effect.
Unit-III	(15-Hours) Block comparison for two treatments, sign test for paired comparisons, Wilcoxon signed rank test, a balanced design for paired comparisons, power

	of sign and Wilcoxon signed rank tests and their comparisons.
Unit-IV	(15-Hours) Comparison of more than two treatments, the Kruskal, Wallis test, 2 x t contingency table, comparing several treatments with a control, ranking several treatments.
Unit-V	(15-Hours) Randomized complete blocks, Friedman, Cochran, McNemar tests, Aligned ranks. Tests of randomness and independence, testing against, trend, testing for independence, zxt contingency tables.

Text Books and Reference

Lehmann,E.L.(1975) :Non parameteric:Statistical methods based on Ranks,McGraw Hill.
Gibbons, J.D.(1971) : Non parametric Statistical inference, McGraw Hill.
Hajek, J. and Sidak, Z.(1967) : The theory of rank tests, Academic press.
Hollandar, M. and Wolfe, D.A.(1973) : Non parametric statistical methods, John Wiley.
Walsh, J.F.(1962) : Handbook of non parametric statistics, Van Nostrand.

E-LEARNING RESOURCES

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

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours
Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	A4PSTEL4B	DEC 4- Non Parametric Techniques	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	3	3	2	2	3	3	3	2	2	2.6
CO-2	2	1	1	2	1	2	3	2	2	2	1.8
CO-3	2	1	2	2	2	2	2	2	3	1	1.9
CO-4	1	2	2	3	3	2	2	2	2	3	2.2
CO-5	3	2	3	3	3	3	2	2	2	3	2.6
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**6**	**4**	**English**	**III**	**A4PSTEL4C**
DEC4	**ADVANCED NUMERICAL ANALYSIS**				

Course Objectives:

1. The course aims to provide students with the specialized knowledge in advanced numerical analysis.
2. Understand analytical, developmental and technical principles that the relate to numerical linear algebra, numerical methods for solving differential equations.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand for the implementation of theories in problem solving.	K1
CO -2	Implementation of the knowledge of basic theorems and concepts in the different area of the mathematics	K2
CO -3	Knowledge of different area of research in mathematical statistics.	K2,K3
CO -4	Ability to understand the different math concepts and be able to implement them in our everyday problems.	K3
CO -5	Efficient use of the techniques, skills and tools of modern mathematics.	K4

Unit-I	(15-Hours) Finite differences-forward and backward differences, operators E and Δ, and their basic properties, Interpolation with equal intervals: Newton's forward and backward differences- simple problems.
Unit-II	(15-Hours) Interpolation with unequal intervals:Divided differences and their properties, Newton's divided differences formula and Lagrange's formula for interpolation-simple problems.
Unit-III	(15-Hours) Central difference interpolation formula-gauss forward and backward differences formulae-Stirling,Bessel's Everett's central difference formula.
Unit-IV	(15-Hours) Inverse interpolation-Lagrange's method-iteration of successive approximation method-simple problems. Numerical differentiation-Numerical differentiation upto second order only-simple problems.

Unit-V	(15-Hours)
	Numerical integration-Trapezoidal rule-simpsons 1/3rd and 3/8th rules-Weddle's rule-Euler's summation formula. Numerical method of solution of ordinary differential equations-Taylor's series method-Euler method and Runga Kutta upto second order – simple problems.

Text Books for Reference:

1. Calculus of finite differences and Numerical analysis by Gupta-Malik, Krishna Prakastan Mandir, Meerut.
2. Numerical methods in Science and Engineering by M.K. Venkataraman, National publishing house, Chennai.
3. Numerical Analysis by B.D. Gupta, Konark publishing.
4. Calculus of finite differences and Numerical Analysis by Saxena,S. Chand & Co.
5. Numerical mathematics by M.M.Ramasamy and Palaniappan.

E-LEARNING RESOURCES

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

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credits
IV	A4PSTEL4C	DEC4- Advanced Numerical Analysis							5	4
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	3	3	1	1	3	2	3	2	1	2.1
CO-2	2	3	3	2	3	3	3	2	3	2	2.6
CO-3	2	3	3	2	3	3	3	2	3	2	2.6
CO-4	3	1	1	3	3	1	2	1	3	3	2.1
CO-5	3	1	1	3	3	1	2	1	3	3	2.1
Mean Overall Score											2.3 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**5**	**4**	**English**	**III**	**A4PSTEL4D**
DEC5	**COMPUTER PROGRAMMING WITH C++**				

Course Objectives:

1. Write clear, elementary C++ programs.
2. Understand algorithmic thinking and apply it to programming.
3. Understand problem-solving techniques.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand and trace the execution of programs written in C ++ language.	K1
CO -2	Arm the students with the basic programming concepts.	K2
CO -3	Introduce different techniques pertaining problem solving skills	K2
CO -4	Arm the students with the necessary constructs of C++ programming.	K3
CO -5	To emphasis on guided practical sessions	K4

Unit-I	(15-Hours) Principles of Object – Oriented Programming – Software Evolution Procedure and Object Oriented Paradigm – Basic concepts of Object – Oriented Programming – Benefits of OOP – Object Oriented Languages – Application of OOP - Beginning with C++ - What is C++?. - Application of C++ - C++ statements – Structure of C++ Program – Tokens , Expressions and Control Structures – Tokens – Identifiers – Basic and User – Defined Data Types – Operators in C++ - Operator Overloading – Operator precedence – Control Structures.
Unit-II	(15-Hours) Functions in C++:- The Main Function – Function Prototyping – Call by Reference – Return by Reference – Inline functions – Function Overloading – Friend and Virtual Functions – Classes and Objects – Introduction – Specifying a Class – Defining Member function – Nesting of Member Function – Private member Functions – Arrays within a Class – Static Data Members- Static Member Function – Array of Objects – Objects as Function Arguments, Friendly Functions – Pointers to Members.
Unit-III	(15-Hours) Constructors and Destructors:– Constructors – Copy Constructor Dynamic Constructor- Constructing Two – Dimensional Arrays – Destructors – Operators Overloading –Type Conversions.

Unit-IV	(15-Hours) Inheritance, Extending Classes:- Defining Derived classes - Single, Multilevel, Multiple, Hierarchical and Hybrid inheritance - Virtual Base Classes - Abstract Classes-Pointers, Virtual Functions and Polymorphism - Pointers to Derived Classes - Virtual Functions.
Unit-V	(15-Hours) Managing Console I/O Operations:-C++ streams - C++ stream Classes - Unformatted I/O Operations - Formatted Console I/O Operations - Managing output with Manipulators- Working with Files:- Classes for File Stream Operations- Opening and Closing a File - File Pointers and their manipulators - sequential I/O Operations. Simple Statistical Problems.

Text Books and Reference

E.Balagurusamy (1998) : Object Oriented Programming with C++. Tata McGraw Hill Publishing Company Limited.

K.R.Venugopal, Rajkumar, T.Ravi shankar (1998): Mastering C++, Tai.

E-LEARNING RESOURCES

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

https://freecomputerbooks.com/Mastering-Cpp-By-Venugopal.html

https://ashking24.files.wordpress.com/2017/08/e_balagurusamy-object_oriented_programming_with_c.pdf

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	A4PSTEL4D	DEC5 - Computer Programming with C++	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	2	2	3	2	3	3	2	2	2	2	2.3
CO-2	1	3	2	2	2	2	2	2	1	3	2.0
CO-3	2	2	2	2	2	2	2	2	3	3	2.2
CO-4	2	2	2	3	2	2	3	2	3	2	2.3
CO-5	3	2	2	2	2	2	2	3	2	2	2.2
Mean Overall Score											2.2 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**5**	**4**	**English**	**III**	**A4PSTEL4E**
DEC5	**DETERMINISTIC INVENTORY MODELS**				

Course Objectives:

1. To ensure a continuous supply of materials and stock so that production should not suffer at time of customers demand.
2. To avoid both over stocking and under – stocking of inventories.

Course Outcomes:

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand the methods used by organisation to obtain the right quantities of stock or inventory.	K1
CO -2	The stochastic models possess some inherent randomness.	K1,K2
CO -3	The output of the model is fully determined by the parameter values and initial conditions.	K2,K3
CO -4	The same set of parameter values and initial conditions will lead to an ensemble of different outputs.	K3
CO -5	Case study requires student's comprehension of inventory management and emphasizes supply chain management applications.	K4

Unit-I	(15-Hours) Inventory models – definition – general inventory model – Role of demand in the development of Inventory models.
Unit-II	(15-Hours) Static economic order quantity –EOQ problems – with one price breaks – simple problems.
Unit-III	(15-Hours) Multi items deterministic problems - limitations of inventories – limitations of storage area.
Unit-IV	(15-Hours) Dynamic EOQ models – set of EOQ model – General dynamic programming algorithm –Programming algorithm with constant or decreasing marginal cost – silver meal heuristic.
Unit-V	(15-Hours) Purchase Inventory model with n price break multi item deterministic model – No set of EOQ model.

Text Book and Reference

Hamdy A.Taha Operations Research An Introduction, Pearson(9th Edition)

E-LEARNING RESOURCES

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

https://books-library.net/files/books-library.online-01251340Yz1V8.pdf

https://link.springer.com/chapter/10.1007/978-3-319-07863-2_55

Question Paper Pattern

Maximum Marks:75Exam duration: Three Hours

Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)

Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)

Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	A4PSTEL4E	DEC5-Deterministic Inventory Models	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	2	2	3	3	3	2	2	2	2.4
CO-3	2	2	2	2	3	2	3	3	3	2	2.4
CO-4	3	2	2	3	3	1	3	2	3	3	2.5
CO-5	3	1	1	3	2	1	2	1	3	3	2.0
Mean Overall Score											2.3 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**5**	**4**	**English**	**III**	**A4PSTEL4F**
DEC5	**Statistical Analysis Based on R - Language**				

Course Objectives:

The main objectives of this course are to:

1. Know the concept and types of Data Analytics
2. Understand R features
3. Know the Data Summarization & Visualization

Course Outcomes

At the end of the course the Students will be able to		**Cognitive Level**
CO -1	Understand basics of R environment.	K1,K2
CO -2	Able to work with R packages and their installation	K2,K3
CO -3	Demonstrate exploratory data analysis (EDA) for a given data set.	K3,K4
CO -4	Implement and assess relevance and effectiveness of machine learning algorithms for a given dataset.	K3,K4,K5
CO -5	To provide the programming skills using job oriented concept in R program.	K4,K5

Unit-I (6 Hours)

Data Handling: Data Collection, Entry and Classification on the aspect of Raw, Discrete and Continuous data - Univariate, Bivariate and Multivariate frequency distributions.

Unit-II (6 Hours)

Diagrammatic representation: Plotting an appropriate graph for the given data viz. pie chart, Histograms (equal class intervals and unequal class intervals), Box and Whisker plot, stem and leaf plot, frequency polygon, Ogives with graphical summaries of data.

Unit-III (6 Hours)

Analysis: Descriptive Statistics - measures of central tendency and measures of dispersions

Unit-IV (6 Hours)

Comparison Measures- correlation and lines of regression.

Unit-V (6 Hours)

Statistical Inference: Hypothesis testing and computation of p-values.

Books for Study

1. Sudha G. Purohit, Sharad D. Gore, Shailaja R. Deshmukh, *Statistics Using R*, Narosa, Publishing House Pvt. Ltd., 2nd Ed., Reprint 2019.
   Unit –I*Chapter 1 (Sec: 1.4 – 1.8)*, **Unit – II***Chapter 2 (Sec : 2.1 – 2.3)*
   Unit – III*Chapter 2 (Sec: 2.4 – 2.6 ;* **Unit – IV.***Chapter 5 Sec : 5.1 – 5.6)*
   Unit – V*Chapter 4 (Sec: 4.1 - 4.6)*

Books for Reference

1. John Maindonald and John Braun, *Data Analysis and Graphics Using R.* Cambridge University Press, Cambridge, 2010.
2. Brian Everitt and TorstenHothorn, *A Handbook of Statistical Analyses Using R.* Chapman & Hall/CRC, Boca Raton, FL, 2009.
3. Moore, D.S. and McCabe, G.P. and Craig, B.A, *Introduction to the Practice of Statistics*, W.H. Freeman, 2014.

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

1. https://en.wikipedia.org/wiki/Data_analysis
2. https://www.tutorialspoint.com/r/r_overview.htm
3. https://en.wikipedia.org/wiki/Case_study

Question Paper Pattern

Maximum Marks:75 Exam duration: Three Hours
Part A 10 x 2 = 20 Answer **All** Questions (Two questions from each unit)
Part B 5 x 5 = 25 Answer **All** Questions (Either or type-Two questions from each unit)
Part C 3 x10 = 30 Answer Any **Three** Questions (One question from each unit)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course					Hours				Credits
IV	A4PSTEL4F	DEC5 Statistical Analysis based on R – Language					5				4
Course Outcome (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scoresof Cos
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	3	1	2	3	1	3	3	2	3	1	2.2
CO-2	2	3	3	2	1	3	3	3	2	1	2.3
CO-3	3	2	2	2	1	3	3	3	3	2	2.4
CO-4	3	2	2	3	1	3	3	3	3	2	2.6
CO-5	2	3	3	2	2	3	3	3	3	2	2.5
Mean Overall Score											2.4 (High)

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Semester	**Hours / Week**	**Credit**	**Medium of Instruction**	**Part**	**Sub. Code**
IV	**2**	**2**	**English**	**IV**	
SS2	**BIO STATISTICS**				

Unit-I	(6-Hours) Introduction – Basic concepts – Measurement and Measurement scales- The ordered array- Types of data - Grouped data – Frequency distribution
Unit-II	(6-Hours) Measures of central tendency in biological applications– Mean, Median and Mode. Geometric mean and Harmonic mean - Merits and demerits.
Unit-III	(6-Hours) Measures of Dispersion in biological applications – Range, Quartile deviation, Mean deviation, Standard Deviation, Coefficient of Variation.
Unit-IV	(6-Hours) Correlation Analysis – Definition and types of Correlation properties (Statement and proof), Methods – Scatter diagram, Karl Pearson's Coefficient of Correlation and Spearman's Rank Correlation Coefficient.
Unit-V	(6-Hours) Testing of hypothesis – Definitions – Chi-Square test – Goodness of fit – Student's t test (test for means only) - F test – test procedures only.

Text Book and Reference

1. Biostatistics- Ninth edition –Wayne W. Daniel, John Wiley –Publication.

2. Principles and Practice of Biostatistics - E-book Kindle Edition

   by B Antonisamy , Prasanna S. Premkumar ,and Solomon Christopher .

3. Research Methodology and Biostatistics - E-book: A Comprehensive Guide for Health Care Professionals Kindle Edition. by Sharma Suresh (Author) Format: Kindle Edition.

4. Basic Biostatistics and Research Methodology for Medicos: Special book for Exams & Journal Clubs (Community Medicine in Brief) Kindle Edition. by Ankit Chandra.

Question Paper Pattern

Note: Question Patterns based on theory part only.

Maximum Marks:75 Exam duration: Three Hours

5 x15 = 75 Marks Answer Any FIVE Questions out of EIGHT Questions.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code		Title of the Course					Hours	Credits
IV			SS2 - BIO STATISTICS					2	2
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Scores of COs
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	
CO-1	1	3	3	1	2	3	2	3	2	1	2.1
CO-2	2	3	2	2	3	3	3	2	2	2	2.4
CO-3	2	2	2	2	3	2	3	3	3	2	2.4
CO-4	3	2	2	3	3	1	3	2	3	3	2.5
CO-5	3	1	1	3	2	1	2	1	3	3	2.0
Mean Overall Score											2.3 (High)

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Extra

Credit Courses

BIOSTATISTICS AND SURVIVAL ANALYSIS

Course Objectives

The main objectives of this course are to:

1. Initiate the awareness of Biostatistics and its need.
2. Make the students have a clear understanding of special kinds of various statistical Tools used in biostatistics.
3. Be knowledgeable about the potential applications of these tools.

Course Outcomes

On the successful completion of the course, student will be able to:

1 Understand the concepts and statistical tools used in Biostatistics.

2 Effectively apply these tools on solving the biological problems occurring in real life.

3 Analyze the given bio-statistical data as per the objectives of the problem.

4 Interpret the outcomes of the analyses meaningfully.

5 Create research problems of his own and able to proceed with them.

Unit:1 Clinical Trials

Introduction to Biostatistics – Various types of studies - Ethics - Measures of disease frequency and disease burden. Clinical Trials - Goals of Clinical Trials - Phases of Clinical Trials.

Unit:2 Classification of Clinical Trials - Randomization: Fixed Allocation, Simple, Blocked, Stratified, Baseline Adaptive and Response Adaptive - Blinding: Single, Double and Triple - Designs for Clinical Trials: Parallel Groups Design, Cluster Randomization Designs, Crossover Designs.

Unit:3 Logistic Regression

Logistic regression: Introduction – Logistic regression model – relative risk – logit – odds ratio – properties of odds ratio – the relationship between the odds ratio and relative risk – Maximum Likelihood estimates and interpretation of coefficients – Test for coefficients - Test of overall regression and goodness of fit using Maximum Likelihood technique – Deviance statistics, Wald test, LR test and score test.

Unit:4 Survival Analysis

Introduction to Survival analysis - terminology and functions of survival analysis - goals -Basic data layout - Censoring-different types of censoring - Parametric survival models based on basic life time distributions - Exponential, Weibull, Gamma, Gompertz-Makeham, log-logistic and log-normal distributions - General method for incorporating covariates in parametric models.

Unit:5 Survival Models

Kaplan-Meier's method - general features and assumptions - Log rank test for two groups, several groups - alternatives to log rank test: Wilcoxon, Tarone-Ware, Peto-Prentice and Fleming- Harrington tests - Cox PH model and its features - ML estimation of the Cox PH model-Hazard Ratio - Adjusted survival curves-Cox likelihood.

Books for Study

1 Chow, S. C., and Liu, J. P. (2004). Design and Analysis of Clinical Trials: Concepts and
Methodologies, Second Edition, Wiley – Interscience, John Wiley & Sons, NJ.
2 Friedman, l. M., Furberg, C. D., and DeMets, D. L. (2010), Fundamentals of Clinical Trials,Fourth edition, Springer – Verlag, NY.
3 Van Belle, G., Fisher, L. D., Heagerty, P. J., and Lumley, T. (2004). Bio-Statistics - A Methodology for the Health Science, Second Edition, Wiley, NY.
4 Daniel, W. W. and Chad L. Cross(2018). Bio-Statistics: A foundation for analysis in theHealth Sciences, Eleventh Edition, John Wiley & Sons, NY.
5 Kleinbaum, D. G., and Klein, M. (2012): Logistic regression: A Self-Learning Text, ThirdEdition, Springer – Verlag, NY.
6 Kleinbaum, D. G., and Klein, M. (2012): Survival Analysis: A Self-Learning Text, ThirdEdition, Springer – Verlag, NY.

Reference Books

1 Hosmer, Jr. D. W., Lemeshow, S., and Sturdivant, R. X. (2013). Applied Logistic Regression, Third Edition, John Wiley & Sons, Inc., NY.
2 Lee, E. T., and Wang, J. W. (2013). Statistical Methods for Survival Data Analysis, FourthEdition, Wiley, NY.
3 Rossi, R. J. (2010). Applied Biostatistics for Health Sciences, John Wiley & Sons, Inc.
4 Klein, J. P. and Moeschberger, M. L. (2003). Survival Analysis: Techniques for Censored and Truncated Data, Second Edition, Springer – Verlag, NY.

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

1. Prof.Shamik Sen, Department of Bioscience and Bioengineering, IIT Bombay, "Introduction to Biostatistics", NPTEL.
[https://swayam.gov.in/nd1_noc20_bt28/preview]
2. Dr.Felix Bast, Central University of Punjab, Bathinda, 2020, "Biostatistics and Mathematical Biology", (NPTEL).
[https://swayam.gov.in/nd2_cec20_ma05/preview]
3. www.healthknowledge.org.uk

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MACHINE LEARNING USING PYTHON

Course Objectives:

The main objectives of this course are to:

1. Comfortably perform basics operations in Python
2. Understand machine learning concepts
3. Explore and execute the machine learning concepts for real time data using Python

Course Outcomes:

On the successful completion of the course, student will be able to:

1 Perform basic operations and concepts in Python
2 Understand and use the essential modules in Python
3 Evaluate the scope and opportunities of machine learning
4 Gain knowledge and hands-on training in machine learning techniques
5 explore program skills for machine learning techniques

Unit: 1 Basics of Python

Type of variables, data types, lists, control statements, functions, classes, files and exceptions.

Unit:2 Essential Modules in Python

Jupyter Notebook, Numpy, Scipy, Matplotlib, Pandas, mglearn

Unit:3 Supervised Learning

Classification and Regression, k-Nearest Neighbors,k-Nearest Neighbors, Decision Trees,Neural Networks

Unit:4 Unsupervised Learning -1

Preprocessing and Scaling, Scaling training, Dimensionality Reduction, Feature Extraction, and Manifold Learning

Unit:5 Unsupervised Learning -2

Clustering: k- Means clustering, Agglomerative Clustering, DBSCAN

Text Book(s)

1 Introduction to Machine Learning with Python – A Guide for Data Scientists by Andreas C.Muller & Sarah Guido(2017), O'Reilly
2 Machine Learning in Python : Essential Techniques for Predictive Analysis by Micheal Bowles (2015), Wiley
3 Python Crash Course : A hands-on, Project- Based Introduction to Programming by EricMatthes(2016), no starch press

Reference Books

1 Python for Probability, Statistics and Machine Learning (second edition) (2019) by Jose Unpingco, Springer
2 Practical Statistics for Data Scientists(second edition)(2020) by Peter Bruce, Andrew Bruce& Peter Gedeck, O'Reilly

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

1 https://swayam.gov.in/nd1_noc20_cs29/preview
2 https://swayam.gov.in/nd1_noc19_cs59/preview
3 https://nptel.ac.in/courses/106/106/106106202/

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Statistical Software using SPSS and MINITAB

Course Objectives

The main objectives of this course are to:

1. Provide intensive training in statistical computation using software
2. Impart knowledge in handling statistical data for analysis
3. In still the students to familiarize with the application of statistical tools

Course Outcomes

On the successful completion of the course, student will be able to:

1 Use the software for various applications
2 Draw statistical graphs, charts and diagrams
3 Compute statistical measures using software
4 Perform statistical data analysis

Unit: 1 Descriptive Statistics and Generating Random Samples

Classification, diagrams, graphical representation of data and descriptive statistical measures. Calculation of probabilities under various distributions and generating random samples from probability distributions

Unit: 2 Regression Analysis, Interval Estimation and Parametric

Correlation and regression: Simple, partial and multiple correlation coefficients, simple linear and multiple regression, curve fitting, time series and forecasting models. Confidence intervals for mean, variance and proportions, tests of significance based on normal, t, chi-square, F and Z statistics.

Unit: 3 Non-parametric Tests and Design of Experiments

Run, sign and median tests, test based on Kruskal – Wallis statistics, Freedman's test. One way ANOVA-two way ANOVA-factorial designs– Multiple comparison tests

Unit: 4 Multivariate Analysis and Statistical Quality Control

Principal component analysis, factor analysis, cluster analysis and discriminant analysis. Statistical quality control charts

Unit: 5

Determination of parameters for constructing basic control charts, suchas $\bar{X}$, R, S, p and c charts.

Reference Books

1 Landau, S., and Everitt, B.S. (2004). A Handbook of Statistical Analyses using SPSS, Chapman & Hall/CRC Press, New York

2 Almquist, Y. B., Ashir, S., and Brännström, L. A Guide to SPSS: The Basics, Version 1.0.1,Stockholm University, Sweden.

3 Evans, M. (2009). MINITAB Manual, W.H. Freeman and Company. New York.

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

1.https://nptel.ac.in/courses/110/107/110107113/

2. https://nptel.ac.in/courses/110/105/110105060/

3.https://nptel.ac.in/courses/111/104/111104098/

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STATISTICAL METHODS FOR BIOLOGISTS

Course Objectives

The main objectives of this course are to:

1. Introduce the basics of biostatistics
2. Instil knowledge to compute statistical measures for analysing data
3. Instruct the applications of statistical methods for biological problems

Course Outcomes

On the successful completion of the course, student will be able to:

1 Understand the theory and applications of basic statistics
2 Compute statistical measures for decision making
3 Formulate hypotheses and perform statistical analysis for biological problems
4 Perform analysis of variance for experimental designs
5 Make interpretations of results from the derived results

Unit:1 Statistical Data, Classification and Tabulation

Nature of Biological and Clinical experiments of data-Classification and tabulation of data- Diagrammatic representation of data- Histogram and frequency curves

Unit:2 Basic Measures of Statistics

Measures of Central tendency-Mean, Median, Mode, Geometric mean, Harmonic Mean- Measures of deviation – Range, Mean deviation, Quartile and standard deviation – Measures of Skewness and Kurtosis.

Unit:3 Correlation and Regression

Correlation: Rank Correlation – Multiple and Partial Correlation – Regression – Regression equations for biological problems.

Unit:4 Basic Sampling Methods

Basic concepts of sampling – Simple random sample – Stratified sample – systematic sample –cluster sample. Test of significance based on large sample – Mean, Variance and Proportions.

Unit:5 Analysis of Variance and Basic Experimental Designs

Analysis of variance –One way and Two way classifications - Completely Randomized blocks –Randomized Block design and Latin Square Design (Simple problems based on biological data)

Books for Study

1 Lewis, A. E. (1984). Biostatistics, Van Nostrand Reinhold Publications.
2 Campbell, R. C. (1967): Statistics for Biologists, University Press, Cambridge, UK.
3 Kapur, J. N., and Saxena, H. C. (1986). Mathematical Statistics, S. Chand & Co., Ltd., New Delhi.

Reference Books

1 Pagano, M., and Gauvrean, K. (2018). Principles of Biostatistics, Second Edition, Chapman and Hall/CRC Press, NY.

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

1 https://nptel.ac.in/courses/102/106/102106051/
2 https://nptel.ac.in/courses/102/101/102101056/

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PSYCHOLOGICAL STATISTICS

Course Objectives:

The main objectives of this course are to:

1. Know the application of scaling procedures
2. Understand reliability and validity tests
3. Know the different types of correlation

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Understand scaling procedures and different scores
2. Know the reliability of test scores and methods for determining test reliability
3. Estimate validity and intelligence quotient
4. Know the Biserial correlation
5. Know the partial and multiple correlation

Unit:1 Scaling Procedures

Introduction-scaling procedures- Z or σ scores-standard scores-Normalized scores-T-scores- Percentile score-Scaling of rankings in terms of Normal Probability curve-scaling of ratings in terms of Normal Probability curve

Unit:2 Reliability

Reliability of test scores- definition of reliability- index of reliability- Parallel tests-Methods for determining test reliability- the test-retest method- Alternate or parallel forms method- split half method - effect of test length on the reliability of the test-effect of different ranges on the reliability of the test

Unit:3 Estimation of validity

Estimation of validity- types of validity- validity and test length- comparison between reliability and validity- Intelligence tests- Mental age- Intelligence quotient

Unit:4 Biserial Correlation

Biserial correlation- correlation from fourfold tables- the contingency coefficient-curvilinear relationship.

Unit:5 Partial and multiple correlation

Correlation ration- intra-class correlation- partial and multiple correlation- definition - formula for three variables- limitations- simple problems

Text Book

1. Gupta, S.C., and Kappor, V. K. (2019). Fundamentals of Applied Statistics, Fourth Edition, Sultan Chand & Sons (Publisher), New Delhi, India
2. Gupta, S.C., and Kappor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons (Publisher), New Delhi, India

Reference Books

1. Garett, H, E.(2005). Statistics in Psychology and Education, Paragon Int. Publishers.

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

1. https://t4tutorials.com/z-score-normalization-Data-mining
2. https://www.yourarticlelibrary.com/statistics-2/determining-reliability-of-a-test-4-methods/92574
3. https://www.real-statistics.com/correlation/biserial-correlation

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ACTUARIAL STATISTICS

Course Objectives:

The main objectives of this course are to:

1. know the different acts of insurance
2. understand National income and five year plans
3. know the life table and mortality

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Understand general insurance and business environment
2. Know the National income and five year plans
3. Understand political environment, income and savings, health and education
4. Know the concept and construction of life table
5. Know the mortality

Unit:1 Insurance

Insurance Business Environment – Regularity Environment – Insurance act 1938- Insurance regularity and development authority act 1999, LIC of India act 1956, and General Insurance Business act 1972– Legal Environment – Motor vehicles act 1939 - The public liability insurance act 1991- The Indian steam vessels act 1917- Marine Insurance act 1963

Unit:2 National income and five year plans

The Economic environment – National income – 5 year plans, Recession Fiscal policy – Value Added Tax (VAT), Information Technology, Telecommunication Technology, World Economic forum – Agricultural sector – Natural resources.

Unit:3 Political Environment

Political Environment, Pollution-age profile, Income and savings, education, health, Employment spending and saving patterns, Readership, ethos and culture

Unit 4 Life table

Life table – Features – source of information – construction, interpretation, human mortality, Life table function, Non-integer ages uniform distribution of deaths.

Unit:5 Mortality

Constant force of mortality, Mortality, characteristics, shape of qx, lx, and dx. Evaluation of means and variance with and without life table.

Text Book

1. IC-12 Insurance Business Environment, By S.Balachandran Insurance Institute of India
2. CT-5 General Insurance, Life and health contingencies, Institute of Actuaries of India.

Reference Books

1. Jarvis, R. A. (2016), Finding Life at the Table, XLIBRIS
2. Hitchens, . (2014). Mortality, Twelve (Hacbette Book Group), US.

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

1. https://www.cengage.co.in/category/higher-education/business-economics/finance/insurance/insurance-business-environment-and-insurance-company-operations-8o
2. https://en.wikipedia.org/wiki/National_fiscal_policy_response_to_the_Great_Recession
3. https://infinityisreallybig.com/2019/04/09/constant-force-of-mortality-exponential-distribution

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GENITCAL STATISTICS

Course Objectives:

The main objectives of this course are to:

1. know the Elements of Genetics
2. understand Mandel's Law of inheritance and Use of $\chi 2$ (chi-square) tests in testing the Mendel's segregation law
3. know the Method of maximum likelihood and other methods of estimation

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Understand the Elements of Genetics
2. Know the Mandel's Law of inheritance
3. Understand Concept of gene frequency and concept of random mating detection
4. Understand method of maximum likelihood estimation
5. Understand Multiple allelic systems

Unit:1 Elements of Genetics

Elements of Genetics: Physical basis of heredity-cell structure chromosomes and genes – Interaction of genes concept of genotypes and phenotypes –Linkage and crossing over-Genetic maps.

Unit:2 Mandel's Law of inheritance

Mandel's Law of inheritance –Laws of segregation and independent assortment – concept over generation.

Unit:3: Use of $\chi 2$ (chi-square) tests in testing the Mendel's segregation law-Sex linked genes –Concept of gene frequency –concept of random mating detection and estimation of linkage from back cross, F2,& F3 Data

Unit:4 Method of maximum likelihood and other methods of estimation- Planning of experiments.

Unit:5 Multiple allelic systems-Elementary aspects of the study of human blood group.

Text Book

1. Sinott, E. (1958). Principles of Genetics, 5th Edition, McGraw Hill.
2.Mather, K. (1963). Measurement of Linkage in Heredity, John Wiley & Sons, New York, US.

Reference Books

1. Kempthorne, O. (1957). An Introduction to Genetic Statistics, John Wiley & Sons, New York,
2. Mackay, T. F. C., and Falconer, D. S. (1995). Introduction to Quantitative Genetics, Longman (Publisher)

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

1. https://en.wikipedia.org/wiki/Mobile_genetic_elements

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QUANTITATIVE TECHNIQUES FOR MANAGERIAL DECISIONS

Course Objectives:

The main objectives of this course are to:

1. know the Basic principles of accountancy
2. understand Tools of financial analysis
3. know the Analysis of operating and financial leverages

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Understand the Basic principles of accountancy
2. Know the Tools of financial analysis
3. Understand Analysis of operating and financial leverages
4. Know the Approaches to financial forecasting
5, Understand the project analysis

Unit:1

Basic principles of accountancy and analysis of balance sheets

Unit:2

Tools of financial analysis-Flow of funds, analysis-Cost, Volume, Profit analysis

Unit:3

Analysis of operating and financial leverages.

Unit:4

Approaches to financial forecasting.

Unit:5

Project analysis.

Text Books

B.L.Agarwal, **Quantitative Techniques,** New age international limited.

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FUNDAMENTALS OF HUMAN RIGHTS

Course Outcomes

On completion of this course, the graduates will be able to:

1. Identify the importance and the values of human rights
2. understand the historical background and the development of Human Rights and the related organizations
3. Apply the provisions of National and International human rights to themselves and the society
4. Analyses the violations of human rights to the marginalized section in the society
5. animate the people to involve in the struggles and activities of the human rights organizations

Unit-I Human Rights - An Introduction

Introduction - Classification of Human Rights- Scope of Human Rights- Characteristics of Human Rights-NHRC-SHRC- Challenges for Human Rights in the 21stCentury.

Unit-II Historical Development of Human Rights

Human Rights in Pre-World War Era- Human Rights in Post-World War Era- Evolution of International Human Rights Law - the General Assembly Proclamation- Institution Building, Implementation and the Post- Cold War Period. The ICC.

Unit-III India and Human Rights

Introduction-Classification of Fundamental Rights-Salient Features of Fundamental Rights- and Fundamental Duties.

Unit-IV Human Rights of Women and Children

Women's Human Rights- Issues related to women's rights - and Rights of Women's and Children

Unit-V Human Rights Violations and Organizations

Human Rights Violations - Human Rights Violations in India - the Human Rights Watch Report, January 2012- Human Rights Organizations.

Books for Study:

1. Venkatachalem. Dr.*The Constitution of India,Salem:Giri Law House,* 2005.

2.NaikVarunand Mukesh Shany. *Human rights education and training,* New Delhi:crescent Publishing Corporation, 2011.

3.BhathokeNeera. *Human Rights content and extent,*New Delhi: swastika publications, 2011.

Web Sources:

https://www.un.org/en/universal-declaration-human-rights/. Accessed 05 Mar. 2021.

https://www.ilo.org/global/lang--en/index.htm. Accessed 05 Mar. 2021.

https://www.amnesty.org/en/. Accessed 05 Mar. 2021.

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QUANTITATIVE METHODS

Course Outcomes

On completion of this course, the graduates will be able to:

1. Acquire the knowledge of replacement problems and its applications
2. Explain the decision analysis
3. Solve a problem using simulation techniques
4. Carry out the nonparametric test
5. Examine the importance of testing of significance.

Unit – I : Replacement of equipment that deteriorates gradually: Replacement policy when value of money does not change with time – Replacement policy when value of money changes with time. Replacement of equipment that fails suddenly: Individual and group replacement (Problems only).

Unit-II: Decision analysis: Concept and methods - Construction of pay – off and loss tables - EMV, EOL and EVPI - Decision Tree Analysis. (Problems only).

Unit – III : Simulation: Introduction – Simulation models – Generation of random numbers – Monte-Carlo simulation – Simulation of inventory problems – Simulation of queueing problems (Problems only).

Unit –IV : Test of Significance: t-test for single mean and two means, F-test for Equality of two chi –square variances --test for Association and Goodness of fit. (Problems only)

UNIT-V: Non-parametric tests: Run Test - Test for Randomness - Wald Wolfowitz Run Test - Mann Whitney U-test - Median Test (Problems only).

Books for Study

1.KantiSwarup, Gupta, P.K. and Man Mohan: *Operations Research*, Sultan Chand & Sons, New Delhi, 13th Edition, 2019. Unit-I Chapter 18 (Sec: 18.1-18.5) Unit-II Chapter 16(Sec: 16.1-16.7) Unit-III Chapter 23 (Sec: 23.1-23.9)

2. P.R.Vittal, *Mathematical Statistics*, Margham Publications, Chennai 2013. Unit-IV *Chapter 25 (Sec:25.1-25.31), Chapter 26 (Sec:26.1), Chapter 27 (Sec:27.1)*

3. O.P. Gupta & Vishal Sharma, *Mathematical Statistics*, Revised Edition, Mohan Print Media (P) Ltd., Meerut, 2019.**Unit-V** *Chapter 24 Sec: 24.4-24.9)*

Books for Reference

1. Taha, H.A., An Introduction to Operations Research, Colliat Macmillan.

2. Gupta S.P. &Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 12th Edition 2020.

3. Hillier, F.A and Lieberman, G.J., Introduction to Operations Research-Concepts and cases, 9th Edition, Tata McGraw Hill, 2010.

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